ABSTRACT OF CAPSTONE

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The Graduate School

Morehead State University

May 31, 2018

EFFECTS OF ONLINE MODULARIZED INSTRUCTION ON THE ENGAGEMENT LEVELS OF LOW-ACHIEVING HIGH SCHOOL SENIORS ENROLLED IN PRE-COLLEGE ALGEBRA

Abstract of Capstone

A capstone submitted in partial fulfillment of the
Requirements for the degree of Doctor of Education in the
College of Education
At Morehead State University

By

Donovan M. Hawkins

Cox's Creek, Kentucky

Committee Chair: Dr. Jeannie Justice, Assistant Professor

Morehead, Kentucky

May 31, 2018

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EFFECTS OF ONLINE MODULARIZED INSTRUCTION ON THE ENGAGEMENT LEVELS OF LOW-ACHIEVING HIGH SCHOOL SENIORS ENROLLED IN PRE-COLLEGE ALGEBRA

The purpose of this mixed-methods case study is to analyze the engagement levels of low-achieving high school seniors enrolled in a basic algebra course called Pre-College Algebra. The term *low-achieving* pertains to the class member participants enrolled in a course that is perceived and even described as the less rigorous of the choices of all fourth-year math courses. The course curriculum is indeed aligned with the most basic of algebra concepts - many of them aligning with sixth and seventh-grade concepts. However, students who enrolled in Pre-College Algebra experienced a change from teacher-centered pedagogies to student-centered heutagogy augmented by technology and influenced by developing a self-determined mindset towards learning. During a period of two academic semesters, students proceeded through an online modularized line of instruction activated through a subscription-based service that provides instruction aligned with a chosen textbook. Students took a pre- and post-survey and responded to items pertaining to engagement. The cross-survey results indicate changes in engagement of four types (known as engagement dimensions): behavioral, emotional/affective, cognitive, and social. To complement the survey results, students were asked five questions that were designed to elicit replies pertaining to their levels of satisfaction with the online modularized format. The replies to this questionnaire were analyzed in conjecture with noted observations of classroom occurrences. Student engagement was found to be influenced by the design and ensuing dynamics of an online modularized line of mathematics instruction. Statistically significant changes in engagement were found to be in the behavioral dimension.

KEYWORDS: Math engagement, online modularized instruction, self-determined learning, heutagogy, low-achieving seniors.

Candidate Signature

Date

EFFECTS OF ONLINE MODULARIZED INSTRUCTION ON THE
ENGAGEMENT LEVELS OF LOW-ACHIEVING
HIGH SCHOOL SENIORS ENROLLED IN PRE-COLLEGE ALGEBRA

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Name	Date

CAPSTONE

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DEDICATION

I want to dedicate this work to a true self-determined learner, teacher, mentor, friend, partner, and wife - my beloved Tammy. This work is the result of the way you continue to inspire me. I love you.

ACKNOWLEDGMENTS

I would first like to acknowledge my creator, who I refer to as Jesus Christ, God in the Flesh. Through Him all the things that I have accomplished were possible and will continue to be.

I want to thank my better half, Tammy. Thank you for believing in me and being there for me every step of the way. I cannot possibly name all the things you have done while I secluded myself in the basement working on this project. I can only say that after each time I studied, I would climb the stairs and enter a world made clean and beautiful by you. All of that and your unwavering support is the foundation for this project. I want to also thank you for bearing the children we share. You have been a profound influence on their lives and in turn you all have been a profound influence on mine.

Additional thanks go out to the all the professors I have had the privilege of working with at Morehead State University. What I have learned at this institution will forever be a part of my being. A special thanks to Dr. John Curry. He knows why I personally thank him and that is enough. A special thanks to my committee members as well - Dr. Edna Schack and Dr. Chris Schroeder. I appreciate the attention to detail each of you showed towards my work. Without your guidance, I would not have been able to finalize this project. An extra-special thanks to my committee chair, advisor, mentor, and friend, Dr. Jeannie Justice. That was quite a journey you led me through. May it continue, even if in some small way.

Finally, I want to thank the students, parents, supporting faculty and staff, and administration from Spencer County High School. Among the people at SCHS I especially want to thank the study participants and their parents, colleagues Jonathan Wilkins and Andrew Coleman, and Principal Curt Haun. Thank you all for putting up with my “outside the box” teaching methods. I can only hope that together we have served the children well.

TABLE OF CONTENTS

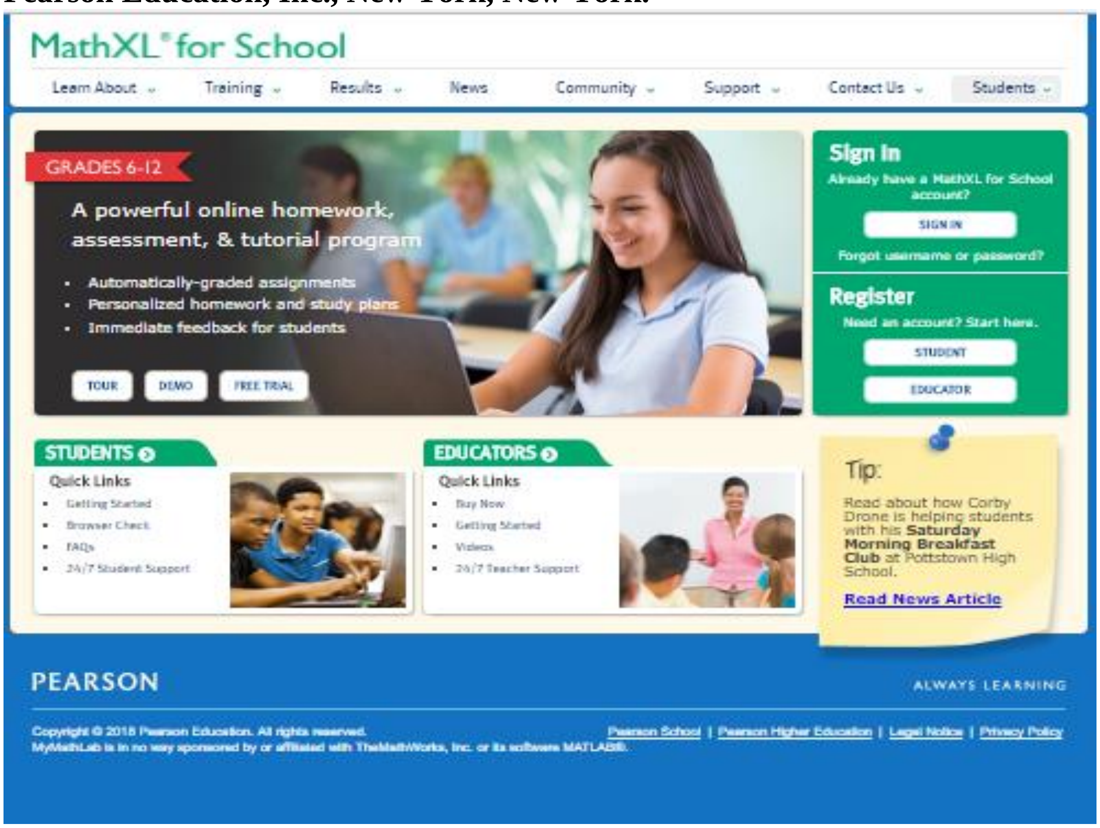
CHAPTER 1

INTRODUCTION

This study investigates engagement levels of high school seniors who receive mathematics instruction from online learning modules. The focus of this study is on a specific subgroup of seniors – those who have been deemed low achieving in mathematics throughout their previous three years of high school. These students were presented with a typical high school algebra curriculum in a way that is atypical, particularly for a rural Kentucky high school. This new way of learning is nothing new to academia, however. Institutions of learning have been using technology-enhanced learning modules for decades (Peterson-Karlan, 2015). What is worthy of examination is the impact a non-traditional, modularized approach to learning math has on students who have previously conformed to learning routines and procedures devised and implemented by their previous teachers. The aim is to examine a potential variety of ways student engagement might change, either positively or negatively, when student participants receive instruction almost entirely from a subscription-based online learning platform called MathXL® for School (Pearson, 2017). This line of instruction is one that ideally encourages students to take ownership of their learning. Not as a *sink-or-swim* approach per se, but as an opportunity to engage in a type of learning what various researchers in academia refer to as self-determined learning, or *heutagogy* (Hase & Kenyon, 2007; Deci & Ryan, 2008; Blaschke, 2012; Cochrane, Antonczak, Keegan, & Narayan; 2014).

The implications that support heutagogical practices lie in the autonomy established for students. In addition to math instruction delivered from a modularized platform, daily classroom routines and procedures were developed for accessing the online learning modules. As students entered the classroom, they procured a laptop computer and used it to access the learning modules from MathXL® (see Figure 1.1). The computers were “checked out” from a mobile cart that stores and charges the set of laptops, and the routine of accessing the online modules and learning mathematics followed.

Figure 1.1. MathXL® for School Homepage. ***PEARSON, 6-YEAR MATHXL FOR SCHOOL VIA EASYBRIDGE DIGITAL COURSEWARE LICENSE GRADE8-12, 0, ©2011.*** **Reprinted by permission of Pearson Education, Inc., New York, New York.**



It was anticipated that some of the students would forego the checkout procedures and bring their own laptops and some would use their smartphones. This adds information to the study that considers a generalized learning model that also fosters heutagogy - the *Bring Your Own Device* (BYOD) model (Cochrane et al., 2014). While it is perhaps arguable that the model followed in this study is not an exclusive BYOD model, the affiliated literature reviewed for this study places no emphasis on the way students procure the devices used for classroom activities and instruction. An emerging misconception is that students are held to bringing their own devices to the classroom even as some students do not have a device to bring. Thus, there is a slight misuse of the phrase *bring your own.* Participants for this study are not required to bring their own device to class with them daily. They are only required to have access to a device. This does not remove any connection to the BYOD model as researched. All literature associated with the ensuing classroom dynamics has been examined and found to be pertinent to this study. Moreover, while the use of personal computerized devices is important for this study, the focus was on student-centered learning through technology rather than on the type of device the students were using (Stork, Rose, & Wang, 2015). Likewise, several studies have been conducted over the years regarding the use of the Internet to access course content in the classroom (Winters, Greene, & Costich, 2008; Flumerfelt & Green, 2013; Cochrane et al., 2014; Grant, Tamim, Brown, Sweeney, Ferguson, & Jones, 2015). There have also been studies regarding student disengagement from math instruction (Skemp, 1987; Wahlberg, 1997; Frenzel, Pekrun, Dicke, & Goetz, 2012; Jameson, 2013; Rice, Barth, Guadagno, Smith, & Mccallum, 2013;). These studies were used in conglomeration to examine classroom dynamics that might influence engagement or disengagement in math instruction delivered through an online modularized format.

This study specifically examines the effects online modularize instruction (OMI) has on engagement levels of *low-achieving* high school seniors. The purpose is to examine the use of MathXL® as a potential remedy for the familiar disengagement of low-achieving math students from math instruction as it is widely understood to be (Mitchell, 1995; Wahlberg, 1997). The interactions with the students and the teacher created a new classroom dynamic for most, if not all of the student participants - one that responds to the recurring use of technology by the students. The researcher implemented the use of modules accessed from laptop computers as the primary source of instruction, thereby digressing from more traditional teaching and learning practices that have been deemed ineffective for the low-achieving student (Flumerfelt& Green, 2013). Students were no longer expected to participate in ordinary practices such as watching the teacher do math problems on a whiteboard and then mimicking this behavior while taking notes. Instead, they used their assigned tablets to access various instructional materials posted from MathXL®. Subsequently, students proceed through the course in a way that is tailored to their personal approach to learning (see Figure 1.2).

Figure 1.2. **MathXL® For School Product Overview.** ***PEARSON, 6-YEAR MATHXL FOR SCHOOL VIA EASYBRIDGE DIGITAL COURSEWARE LICENSE GRADE8-12, 0, ©2011.*** **Reprinted by permission of Pearson Education, Inc., New York, New York.**


Product Overview

Transform learning and teaching with MathXL® for School

Learn more about MathXL for School at one of our free product webinars!

MathXL® for School is the essential online addition to any core curriculum that provides personalized instruction and practice for middle and high school students of all levels. Tied directly to more than 300 Pearson mathematics and statistics texts, teachers can easily create, edit, and assign homework and tests.

- Personalize learning
- Grade homework automatically
- Focus instruction
- Engage with interactive media

Students can:

- Work in personalized study plans that highlight strengths and weaknesses
- Get help from interactive study aids, stepped-out examples, video tutors, and animations
- Receive immediate feedback
- Reference pages from the textbook for additional support (where available)

Teachers can:

- Avoid piles of ungraded homework with auto-graded assignments
- Quickly create objectives-based quizzes and tests
- Assess individual and group performance using data-driven reports
- Deliver quality, effective instruction regardless of experience level

Administrators can:

- Ensure consistent instruction for all students
- Collect school or district-wide assessment data
- Improve student performance on Common Core State Standards (CCSS) and benchmarks
- Provide professional development through MathXL for School Teacher Refresher Courses

Research Question

In what ways are the engagement levels of low-achieving high school seniors affected by online modularized mathematics instruction?

Statement of the Problem

A persistent concern examined for this study is one that has been observed by the researcher for over a decade – low-achieving seniors simply tune-out when traditional math instruction is presented to them. They do not come to class prepared, are disruptive, and show no apparent interest in learning (Mitchell, 1995; Wahlberg, 1997). While this may seem to be a narrative supported by mere anecdotes, an actual descriptive term associated with the behavior of this particular age group of students is *senioritis*. Senioritis occurs when apathy towards school in general is displayed through unruly and uncooperative behavior (Mitchell, 1995). The abstract nature of math combined with lectures often perceived as boring may have attributed to negative views towards math and thereby attributed to symptoms of senioritis apparent in any fourth-year math class (Mitchell, 1995; Wahlberg, 1997). These factors contribute to an inability or an unwillingness to undertake the abstract subject of mathematics (Ryan, Moss, & Moss, 2015). Therefore, methods of instructional delivery that include lecture and little or no use of technology are becoming increasingly obsolete (Yildiz & Palak, 2016). Student participants of this study are seniors who have spent years going through the motions while not fully engaged in a lecture-oriented classroom.

Any changes in engagement as a result of changing from traditional methods of instructional delivery are worthy of examination. A listless attitude to direct instruction and the absence of self-determined learning from teacher-centered designs provides evidence that alternative methods of instructional delivery could have merit (Deci & Ryan, 2008; Humphrey & Hourcade, 2010; Blaschke, 2012). In a general sense, adolescent interest in math education has been in decline for decades, and there is a distinct population of students who demonstrate a lingering lack of interest in math and math instruction (Frenzel et al., 2012). This study examines a small subset of this population to determine if any significant changes in engagement in math instruction might be the result of the implementation of OMI.

Assumptions, Researcher Bias, and Limitations

It is an assumption that the students enrolled in Pre-College Algebra are, to varying extents, disengaged from traditional methods of math instruction. This is due to the reputation of Pre-College Algebra as being an easy course and foreknowledge that the curriculum contains less rigorous material than other fourth-year math courses at the site location. Thus, *low-achieving* pertains to the class members as a group based on Pre-College Algebra being a class of historically low-achievers. There were a few participants who were not as confident in their mathematical ability level but did not consider themselves low-achievers. The goal of this study from the standpoint of a practitioner is to examine the use of MathXL® as a possible remedy for the familiar disengagement from math instruction. The engagement analyzed during this study was the result of an adjustment in policy and procedures, as well as how the teacher interacts with the students. In addition, since there is somewhat of a desired outcome for this study, there is a degree of researcher bias. Nonetheless, this study provides an in-depth look at how the behavior patterns of students using learning modules for most aspects of instruction might generate improvements to future instructional design.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

This review specifically encompasses the meanings of the key words and phrases associated with the research question: *In what ways are the engagement levels of low-achieving high school seniors affected by online modularized mathematics instruction?* Literature associated with teaching and learning models akin to online instruction, such as a BYOD model, is ascribed in this study. This information is particularly useful in examining a paradigm shift in instructional delivery augmented by technology – one that involves a transition from pedagogy (teacher-centered learning) to heutagogy (student-centered, self-determined learning). Thus, the role of the researcher was subjected to inquiry; not exclusively as a researcher, but also as a practitioner. This includes the role the researcher had in the designing and planning of instruction associated with MathXL® – the primary source of instruction that elicits heutagogical practices.

Studies that inquire upon the changing aspects of students learning from educational software was the primary consulted material of this literature review. The aim was to inquire specifically about the effects of OMI via MathXL®, along with what it means for a student to be *engaged* in math instruction. Key words and phrases associated with the research problem and question were contextualized with the participants and setting of this study. The headings of this literature review are among the key words and phrases and precede a definition or a pertinent explanation.

Modularized Instruction and Fostering Heutagogy

Virtual Learning Environments. The purposefully selected definition of a *learning module* emanates from a study on modularized Virtual Learning Environments (VLEs), from which it is defined as a set of grouped content (referred to as *Learning Objects, or LOs*) specifically organized to address a specific learning context (Paulsson & Naeve, 2006). The LOs consist of mathematics lessons obtained from preexisting programs aligned towards the textbook chosen for the study participants. The teacher subscribes to MathXL® by Pearson (2017) and chooses the LOs that are pertinent to the course title and curriculum. This program was used for instructional delivery for the academic year. There are hundreds of textbook options that are selected when the instructor subscribes to the program. The textbook selected for this study is one that aligns with the hardbound version that was once used at the school of the study site when Pre-College Algebra was delivered through the traditional format. The students did not use the hardbound version. Instead, they were assigned exercises and instruction organized and delivered through MathXL®, which contains the digital version of the textbook adapted for the modularized LO.

LOs that are administered through VLEs do not always correspond to the teacher-centered pedagogies that many students are accustomed to. These traditional pedagogies do not accommodate the flexibility that VLEs demand (Paulsson & Naeve, 2006). With MathXL® for example, students can access video lectures that contain recorded demonstrations of someone solving a math problem on a whiteboard in the same manner a live teacher does. The teacher-centered pedagogies exist with the latter since the teacher examines the behavioral engagement of the students and make adaptions as needed. Alternatively, the recorded demonstrations align with more student-centered heutagogy with the practice of stopping and starting the instructional medium as needed on an individual basis. Therefore, examining the perceived non-traditional learning practices that take place with modularized instruction is necessary.

Another example of a break from tradition is the construction of unit and lesson plans. With the VLE for this study, the entire course framework is designed online during the summer months before the academic year begins. The timeline for course completion is simply the duration of the school year, with the students having the option of completing the course early by completing more modules than expected for a predetermined unit timeline. The students have a platform to learn where the communication between the student and teacher regarding how to operate that platform takes place during the first week of school. There were moments when it was necessary for the teacher to intervene, but most of the learning is student-centered. This conceptualizes the practice of heutagogy and invites other inquiries on self-determined learning theory (Hase & Kenyon, 2007; Deci & Ryan, 2008).

BYOD. Inquiring upon heutagogy has directed this study to literature encompassing the BYOD platform (Cochrane et al., 2014). BYOD is an acronym for *Bring Your Own Device.* In a more comprehensive study, BYOD is defined as the use of cell phones, laptops, and tablet computers for the purpose of doing work in school (Cochrane et al., 2014). Is modularized instruction accessed from a classroom set of laptops the same general concept as a BYOD model? Perhaps it could be if the inclusion of the words *Bring Your Own* did not perpetuate a misconception of what a BYOD model is. For example, one study indicates that the term BYOD is more relevant to the associated teaching and learning practices rather than to the devices themselves (Stork et al., 2015). The definition of BYOD is often applied in a generic sense to any teacher interested in using student-owned technology in the classroom. Whether or not the devices are student-owned is irrelevant to this study.

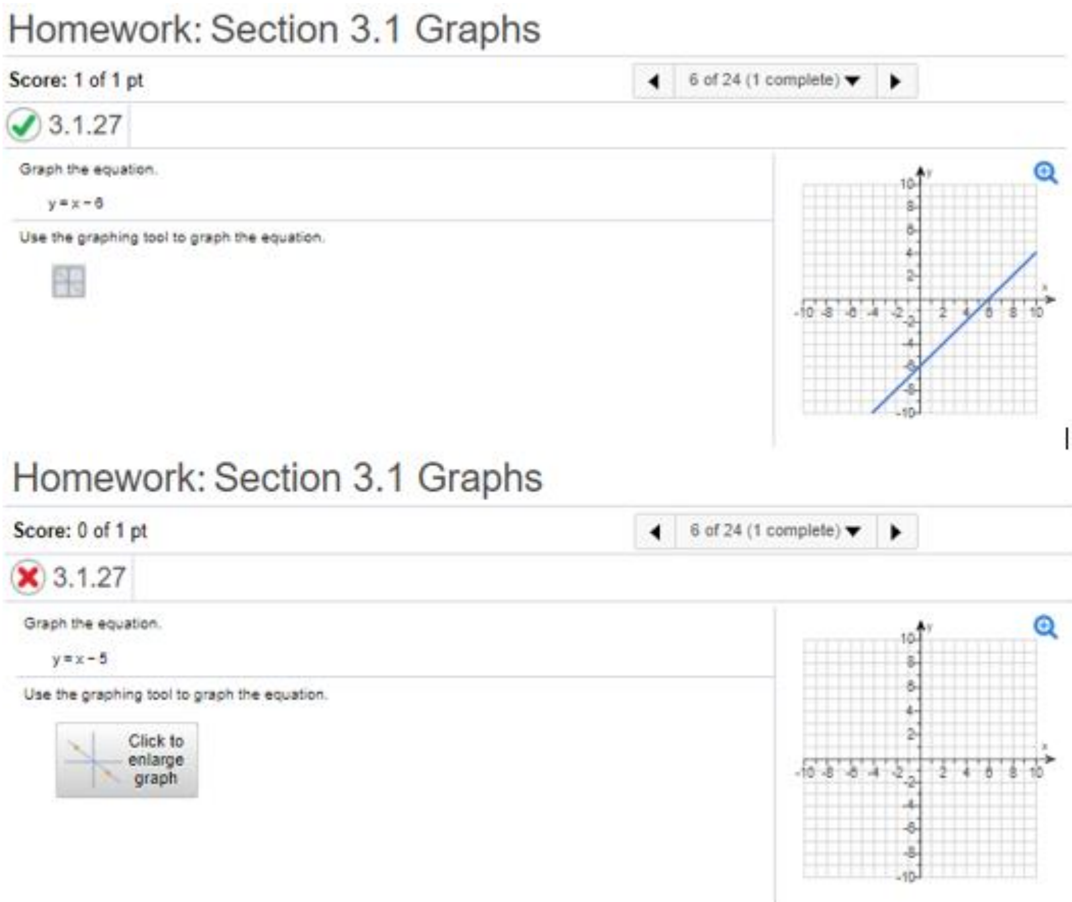
In a broader sense, the focus of this study is on the teaching and learning practices associated with the BYOD model. Since the research question for this study pertains to engagement, the intent is to consider all aspects of teaching and learning while students are using technology for the practice of heutagogy. According to Cochrane et al. (2014), a BYOD-like framework that transitions from teacher-centered pedagogy to student-centered heutagogy must meet the following three criteria: 1) It must model a community of practice, 2) It must redefine correlating pedagogies, and 3) A technology support infrastructure must be provided.

Modeling a Community of Practice. It could not have been determined during the design of this study if a community of practice would be formed when the only information available at the time was that some participants were similarly passive to math instruction in the past. When participants for this study enrolled in a course that is in accordance with their perceived ability level – in this case, Pre-College Algebra – the setting that encourages a community of practice was formed. Among the facets of a community of practice are the similar motivations of each student. In this case, students tend to enroll in this course just to get their final math credit needed to graduate. From the perspective of the researcher, however, the interactions that occur during daily classroom activities are of interest to the formation of a community of practice. Hence, it is possible that an actual community of practice takes form from the collective efforts to succeed in a course that is a final graduation requirement for many (Cochrane et al., 2014).

The research indicates that an effective community of practice in a BYOD-type setting involves a transition from pedagogy to andragogy, and then from andragogy to heutagogy (Cochrane et al., 2014; Yildiz & Palak, 2016). The students who make the successful transition take ownership of their learning, and thereby learn with an objective outlook pertaining to the subject at hand (Yildiz & Palak, 2016). In this case, while the students participate in common activities aligned with the lessons the teacher had planned, they have their own objectives and intrinsic motivators that guide them when choosing how far to advance through the online course assignments (Zhao, Ailiya, & Shen, 2012). Some of the participants are apparently content with a letter grade of D and adhere to a devised scheme of minimizing effort while staying on the positive side of the pass-fail threshold. For some, momentum proceeds to take effect and they acquiesce to the idea of self-determination. For others, intervention strategies that include individualized instruction and guided practice are employed. Students eventually begin to engage in the teacher-created lessons on MathXL®, regardless of how their determination is gauged (Rice et al., 2013).

Since each student has common learning objectives with the rest of the class, they benefit from working together. The design of MathXL® allows this with little or no breach of academic integrity (provided the students work in class and do not allow anyone else to use their login credentials). Take Figure 2.1 for example – an illustration of two separate views of the same problem number. As one student works on his or her assigned device, other students may be working simultaneously on a similar type of problem, but with minor differences. This collaborative effort is comparable to teacher-centered activities such as having students work collectively on a worksheet or problems out of a textbook. Only with MathXL®, the ability to have one student do all the work while others simply copy down the answers does not seem to occur. When students are grouped in a room using each of their own devices, they have the option of working the same problem simultaneously with classmates while discussing the concepts. It is through these conversations and the efforts made to arrive at a successful conclusion that perhaps warrant the formation of an enhanced community of practice (Cochrane et al., 2014).

Figure 2.1. **Problem Comparison from Student Assignment**. ***PEARSON, 6-YEAR MATHXL FOR SCHOOL VIA EASYBRIDGE DIGITAL COURSEWARE LICENSE GRADE8-12, 0, ©2011.* Reprinted by permission of Pearson Education, Inc., New York, New York.**



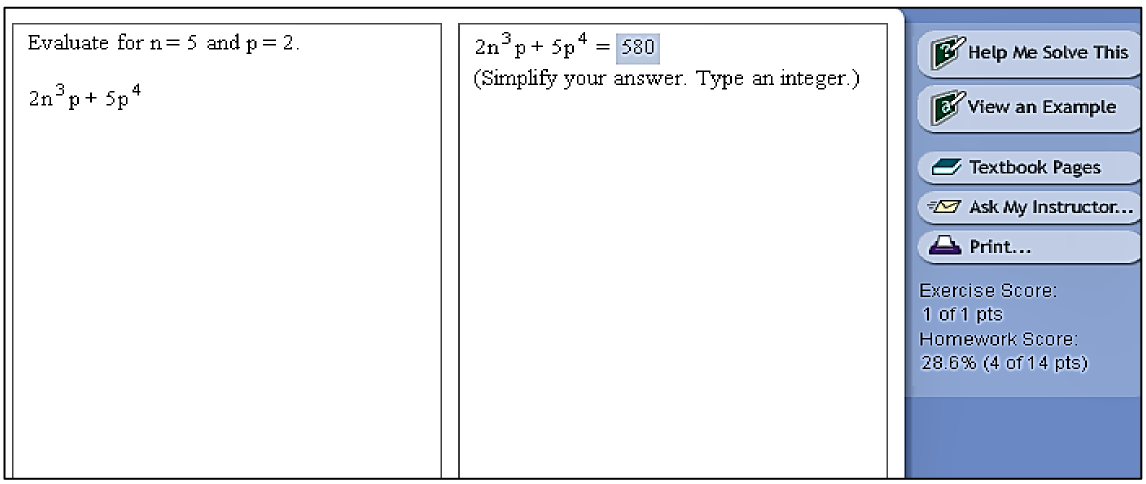
Redefining Correlating Pedagogy. Much of the collaboration and communication among teenagers of the modern era is accomplished through technology. For this reason and to maintain a sense of academic integrity, the self-determined learning of mathematics through modularization demands the use of an external learning utility that cannot always be shared. This is necessary for summative assessment and is possible with MathXL®. A test is generated at the end of each unit, and the students have specified time to complete it. They can choose how they solve each problem, but the answers must be entered into the program. This approach moves toward heutagogy and is emphasized as students are introduced to the instructional framework of MathXL®. If the students do not work the lessons when they have adequate resources to do so, they become less likely to acquire the knowledge needed to demonstrate they have mastered the lesson. Failing scores keep the students from advancing through to the subsequent modules. This alone is indicative of a redefined pedagogy (Cochrane et al., 2014). Furthermore, with heutagogy in this case, students who use any software for something that requires a username and password suddenly become aware of their responsibilities (Charles, 2012). Therefore, the teaching and learning relationship established with this framework also encourages the redefining of common pedagogies. The teacher may still provide a brief lecture over the content but on an as-needed basis. Thus, the OMI model brings about a change in the role of the teacher. The teacher can use it as a platform to encourage heutagogical learning, and therefore takes on a role that has been redefined into that of a facilitator (Winters et al., 2008; Flumerfelt & Green, 2013; Stanhope & Corn, 2014)

Providing a technology support infrastructure. In essence, MathXL® and the option to modularize instruction is conducive to a technology support infrastructure. With modularized math instruction, students learn math from practicing example problems as opposed to learning by watching a teacher do math problems. Thus, the student becomes self-determined and now has a choice to be either a collaborative learner or an independent learner (Deci & Ryan, 2008). This provides support to all students since they observe the patterns of others at some point. This allows both direct and indirect observations to serve as a support system for the class members (Zhao et al., 2012). In addition, Figure 2.2 shows that the technological aspects of MathXL® take on a variety of support features that include:

- *Help Me Solve This* - Students can read a written demonstration of the problem being solved, with the capability of choosing the pace of the explanation. The solution demonstrates the step-by-step processes needed to solve math problems that do not have solutions already visible, as would be the case with a multiple-choice answer format. Once the process is concluded, a new problem of the same concept is generated.
- *View an Example* – If students wish to receive assistance and continue working on the originally accessed problem, they can view a similar problem and its solution by clicking on *View an Example*. By reading a similar example, students can take notes on the process by which the problem is solved and use their assigned problem to practice.
- *Textbook pages*– Students can access an electronic version of the textbook used for this course. When the utility is accessed, a page appears containing examples of the problem being studied.

- *Ask My Instructor* – Students have the option of sending the problem to the instructor as an email attachment. The students can ask questions related to the attached problem.
- *Print* – This option allows the students to print questions onto paper format (Pearson, 2016).

Figure 2.2. Student Support Features. ***PEARSON, 6-YEAR MATHXL FOR SCHOOL VIA EASYBRIDGE DIGITAL COURSEWARE LICENSE GRADE8-12, 0, ©2011*. Reprinted by permission of Pearson Education, Inc., New York, New York.**



As students navigate through MathXL®, they are progressing through the lessons designed by the teacher. As teachers understand the need for intrinsic support, MathXL® is designed to address this by displaying a banner at the completion of each problem that informs the student if the correct solution was obtained. If the problem is solved correctly, a display appears with one of a variety of programmed affirmations, such as “GOOD JOB!”, “EXCELLENT!” and “NICE WORK!”. When students see these banners indicative of success, they become apt to share the information that assists them in the process (Cameron, Pierce, Banko, & Gear, 2005). The technology support infrastructure is formed by the merging of two motivators: the success obtained from solving the math problem and the success obtained from progressing to the next problem in the lesson (Cameron et al., 2005; Zhao et al., 2012). If any student feels like he or she is not ready to move on to the next problem, there is a *similar exercise* option at the bottom of each exercise, which allows the user to practice with a similar problem. The students may choose to do this and still have the most successful attempt saved as part of their grade.

Characteristics of Low-Achieving Students

One of the key terms in the research question is *low-achieving*. This study conflates low-achieving with past behaviors that have played a role in the student being enrolled a low-level math class (Archambault, Janosz, & Chouinard 2012). While these past behaviors have taken many forms, the behaviors that influence how the student engages in math instruction are of particular interest. As academically similar students enroll in the same classroom, over time they begin to develop common perceptions and attitudes towards the subject. Consequently, students identified as low-achieving develop little or no interest in mathematics by the time they enter their senior year (Rice et al., 2013).

A consensus among math educators is that there are fundamental reasons behind a lack of interest that leads to poor performance (Jameson, 2013). An example is math phobia, which tends to develop among high school students who experience long periods of poor performance in the subject (Humphrey & Hourcade, 2010;

Jameson, 2013). Also, an undiagnosed onset of dyscalculia – a cerebral impairment that mars the ability to perform simple math calculations – could also attribute to years of falling behind in math (Soares, & Patel, 2015). Whatever the case, low-achieving students tend to proceed through math lessons passively. As they reach their teenage years, they disguise their ineptitude for the subject by adopting a commonly perceived notion that math is of no value to them (Valero, & Meaney, 2015).

By the time low-achieving math students enter high school, they have been systematically placed in classes that match their ability level, so high school classrooms contain varying populations o f like-minded students (Archambault et al., 2012). These classes often require extra time and energy to address a variety of learning needs. The efforts of delivering quality instruction are often overshadowed by the implementation of strategies associated with classroom management (Azevedo, diSessa, & Sherin, 2012). While it is the responsibility of the teacher to design instruction that maximizes learning outcomes, consideration of a history of poor performance and apathy and a general understanding of how the student engages in math instruction would be a significant aid in designing corresponding instruction (Ryan et al., 2015).

Defining Student Engagement

Teachers face aggregating challenges of increasing interest and engagement in the subject of mathematics (Wang, Fredericks, Ye, Hofkens, & Linn, 2016). As adolescent interest in mathematics is in decline, motivation serves as a construct to reverse the decline (Frenzel et al., 2012). Increasing student motivation involves strategies that coalesce with their social interests (Rice et al., 2013). Some current social interests include the use of technological devices, such as cell phones and tablet computers. Teachers of today are likely to seek innovative ways to deliver instruction with the use of these devices and their many capabilities. However, just because students are interested in using their devices does not mean they will be interested in using their devices for math instruction (Charles, 2012). Yet, it is conceivable that they become more interested after a period of increased engagement (Azevedo et al., 2012). With secondary schools in the United States facing increasing demands to fully incorporate the use of technology into instruction, any model that involves math instructional activities is timely (Bottge et al., 2010; Scalise, 2016).

For a teacher to say that a student is engaged can be quite subjective. For this study, the definition of engagement was aligned with that of Azevedo et al. (2012), who define engagement as,

> the intensity and quality of participation in classroom activities, as seen in such things as students' ability to contribute materially and discursively to ongoing work (p.270).

But even this definition has its limitations. In the setting for this study, for example, it may be easy to construe a student aimlessly browsing the Internet as one heavily delved into the assignment, and will not likely have these behaviors policed in an environment that encourages self-determined learning (Deci & Ryan, 2008). Therefore, it is perhaps more sufficient to monitor engagement with an analysis of recognizable factors of the otherwise lack of engagement, or a state of mind called *entropy*. Csikszentmihayli (1997) asserts that what follows a tamed entropy is a state of mind he calls *flow*. When there are observational pieces of evidence that supports an increased or decreased state of flow, there are also depictions of increased or decreased engagement following the implementation of modularized instructional procedures, and that is the crux of this research.

Four Dimensions of Engagement

While this study uses the word *engagement* as defined by Azevedo et al. (2012), it is also sufficient to monitor engagement with the definition from the design of the survey instrument used in this study (Fredricks, Wang, Linn, Hofkens, Sung, Parr, and Allerton, 2016; Wang et al., 2016). The survey instrument used in this study (see Appendix A) is designed to analyze four dimensions of classroom engagement: behavioral, emotional/affective, cognitive, and social.

The instrument design was based on the lack of sufficient instruments that allow educational researchers and practitioners to recognize the desired level of engagement on a scientific basis (Fredericks et al., 2016). In other words, what creates those pleasant moments teachers experience whenever classroom activities run efficiently and effectively can be measured with this instrument. Since this Math and Science Engagement Scale used for this study is to measure engagement in a modularized line of mathematics instruction, it is essential to elaborate on each type of engagement and the inclusion of supporting literature. Likewise, since questions from the survey were not used to analyze any opinions on science class, it is henceforth be regarded as either the Math Engagement Scale or MES.

Behavioral Engagement. With behavioral engagement, the emphasis is on participation, effort, and the absence of disruptive behavior. Students in this dimension can appear to be tuned in to the lessons by going through the daily motions set forth by the teacher but without any conceptual understanding of the contents of the lesson (Fredericks et al., 2016; Wang et al., 2016). Many teachers are content with this, succumbing to the notion that students from socioeconomically disadvantaged backgrounds are rarely cognitively engaged (Bradley & Corwyn, 2002; Flumerfelt & Green, 2013; Valero & Meaney, 2014). This is not to suggest that they are not behaviorally engaged. It is for this reason that the behavioral engagement dimension provides valuable research regarding engagement in an OMI platform. The survey items regarding behavior engagement are:

1. I stay focused.
2. I answer questions in class.
3. I put effort into learning.
4. I keep trying even if something is hard.
5. I ask questions in class.
6. I complete my homework on time.
7. I talk about math outside of class.
8. I try to learn more about the topics we cover in class.
9. I don't participate in class.

10. I do other things when I am supposed to be paying attention.
11. If I don't understand, I give up right away.

Emotional/Affective Engagement. The second set of survey items pertain to emotional/affective engagement, where the focus is on the relationships the student has with his or her teachers and classmates in regards to an overall sense of belonging (Wang et al., 2016). With emotional engagement, there is a motivational paradigm to consider with the implementation of a modularized instruction model (Zhao et al., 2012). When students can select their courses for themselves, they are motivated to seek out less challenging courses; not necessarily as a display of apathy, but out of simply not knowing how to study (Ryan et al., 2015). To address this at the high school level, teachers see the potential for technological devices being used for instructional activities (Humble-Thaden, 2011). The survey items regarding emotional/affective engagement are:

12. I often like to be challenged in math class.
13. I look forward to math class.
14. I enjoy learning new things in math class.
15. I want to understand what we are learning in class.
16. I feel good when I am in math class.
17. I often feel frustrated in math class.
18. I think that math class is boring.
19. I don't want to be in math class.
20. I don't care about learning math.

21. I often feel discouraged when I am in math class.
22. I often get worried when I learn new things about math.

Cognitive Engagement. Cognitive engagement occurs when the student is invested in learning. When a student is cognitively engaged, the emphasis is placed on the effort necessary to gain a full understanding of complex ideas and the mastery of specific skills (Wang et al., 2016). As motivation is an element of emotional/affective engagement, it also plays a key role in cognitive engagement by the way it corresponds to the cognitive domain of Bloom's Taxonomy (1956).

Learning at the upper and middle levels of Bloom's cognitive domain - analysis, synthesis, application, and comprehension - seldom happens when students are lacking in motivation (Bloom, 1956, as cited in Ryan et al., 2015; Ryan et al., 2015). The researcher for this study facilitates the development of these models by using the Bloom's levels as a cognitive sequence. For example, when students see their assigned math problems on MathXL®, the analysis phase of the sequence begins by applying prerequisite knowledge with what is being asked in each question. Their thinking then transitions to the synthesis phase when they utilize information needed to solve problems; in this case, using the many learning aids available on MathXL®. After the synthesis phase, students apply the new knowledge gained to the problem. Finally, they comprehend the information from the patterns formed in obtaining information. By following this sequence, the students are not only learning math per se, but are using intrinsic motivators to assist them in learning how to learn math (Zhao et al., 2012). Ideally, as this cycle continues, the students begin to learn the required content (Ryan et al., 2015). The survey items pertaining to cognitive engagement are:

23. I go through work that I do for class to try to make sure it is right.
24. I think about different ways to solve a problem.
25. I try to connect what I am learning to things I have learned before
26. I try to understand my mistakes when I get something wrong.
27. When I am studying, I only review problems I have solved before.
28. I would rather be told the answer than have to figure it out myself.
29. I don't think that hard when I am doing work for class.
30. When work is hard, I only study the easy parts.
31. I do just enough to get by.

Social Engagement. Social engagement is defined as “students' prosocial behavior in classrooms and the quality of interactions with peers around instructional content” (Fredricks et al., 2016, p.6). The definition from a complementary study includes interactions with both peers *and* adults, with focus on continuous investment in relationships while engaged in learning (Wang et al., 2016). This is an important construct for this study since various technologies encourage collaboration (Rath, 2013). The survey items in this regard allow the researcher to determine the extent of this collaboration and are as follows:

32. I build on others' ideas.
33. I try to understand other peoples' ideas in math class.
34. I try to work with others who can help me in math.

35. I try to help others who are struggling in math.

36. I don't care about other peoples' ideas.

37. When working with others, I don't share my ideas.

38. I don't like working with my classmates.

Conceptual Framework

Mixed Methods Case Study. While the methodology for this research is detailed in the next chapter, this literature review concludes cited research that justifies a mixed-methods case study to analyze engagement. The primary justification is the use of the MES, which is used for quantitative analyses but designed from qualitative studies in education (Fredericks et al., 2016; Wang et al., 2016). This study proposes a need to examine a measurable change in engagement from before to after modularized instruction is implemented, but there is also a need to discover the intricate phenomenon associated with teaching and learning by way of an unfamiliar model (Gall, Gall, & Borg, 2010; Fredricks et al., 2016; Wang et al., 2016). According to Creswell (2008), there are two fundamental distinctions between quantitative and qualitative studies: 1) quantitative research is specific and narrow while qualitative research is general and broad; and 2) quantitative studies seek measurable, observable data while qualitative studies demonstrate a quest for understanding participant experiences. Furthermore, a qualitative study satisfies the “need to learn more from participants through exploration” (Creswell, 2008, p.53). In this study, the social phenomena are the cultural adaptations to technology usage for learning (Grant et al., 2015). Many of the students of today bring a smartphone to class, making it possible to use the Internet and YouTube to access video explanations of math concepts. They are also likely to communicate with peers about assignments, class procedures, and observations that take place in the classroom. This exploration results from observations conducted by the researcher in conjunction with responses to the survey instrument.

Quantitative Case Study. Quantitative measures for this study contain a simplistic approach. The specificity of this aspect of the study lies in the way the survey instrument is administered. The survey was administered twice, with only a slight modification is the directions between the first survey, identified as MES 1, and the second survey, identified as MES 2. Instructions that were written on MES 1 direct the students to respond to items concerning their past math classes while MES 2 instructions direct them to respond to the items as they pertain to instruction via MathXL®. The first time the subject completed the survey was before the OMI was introduced. After the student adapts to OMI – after a period of about six months – they were given the survey a second time. The measurable, observable data was the noted changes in their engagement levels that may have resulted from a paradigm shift in the way the students learned math (Creswell, 2008).

Qualitative Case Study. Qualitative methodology aspects of this study encompass a questionnaire consisting of five questions. This instrument was designed by the researcher and was given the title of MathXL® Satisfaction Questionnaire (MSQ). The title was chosen so that student would be apt to explain how satisfied or dissatisfied with the program. From the perspective of the researcher, the more open the students were in their replies the more feedback regarding their engagement was obtained. The questions were designed to elicit responses that provide feedback on the instructional design implemented for this study. The responses were used to explain and perhaps justify classroom phenomena with respect to its influence on engagement. The general and broad aspects of this study are justified through the observations of a phenomenon originating in its natural context (Baumann & Duffy, 2001; Gall et al., 2010). Thus, the responses to the questionnaire items were contextualized with noted observations. The triangulation of this data supplement the findings from the survey instrument designed and validated by Wang et al. (2016). Various forms of communication facilitated by the researcher was noted to determine the ways in which modularized instruction impacts student levels of engagement. The literature reviewed in this regard suggests there are elements of a narrative qualitative case study in the sense that teacher reflections are being examined (Creswell, 2008; Gall et al., 2010).

Role of the Researcher. The role of the researcher was more prevalent in the qualitative aspects of this study. The researcher opted to teach Pre-College Algebra and thereby requested enrolled students to be participants in the study for the purpose of analyzing a classroom phenomenon. As noted earlier, it was assumed that the students do not engage well with mathematics simply because they enrolled in this particular Pre-College algebra course; a course that has the reputation of being easy. Once the participants of the selected class begin their school year, a classroom inquiry was initiated by the teacher (Baumann & Duffy, 2001). The teacher reflections contribute to the qualitative aspects of this type of research, resulting from a persistent teaching problem that came to be recognized over the span of a fifteen-year career in education.

By the way fieldwork was conducted in this study, it is sufficient to define the researcher as a participant-observant (Frenzel et al., 2012). This fieldwork consists of unstructured interviews and classroom narratives used for the analysis of behavior, belief, and language patterns to draw an overall conclusion regarding the research question (Gall et al., 2010). Information obtained from the interviews were used to design the MSQ. Specifics questionnaire items were designed from the conversations students had about MathXL®. These conversations included what the students liked and disliked about the program, about OMI in its entirety, and about their personal motivations to completing the modules. A pattern that emerged within the conversations was a consistent comparison to math classes taken in the past. This allows a comparison to new behaviors that may help in deciding if the changed classroom dynamic is more apt to attend to the learning needs of the students. The methods of instructional delivery shall be in accordance with the expert foreknowledge of the researcher (Creswell, 2008; Gall et al., 2001).

Summary of Literature Review

This literature review espouses many studies on the topics relevant to this study: modularized instruction, the BYOD model, low-achieving math students, apathy, senioritis, and student engagement. The ascribed literature encompasses these topics purposefully conglomerated to analyze the question: *In what ways are the* *engagement levels of low-achieving high school seniors affected by online modularized mathematics instruction?* For analyzing this classroom phenomenon, it is first necessary to relate modularized instruction to more familiarly studied models and identify the characteristics thereof, particularly those that bolster heutagogy. According to Cochrane et al. (2014), an effective BYOD-type model that transitions from teacher-centered pedagogy to student-centered heutagogy must: 1) Have evidence of a community of practice, 2) Must redefine correlating pedagogies, and 3) Must have a technology support infrastructure. The community of practice for this study is in a sense procedurally formed as a classroom of high school seniors with common learning characteristics. The correlating pedagogies that commonly exist in a senior-level math class are redefined as heutagogy (Hase & Kenyon, 2007; Blaschke, 2012). The technology support infrastructure is comprised of the devices used to access math instruction from the online learning platform MathXL® (Pearson, 2016).

The survey item chosen for this study examines the four dimensions of engagement: Behavioral, emotional/affective, cognitive, and social (Wang et al., 2016). The conceptual framework that organizes this study consists of a mixed methods case study. The quantitative aspects consist of the evaluation of the changes or lack of changes in engagement from before the modularized instruction begins to when it is in full effect. Since the researcher takes on a significant role in this study, an analysis of common beliefs, attitudes, and narratives of the study subjects was conducted through observations (Baumann & Duffy, 2001; Creswell, 2008; & Gall et al., 2010). The way the results of the Math Engagement Survey were triangulated with MathXL Satisfaction Questionnaire replies and noted observations qualifies this study as a mixed-methods case study (Baumann & Duffy, 2001; Creswell, 2008; Gall et al., 2010; Wang et al., 2016).

CHAPTER 3

METHODOLOGY

This study is an investigation of the extent student engagement is affected during the transition to online modularized mathematics coursework. The modularized instruction coursework was accessed from an online source while in a traditional classroom setting. The source is a subscription-based program called MathXL® (Pearson, 2017). MathXL® contains many learning utilities in the form of slide lectures, videos, pages from a linked textbook, and example problems with solutions. Students access these utilities to learn the content selected by the teacher. The students had the option of bringing his or her device to be used for classroom instruction. While the students did bring their devices, most opted to use an assigned laptop provided by the school and chose to complete most of their work in class. With changes made to conventional instructional delivery, this study centers on any impact the implementation of an online modularized model had on low-achieving student engagement. This chapter presents the origins of the methods by which the study was conducted.

Research question

The question that frames this study is: *In what ways are the engagement levels of low-achieving high school seniors affected by online modularized mathematics instruction?*

Research Setting

Study Site Selection and Design. The classroom that contains the student group is an otherwise traditional high school math class located in a rural district in Central Kentucky. The classroom was designed to accommodate approximately thirty students. The teacher had two computers located his desk in the front of a classroom. A smart television hung over a large white marker-board mounted on the front wall. The desks were aligned in such a way that allowed the students to see the activities on the smart television, which is at times was used to deliver instruction via video or presentation format. The whiteboard was also used to supplement lectures with example math problems.

The online component of the class requires a subscription to MathXL® (Pearson, 2016). Each student is able to sign up for a free trial period, and the remaining subscription period is paid for with school funds. The lesson outline and the lessons themselves are designed at the discretion of the teacher. In the classroom, the teacher has the capability of accessing MathXL® online and displaying the interactions with the program on the smart television. The students can watch the teacher for a problem/solution demonstration on the whiteboard and then use the information obtained to answer a similar problem displayed on their device. It was illustrated in Chapter 2 (Figure 2.1, page 27) that the question type and the number that labels it is the same for both displays, but with slight variations for each student.

The teacher can use the distinctions in the problems as a visual aid in further explaining the associated math concepts with the students.

Selecting the Participants. After each school year, the teachers in the math department of the selected site meet to place each student in a class that aligns with his or her academic needs and abilities. The students who are placed in Pre-College Algebra are typically those who perform at minimal satisfactory levels in math classes during their first three years of high school. An assumption for this study, as noted in Chapter 1, is that minimal engagement in past math classes is a contributing factor for choosing this class, whether it be the choice of the teachers or students, for it has a reputation of being less rigorous than the other math classes at this high school. The researcher had taught this class before and determined that the class would provide information on an interesting dynamic worthy of analysis. Once the class for this study was formed, the students were notified of the changes that would take place in the classroom. Proper permission for students to participate in the study was obtained.

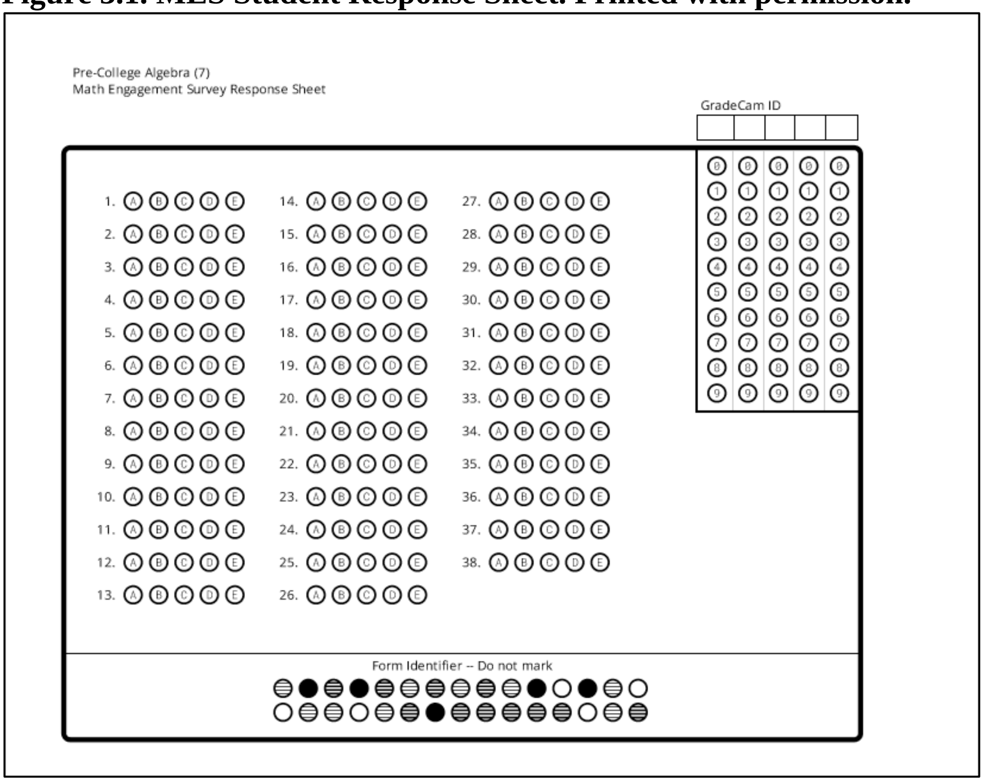
Nineteen twelfth-grade students enrolled in one forty-five-minute course called *Pre-College Algebra* were identified as the participants. These student participants represent those who remained in the course until the completion of the study. The number of students enrolled in the course began at twenty-four. For various reasons, five students withdrew from the course before they could complete MES 2 and the MSQ. Their results of the MES 1 were not used and were discarded. Of the remaining students enrolled, seven are female and twelve are male. The females are Caucasian. Of the males, nine are Caucasian and three are biracial, two being African America/Caucasian and one being of African-American/Hispanic descent.

The researcher for this study is the only teacher on site who teaches Pre-College Algebra. The teacher conducts six math classes over six forty-five-minute periods, with only one of them being Pre-College Algebra – the last period of the school day. This class was purposely selected for this research with no consideration given to the individual students who enrolled in this class. The teacher has fifteen years of experience teaching mathematics and facilitating instruction from an online platform.

Survey Instrument Selection. Appendix B depicts the Math Engagement Survey administered to the student participants. The inclusion of a Likert response scale allows the researcher to quantify the opinions of the subjects studied regarding certain issues associated with engagement in math instruction; in this case, modularized math instruction (Fredricks et al., 2016; Wang et al., 2016). It also allows an analysis of engagement by students before and after an online, modularized line of instruction is presented to them. MES 1 was issued to the students before the modularized instruction begins. MES 2 follows a period of approximately six academic months after the line of instruction was first introduced to the students.

The survey instrument was the basis for the quantitative study in analyzing engagement (Fredricks et al., 2016). The instrument contained headings that represent four dimensions of engagement - behavioral, emotional/affective, cognitive, and social. The dimension identifier headings were not visible to the survey respondents, and the questions were labeled with a number in the range 1-38. Survey respondents were asked to circle the letter that corresponds to a five-level Likert-type scale. The participants answered each question with a letter A, B, C, D, or E, with A indicating strongly disagree, B disagree, C neither agree nor disagree, D agree, and E strongly agree. The responses were coded on a separate answer sheet. The students filled in a corresponding “bubble” on a separate data-analysis sheet provided by a grading program called *Gradecam*®. Gradecam® was initially designed for grading student work by taking a photograph of a provided answer sheet. Figure 3.1 depicts an example of the student response sheet.

Figure 3.1. MES Student Response Sheet. Printed with permission.



Under normal circumstances, the intent of Gradecam® is to have students record answers to a multiple-choice assessment on an answer sheet. The answer sheet works similar to programs like Scantron®; only with Gradecam® the student responses are photographed, and the software matches their response image to an image of a predetermined answer key. There is certainly no *answer key* to this study, so the program is used to provide an item analysis for survey item is, showing what percentage of the class answered each item (see Appendix C). The responses collected from the photographed response documents were assigned ordinal values, with A=1, B=2, C=3, D=4, and E=5.

Reverse Coded Questions. A variety of the survey items have been labeled as reverse coded by Wang et al. (2016). Reverse coded items allow the researcher to cross-check the validity in the student replies, thereby reducing response acquiescence bias (Creswell, 2008; Wang et al., 2016). The words “reverse coded” were seen by the respondents. The researcher identified which questions were reversed coded whenever the data was compiled and the ordinal values with those particular items were changed from the range of 1through 5 to the range 5 through 1. Upon analysis, the responses to the reverse coded questions assisted in determining the validity of responses, for they signify that the responses of these questions have the opposite magnitude as those from questions that are not reverse coded. Of the thirty-eight questions on the survey, sixteen of them were reverse coded.

Notes, Questionnaires, and Observations. For purposes of investigating a variety of ways OMI impacts engagement, an inquiry on attitudes and beliefs regarding MathXL® extends this study. The qualitative data for this project came as the result of responses to questionnaires developed for students on how they conceptualized the workings of MathXL® for their benefit. It also assists in identifying specific ways engagement is impacted by modularized instruction. As students proceed through the online modules on MathXL®, interactions and other occurrences assist in determining some measure of a student viewpoint reflective of engagement. Noted interactions among the students were used to supplement responses to the questions in the *Behavioral Engagement* categories of the survey instrument. This information was useful in not only analyzing the extent the students were engaged in OMI but for seeking ways to improve the instruction for future students if a need to do so is determined. The researcher used more formal measures to gather student data in this regard. Students were asked to provide a short-answer response to the questions outlined in Appendix D, labeled *MathXL® Satisfaction Questionnaire* (MSQ). The design of the MSQ along with the student responses provided information that appeals to a qualitative study. The responses were compared with other noted observations and play an important role in the further analysis of engagement.

Procedures

Data Collection Methods. Early in the 2017-2018 academic year, students enrolled in Pre-College Algebra were given the first math engagement survey, labeled MES 1. The survey contained a numerical identification code placed on a student response sheet. This number is associated with each student name stored in a database and used to associate data in a spreadsheet. The survey was administered after the response sheets have been given to the students, and all documents were collected and filed into a large envelope. The survey responses were transferred to a spreadsheet and then organized into one of the four engagement categories: behavioral, emotional/affective, cognitive, and social.

During the first week of school and after MES 1 was administered, students were oriented to the policies and procedures regarding the modularized model of instruction via MathXL®. They were also informed that the class would follow a heutagogical framework. Once each student procured a device to work with, they were directed to the Pearson® home page and began the process of using MathXL®. Observations and notes were collected and organized as the students engaged in a day-by-day routine of entering the classroom, procuring a device from a mobile cart, accessing MathXL® course material, and proceeding through the learning modules. During the daily facilitation of classroom activities, noteworthy occurrences and conversations were continually documented and collected as data to be compared with the MES and the MSQ used in this study. All data collected was used to discuss varying ways the students engage in instruction delivered through MathXL®. Once the responses to the MES were collected, the items were sealed for approximately two months before the results were entered in Gradecam®. They were then partitioned into the categories corresponding to the types of engagement indicated on the original MES: Behavioral, emotional, cognitive, and social (Wang et al., 2016).

Data Analysis Strategy. Tables, charts, and diagrams in Appendices C, D, and E provide a quick view of stimulus data as it is aggregated for a mixed-methods study. The raw data from MES 1 presents findings related to the assumptions made in Chapter 1 – that students enrolled in Pre-College Algebra are low-achieving to varying extents. It is also used with the literature examined in Chapter 2 as to how the low-achieving senior is defined. This information is compared to questionnaire replies and classroom anomalies. The information provided from the second survey, labeled MES 2, is used in the same manner as responses from MES 1, but also to compare mean engagement in traditional math instruction to mean engagement in OMI in the four dimensions. Approximately six months after completing a semester of OMI, the MES was given a second time. A noted distinction with MES 2 is that it pertains specifically to engagement in the modularized line of instruction. The students were notified of this distinction. They were told that MES 1 reflects their engagement in their math classes of the past and MES 2 reflects their engagement in OMI delivered through MathXL®.

Since the mean responses to each survey item of the second survey were compared to the mean response to the same survey item of the first survey, a two-sample paired t-test was used for the quantitative aspects of this study. Results from MES1 contain responses specific to a classroom with traditional means of instructional delivery while results from MES 2 contain responses pertaining to instruction delivered through the online modularized format. Changes in the mean number of students who choose a specific answer for a specific question are significant in determining changes in behavioral, emotional, cognitive, and social engagement (Fredericks et al., 2016; Wang et al., 2016). The alternative hypothesis was that significant changes in responses to survey items such as *I feel good whenever I am in math class* would occur after being exposed to modularized instruction. All responses were used to identify any significant distinctions in engagement while following the two different methods of instructional delivery (i.e., the change in the number of students who answered “agree” to the questions on the survey). In addition, any coincidences or contradictions between what was observed by the researcher and what was recorded by the students in the *Behavioral* engagement category were identified for the qualitative aspects of the study.

Data Analysis Methods

Mixed-Methods Design. To understand the ways OMI influenced the engagement levels of the respondents, quantitative and qualitative data was used accordingly. The quantitative data presents the results of the MES administered before and after MathXL® instruction was delivered over a period of six months. This data contributed to an analysis of the ways online learning modules via MathXL® affect the four dimensions of engagement: behavioral, emotional/affective, cognitive, and social. Results from qualitative data were useful in contributing to this study at a micro level. The replies to the MSQ were used in conjecture with the quantitative data to provide an analysis of certain anomalies that take place in class (e.g., a casual-comparison inquiry on a subset of the participants who finish the learning modules early). Various other inquiries on events that took place at the study site and how they relate to MES responses and MSQ replies are discussed in Chapter 5.

Identifying Variables. Results of a two-sample paired t-test were framed following the data emanating from two episodes of when the MES was administered. Specifically, data from MES 1 corresponds to ways in which students were engaged in traditional math instruction of the past, while data from MES 2 corresponds to ways in which students were engaged in instruction from MathXL®. Results from MES 1 serve as an origin from which any changes in engagement in mathematics follows. What remains to be analyzed are the differences between the results of MES 1 and the results of MES 2. Table 3.1 depicts this information as established variables for quantitative statistical analysis.

Table 3.1. Data-Variable Correspondence

Independent Variables	Engagement in Traditional Instruction	Engagement in Modularized Instruction (via MathXL®)
Dependent Variables	MES 1 Responses	MES 2 Responses

Summary

A group of nineteen high school seniors completed a Math Engagement Survey that contained items about engagement in math class. After the survey, students were oriented to a new line of instruction designed to increase student engagement. Participants accessed online course material through a subscription-based program called MathXL®. From this program, students were able to choose favored learning utilities accessed for instructional purposes. These utilities are selected from a list that includes *Help Me Solve This, View an Example, Ask My Instructor*, and *Textbook.* After a period of approximately six months, participants completed the Math Engagement Survey for the second time. The responses to the survey instruments indicate the ways students are engaged in math instruction. The responses to MES 1 indicate the ways students engage in traditional math instruction while responses to MES 2 indicate the ways students engage in OMI. The four dimensions of engagement are identified as behavioral, cognitive, emotional/affective, and social engagement.

With the role of the researcher as a teacher of the participants of this study, a mixed methods analysis was warranted (Gall et al., 2001; Creswell, 2008). Quantitative measured were used to analyze the impact OMI had on engagement in the four dimensions as established by Wang et al. (2016) and Fredericks et al. (2016) in the design of the Math Engagement Survey. Notable changes in the mean in student responses that existed between the replies of the participants are recorded in Chapter 4. To complement the quantitative data, a qualitative inquiry in the form of a five-question MSQ was launched. This questionnaire was designed to elicit replies that could be aligned with MES responses and noted classroom observations.

CHAPTER 4

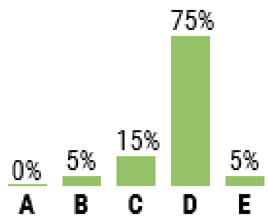
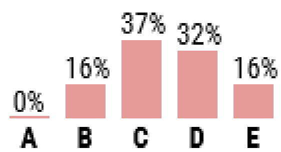
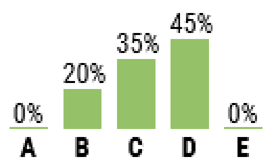
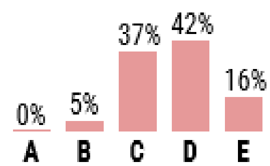
FINDINGS

Overview

This chapter presents a report of a classroom inquiry on high school seniors deemed to be low-achieving in mathematics. The resulting data consists of responses to survey items selected to investigate that which pertains to the overall objective of the study – an examination of the effects OMI has on the engagement levels of nineteen survey and questionnaire respondents. The findings of this examination are organized and presented in accordance with the research methods outlined in Chapter 3. Associated words and phrases within these findings are reported as they were defined in Chapter 2, as are the terms contained within the research question: *In what ways are the engagement levels of low-achieving high school seniors affected by online modularized mathematics instruction?* This chapter presents the results of an engagement survey taken before and after a new instructional delivery method was implemented. The survey respondents were high-school seniors considered to be low-achieving in math. The results of a satisfaction questionnaire taken by the same respondents follows. All information is presented as findings to assist in answering the research question as relevant to nineteen high-school seniors enrolled in a fourth-year math course called Pre-College Algebra.

Preliminary Analysis. The overarching goal of this study was to identify the ways in which students engage differently when receiving OMI delivered from MathXL® in comparison to traditionally delivered mathematics instruction. Once the data was collected, frequency polygons that represent the percentages of students who chose a specific Likert item were created (see Appendix C). The two sets of frequency polygons represent responses to te items of MES 1 and MES 2. From the data displayed from each question in each category, a cross-item preliminary analysis allowed a visual perspective of the changes in the number of students who chose a specific Likert response to each survey item. Significant changes in the number of respondents who chose a specific Likert item are more apparent with some items, such as the case with item number 27, for example. With these types of comparisons, the data was determined to be non-directional. It was also determined that most of the sets of histograms followed the appearance of a normal distribution. This provided useful information in choosing a two-sample paired t-test (Tanner, 2012). Figure 4.1 identifies two examples of data for item analyses from the behavioral engagement category; one set showing significant changes in Likert response percentages between surveys and the other showing minor changes. The letters A, B, C, D, and E represent the five Likert items respectively signifying *strongly disagree, disagree, neither agree nor disagree, agree*, and *strongly agree.*

Figure 4.1. Appendix C Behavioral Dimension Stimulus Material Example

Item Number	MES 1 Response (%)	MES 2 Response (%)
1. I stay focused.		
2. I answer questions in class.		

Data Description. The Likert item responses were compiled separately and categorized as ordinal type within each dimension. The responses were assigned a value of 1, 2, 3, 4, and 5; respective to responses A, B, C, D, and E on the survey response sheet. The frequencies of each choice were tallied and the average response to each item was found. These mean responses were collected and organized into a spreadsheet for data analysis. The value for each mean response serves as a *score* that corresponds to the Likert-type response choices ranging from strongly disagree to strongly agree. As indicated in chapter 3, the means were inferred upon for each engagement category as the dependent variable outcome of the collective survey responses. The null assumption was that there was no significant change in the means following the implementation of modularized instruction. The alternative hypothesis was that there will be a significant change. The alternative hypothesis including a non-directional change in engagement, also provided information useful in selecting a two-tailed t-test (Tanner, 2012).

Results. Prior to the results of this study, it was anticipated that there would be a significant change in engagement in all four dimensions. However, this was only the case with an analysis of the behavioral dimension. With a p-value of 0.03 from a two-tailed t-test, the null hypothesis that there was no significant change in the mean scores upon receiving OMI was rejected. This means there were significant changes in the way students engaged behaviorally. The same t-test was conducted on engagement in the other dimensions and the null hypothesis was accepted (see Table 4.1). There was no significant change in engagement when considering the average response to the MES items in the emotional, cognitive, and social dimensions.

Table 4.1. Results of Paired Two Sample t-Test for Engagement Dimensions

MES Dimensions	*Mean*	*Observations*	*df*	p(T<=t)	t Critical
Behavioral					
MES 1	2.36	11	10	0.03	2.23
MES 2	3.64	11			
Emotional					
MES 1	3.00	11	10	0.33	2.23
MES 2	3.55	11			
Cognitive					
MES 1	3.22	9	8	0.46	2.31
MES 2	2.67	9			
Social					
MES 1	2.86	7	6	0.53	2.45
MES 2	2.43	7			

MathXL® Satisfaction Survey Results. The MSQ was designed to elicit responses indicative of each of the four engagement dimensions. As expected, there are many similarities in replies among the MSQ respondents. Thus, the responses were disaggregated into dimension-type indicators (see Appendix E). For example, if a respondent compared or contrasted the peer-to-peer interactions that took place at the study site, that response would be aligned with the social dimension. It was determined that many of the replies corresponded to more than one dimension, as did the reply of one student to the question *What do you like least about MathXL®?* To which he replied, *"You have to put in a certain way to get the correct answers and I don't feel like I am learning/understanding enough to be prepared for college."* This student is referring to frequently observed frustrations resulting from lack of flexibility within the software when it comes to entering certain syntax. An example is the root feature on the math symbol template. Entering something such as $\sqrt[3]{x}$ alone takes enough concentration to align the 3 as the program expects it to be, and when the students work hard just to get a solution, frustration does ensue when a student knows he or she is correct, but the program indicates otherwise. Perhaps it is for this reason why the student response then indicates that he does not *feel* like he is *learning*. These two buzzwords, *feel* and *learning*, are indicative of the emotional and cognitive dimension respectively (Fredericks et al., 2016; Wang et al., 2016).

Responses to the first question were omitted from Appendix E as they were all indicators of the emotional dimension. Students were asked to report on whether they felt like they learned more or less from MathXL®. With this question, the response choices were limited to *more, less,* and *same.* Since the question regards how the respondent feels, responses are indicative of the *emotional* dimension (Fredericks et al., 2016; Wang et al., 2016). Of the nineteen respondents, seven reported feelings of learning more from MathXL® and five reported feelings of learning less. The remaining seven students either reported that they felt like they learned about the same amount from both forms of instruction or reported something that was unclear. Only a few students elaborated on their answers. One reply that did not fit into either category was an indirect answer with a student replying, “I feel like I am teaching myself.” Other responses were categorized somewhat subjectively. For example, one student replied, “Yes because it tells you the correct way to do it, so you can solve every question.” There is no indication in this reply that the student learned more or less from MathXL®. Another reply stating, “no, it’s difficult” was also considered to be not applicable.

Results of the second and third questionnaire items include replies mostly pertaining to accessibility. Most students favored having “the freedom to move on” and “learning at [their] own pace” – both indicators of increased engagement (Rice et al., 2013). However, comments on the learning utilities offered by MathXL® are indicative of varying opinions on their efficacy. Regarding the learning utility called “View an Example,” most responses were positive, indicating the feature is a factor to increased engagement. On the contrary, student #86 commented on the learning utilities as a *least liked* component in response to question 3: *". . . no true explanations to your assignments . . . it shows you what to do but doesn't always explain why you take those steps within a problem."* When comparing this reply to the corresponding MES 2 responses in the behavioral dimension, it was found that this student responded with *disagree* to "I stay focused" while responding with *agree* to "I put effort into learning" and to "I keep trying even if something is hard." While these observances are ostensibly contradictory, a generalized correlation between lack of focus and lack of effort does not exist with mathematics (Skemp, 1987; Rice et al., 2013). Students with identification numbers 90 and 93 reported similar sentiments.

Among the most challenging results to analyze were the student responses to questions 4 and 5. Both items were designed to elicit responses that address the similarities and differences of learning from MathXL® when compared or contrasted to traditional classroom practices the students have experienced in the past. Yet, it appeared to provoke a declarative reply for some respondents. For example, respondent 98 wrote,

> I understand they are trying to find a better way for us to learn, but it's not for me. Online courses are more difficult.

There were similar responses from respondents 86, 88, and 90 and were interpreted as indicators of the emotional dimension. In fact, most of the responses of question 5 were indicators of multiple dimensions (see Appendix E).

Observations and Interviews. In the interest of the research question, this study shifts focus towards the many narratives and anomalies that occurred at the research site. The figures and tables are useful in determining the existence of factors that would cause changes in engagement. However, it is sufficient to triangulate the results of survey and questionnaire item responses to observations made to two subsets of the participant group: those who are projected to complete the modules early and those who are projected to fail the course entirely. Data associated with students who complete the course significantly early provides a model that exemplifies a higher standard of engagement. On the contrary, data associated with students who are lagging behind could provide insight on modifications to the course design that might be needed for future students. At the conclusion of the first semester of the course, there were students who were identified as proceeding at a significantly faster and slower pace than the rest of the class. Four of the students were projected to complete the course modules earlier than anticipated, and three of them are not expected to complete the course without an intervention strategy.

Summary of Findings

The findings from three forms of data were comprised to answer the question: *In what ways are the engagement levels of low-achieving high school seniors affected by online modularized mathematics instruction?* The first form of data consisted of replies to the first and second administered math engagement survey. The second form of data consisted of replies to a five-question MathXL® Satisfaction Questionnaire. The last form of data was noted observations, with most of the notes pertaining to a few students who rapidly excelled through the online modularized line of instruction and finished the course ahead of schedule.

A two-sample paired t-test was conducted and it was found that significant changes in behavioral engagement existed when two instructional delivery methods were compared – traditional instruction versus OMI. These results were compared to the participant replies to the five question of the MSQ. The replies were categorized as belonging to one of the four engagement dimensions of the MES. Replies that were distinct or otherwise peculiar were compared to noted occurrences that took place in the classroom. It was found that many occurrences, such as finishing the coursework early, were indicative of the replies to the MSQ. The observations were also descriptive of the MES responses when reviewing those of selected students. Overall, the findings showed a variety of ways the engagement levels of the participants were affected by online modularized mathematics instruction.

CHAPTER 5

CONCLUSIONS, ACTIONS AND IMPLICATIONS

Overview

This study examines the effects online modularized instruction (OMI) has on the engagement levels of low-achieving seniors. The research question chosen for this study was: *In what ways are the engagement levels of low-achieving high school seniors affected by online modularized mathematics instruction?* Nineteen twelfth-grade students were placed in Pre-College algebra based on past engagement factors such as low ACT and other standardized test scores, behavior and performance in past math classes, and individual initiatives to pursue less rigorous coursework. The timeline of this study began when a pre-survey was given. The timeline concluded when the data from a post-survey was collected. Results from the pre-survey were consequential to learning math from traditional instructional delivery methods. Results of the post-survey were consequential to learning from an online modularized instruction platform called MathXL®. The data collected consisted of both sets of MES results, MSQ responses, and various reports on informal classroom observations. This chapter discusses the triangulation of this data in a manner that addresses the research question.

The general conclusion is that there are significant changes in the way low-achieving seniors enrolled in Pre-College Algebra engage behaviorally. This means that there were significant shifts in beliefs about the following first eleven items of the MES:

1. I stay focused.
2. I answer questions in class.
3. I put effort into learning.
4. I keep trying even if something is hard.
5. I ask questions in class.
6. I complete my homework on time.
7. I talk about math and science outside of class.
8. I try to learn more about the topics we cover in class.
9. I don't participate in class (RC).
10. I do other things when I am supposed to be paying attention (RC).
11. If I don't understand, I give up right away (RC).

It is important to reiterate that the analysis conducted in this study was non-directional, meaning emphasis is placed on changes in behavioral engagement and not on whether or not behavioral engagement improved (Tanner, 2012). This chapter presents the conclusions made from the study, the actions that could take place as a result of the conclusions, and the implications for educators, researchers, and designers of OMI.

Perceptions of Student MES Responses

This study sought to examine a familiar disengagement from math instruction by twelfth-grade students who typically express little interest in learning mathematics due to the effects of senioritis (Slaton, 1995; Wahlberg, 1997). The primary instrument to measure the changes in engagement in traditional teacher-centered pedagogies to student-centered heutagogy was the MES (Fredericks et al., 2016; Wang et al., 2016). The survey was designed to analyze four dimensions of engagement: behavioral, emotional/affective, cognitive, and social. These dimensions were useful in examining the engagement levels of high school seniors who were deemed low-achieving. The aim was to see if there was an increased level of engagement in each of the dimensions following the implementation of an online modularize line of instruction received through MathXL®. Interest is placed on the outcomes that indicate whether students took an interest in their own learning. The perception was that some of the student efforts were aligned with learning the course material in the sense of what defines learning. Others would simply go through the motions of completing math assignments, sometimes by any means they could get by with, simply because completing the course was a requirement for graduation. The results of this study lead to a general conclusion that the MES was effective for analyzing the engagement levels of individual students, but only collectively in the behavioral dimension, as mentioned. What follows are conclusions reached regarding each of the dimensions.

Behavioral Engagement. As indicated in chapter 4, the MES was effective for analyzing change in engagement in the behavioral dimension. The environment itself lends justification for changes in the responses to items in this dimension. When students were oriented to the course and the contents of the course syllabus, they were informed that this would be a class that fostered independent learning through the implementation of Internet-based, modularized instruction. Thus, the students were given a detailed explanation what it meant to establish their own day-to-day routines that were geared towards individualized, performance-based achievement.

It cannot be exclusively determined if the behavior of the students was influenced by the class orientation, even as the intent of the first-day orientation was to inspire the students to pursue this course following their own motivations. However, student foreknowledge of how to behave in a classroom while pursuing the completion of Pre-College Algebra perhaps had some bearing on the results of the second MES. The most obvious displays of positive behavioral engagement came from two students who finished the course three months early. These students are identified as students 83 and 93 on the MSQ from Chapter 4. Student 83 reported a mean score of 4 with MES 1 and a mean score of 5 on MES 2, answering *strongly agree* (or *strongly disagree* to the reverse coded questions) on all items except for Item 7 – *I talk about math outside of math class.* For this item, student 83 responded with *neither agree nor disagree*. There was no change in the mean for student 93, but there were significant changes in responses to items 6 and 7, with item 6 being *I complete my homework on time.*

While this study did not emphasize increased or decreased engagement, a student who reported significantly less engagement in the behavior dimension exemplifies the sufficiency of further directional studies, such as a one-tailed t-test. Student 82, for example, reported a significant change in behavioral engagement concerning the first three MES items. From the observed behavior of this student, it was apparent that there was no focus (Item 1), no contribution to class discussions (Item 2), and little or no effort put into learning from the MathXL® (Item 3). This student was frequently observed either sleeping in class or playing video games on his cellphone. Yet, the student was able to complete the assignments on time and with high grade percentages. It is worth noting that the discrepancies between the grade of this student and poor classroom performance were explained when the student was overheard telling another student that his grandfather was doing the classwork for him.

Emotional Engagement. Items of the emotional dimension of the MES align with student feelings when engaging in math instruction (Fredericks et al., 2016; Wang et al., 2016). Thus, it is not surprising that the results showed no significant variations in the responses between surveys for this dimension. From the standpoint of a practitioner, students either like math or they do not, and merely being in this class is a good indicator that there are members of this participant group who do not.

Yet, there was an interest in the results of an isolated case – a student who expressed strong feelings toward the online modularized platform.

Student 88 frequently vocalized a strong disdain for this new way of learning math. Not only would the student display unruly behavior by not engaging in instruction for extended periods, the student would complain about the complexity of the curriculum - even with rudimentary content corresponding to a curriculum that would be present in a seventh-grade level math course. During one episode, during the second month of the study, the student launched a silent protest towards the new design and refused to complete any class work. Whenever I asked him what was troubling him, he said that he “can’t learn this way.” Whenever I told him that he had already done this type of math in previous classes, he told me that I was not teaching it like it was taught in his previous math classes. He seemed to conflate exposure to math to the actual learning of math by replying “so, why do I have to learn this again?”

An interesting note about this student was that the displays of apathy and the back-and-forth arguing subsided after an occurrence that involved another student who was not enrolled in the class. An eleventh-grade student who I had as a student in a previous class came to the class to run an errand for another teacher. This is a student with a candid personality, so when she saw some of the content written on the whiteboard she said with a flabbergasted tone, “is this what y’all are learning? Gosh! We did that in seventh grade!” When she concluded her visit, the participant in question told me that she “made [him] feel stupid” by saying that. Interestingly, the student demonstrated a peculiar change in engagement, and he no longer complained about the design of the course. These events associated with this student prompted an inquiry into the responses to the items in the emotional dimension. It was expected, based on the observances in class, that this student would score lower in the engagement dimension for MES 2. However, his mean scores were the same for both surveys.

Cognitive Engagement. During the beginning phases of this study, the cognitive dimension of the MES seemed to be a sufficient measuring instrument. Students who understood the perks of the online modularized design were excited about the opportunity to be able to finish the course early. Many of the male students were observed making comments about their ambitions of finishing early and making plans for the remaining time when they do. From my perspective, there was an opportunity to channel this excitement and engage cognitively in OMI. This would prove to be wishful thinking in just a short time, however. The surplus of excitement dissipated after only a few days of math instruction. It was not by lack of cognitive ability why the students waned as much as it was that the students had not learned how to self-regulate their own learning (Winters et al., 2008). These behaviors justify the premise that many of the students in this sample group acquire the characteristics of a low-achieving student.

It is not the intent of this study to analyze a correlation between cognition and increased technology-enhanced instruction. It has become common knowledge in the field of educational technology that such a correlation does not exist. However, there were isolated incidences of students taking advantage of the opportunities that came with the decision to engage in self-determined learning. These students are either on pace to finish the course early or have already done so. A common trait that these students possess and is worth noting is their ability to focus. These students were observed proceeding through the course quietly and methodically with an unwavering focus to finish with the course in accordance with their own established timeline.

One example was a student who consistently recorded perfect scores on the MathXL® homework, quizzes, and tests of all sections. It appears that the goal of this student was and is perfection. So, Cochrane et al. (2014) perhaps have a point in their assertions that there are effective measurement instruments for classroom teachers who are interested in implementing a change from teacher-centered pedagogies. This student implemented self-determined, heutagogical practices by using the instructional framework to achieve a goal (Deci & Ryan, 2008). It is a satisfactory premise that this study places no emphasis on alpha-numeric scoring. Yet, if there is a correlation with enhanced cognition resulting from a heutagogical framework, participant 89 serves as an example. This further assures that the MES can be used for a variety of statistical analyses (Fredricks et al., 2016; Wang et al., 2016).

Social Engagement. It was anticipated that the social dimension would exhibit the most significant changes in MES item responses. Yet, results show the contrary has occurred. There are observable differences in the way students who receive OMI socialize with their classmates when compared to students who socialize in teacher-centered learning environments. However, these notable distinctions yield the misconception that there is a difference in the way the students *engage* socially. Students who did work together only did so for a short period of time before they would become distracted by wayward and capricious topics and end up not working at all. A few of the students were unable to resist the temptation of getting on the Internet and watching YouTube videos. On many occasions, there were loud bursts of laughter that would echo throughout the classroom as a result of seeing something funny on a video. This would create a divide between students who fostered self-governance and those who exploited the laissez-faire structure. The social interactions among teens have an influence on behavior as the behavior of students has an impact on social interactions. With fifteen years of observing this dynamic, similar distinct socio-behavioral patterns emerge. One study indicates they emerge as a result of sending and receiving information through technology (Humble-Thaden, 2011; Grant et al., 2013). There are similar social patterns in comparison for a study conducted with the implementation of OMI using a classroom set of laptops. This was not a lab setting or a learning center. The setting was a typical classroom, with desks and a whiteboard.

A general conclusion is that the MES was effective for analyzing changes in behavioral engagement when respondents were presented with a new method of instructional delivery. It could not be determined if there were statistically significant changes in the other dimensions. Responses to the MSQ and other noted classroom anomalies further verify the statistical changes in behavioral engagement. There were also incidences of changes in individual engagement in all dimensions, so this tool would be an effective measurement instrument classroom phenomenon at the micro level, such as for classroom teachers who are interested in implementing an online modularized line of instruction for a self-determined group of students. Even for students on the other end of the spectrum, such as those who are seemingly nonfunctioning in a self-contained classroom, this instrument can be used by alternative school programs that rely heavily on technology-enhanced modularize instruction. While this study did not emphasize merit-based performance, modifications can be made to determine if student performance improves when transitioning from traditional classroom teacher-centered pedagogies to student-centered heutagogy (Blaschke, 2012).

Perceptions of MathXL® Satisfaction Questionnaire (MSQ)

The MSQ was designed by the researcher for the purpose of cross-checking survey responses with participant replies to five questions (see AppendixD). As detailed in Chapter 4 and in Appendix E, attempts were made to align the questionnaire replies to dimensions from the MES. The first question was easily aligned with the emotional dimension (Fredericks et al., 2016; Wang et al., 2016). When asked if the students felt like they learn more or less from MathXL®, the replies were a simple *more*, *less* or *same* with minimum or no elaboration. General feelings towards the first question, a question that calls for elaboration, may indicate how students feel about their learning from modularized instruction; not necessarily from MathXL® alone. Since most students indicated they felt like they learned more, it may be justification for moving forward for future courses. However, students who indicated they learned less would be grounds for modifications to those future courses. Even from the one comment that indicated that the student *feels like [he is] teaching himself*, potential modifications to future design depend on such comments.

The design of the remaining questions warranted more elaboration than the first one did, and the students followed through by providing more details in their replies. It was anticipated that questions 2 and 3 of the MSQ would elicit responses that would align with the emotional dimension. However, respondents made connections to other dimensions as well. An obvious example is the number of replies that mentioned something similar *learning at my own pace* for question 2 and *lack of instruction* for question 3. A peculiarity emerged whenever I began to look at the reasons why students were able to move on so quickly with these sentiments. Students were able to move ahead because they would simply mimic the examples without reviewing the associated reading material. Many of the replies to the MSQ questions alluded to this being among the drawbacks of MathXL®. Yet, many were observed using this feature as if they relied too heavily on it. Therefore, it suffices that these comments provide beneficial feedback for the consideration of rigor in future designs.

It appears that most students are trying to learn the material from the *view an example* or the *Help Me Solve This* feature (see Figure 2.2, page 30). Unfortunately, there are no known studies that make a connection to how much is learned from using these features alone. The approach by the students, however, appears to be in accordance with a self-determined mindset. From the standpoint of a practitioner, it appears that the students are receiving more exposure than they would from the teacher-centered pedagogies they have turned away from for years prior to this study.

Student replies to Question 4 provided information to similarities two other platforms. Most students compare this to the traditional lecture-oriented platform. There are others who were reminded of a program or programs from previous grades. There were two students who recalled using a program in middle school called *Study Island*. Other replies seemed to be in the form of vented frustrations. Yet, even this information is useful in creating an anticipatory setting for future designs. This pattern of replies continued with Question 5. The most common sentiment when contrasting modularized instruction with the traditional format was that it involved *self-teaching*. Many times it was not indicated if this was a positive or a negative sentiment, leaving the researcher to rely on other data. In other words, many students would simply state the difference and not indicate if it was a favored or unfavored difference. Overall the MSQ provided information on what to look for in an individual student if they exhibit sentiments indicative of a specific dimension from the MES. Just as was accomplished with student 88 with his seemingly emotionally-driven replies, this information led to a further inquiry into individual responses from the emotional dimension, thereby providing a rationale for the mixed-methods design for this study.

Perceptions on Additional Observations

Many observations that did and did not align with the MES dimensions and the MSQ questions were recorded. Some classroom behaviors brought attention to themselves more than others, just as some students would require more help with math than others would. These behaviors would be noted more than others, for they brought attention to the way students engage in accordance with the MES dimensions. Students who did not bring as much attention to themselves were observed working quietly amongst themselves with earphones in their ears. These students appear to have a pattern of entering the classroom and procuring a laptop, plugging their earphones into their ears, adjusting their music or whatever it is they were listening to and working on MathXL® until it is time to go. Students of this nature were successful with the modularized format, and most either recorded positive responses on their questionnaires or provided constructive feedback with a positive tone. This helps to assure the validity of their response to the MES, and further credits the survey as something likely be used in the future.

Actions and Implications

The purpose of this study was to examine answers to the question: *In what ways are the engagement levels of low-achieving high school seniors affected by online modularized mathematics instruction?* The findings of this study show that there was a multitude of changes in the way low-achieving seniors engaged in math instruction. Statistically, the quantitative aspects of this study showed significant changes in the way students engage in OMI from a behavioral standpoint. There were other ways the participant engagement was affected by OMI, but individually rather than collectively. The effects were examined from a qualitative standpoint with the use of replies to the MSQ. In addition, noted classroom observations provided information on the specific ways the most and least successful students engage. This information can be used as implications for future researchers, teachers, and designers on OMI.

Implications for Educators. Overall, the math engagement survey makes for an interesting measurement tool in comparing documented classroom activities to the responses of individual students. When a teacher is apt to generalize a student body similar to the way students are collectively deemed as low-achieving for this study, the MES can be used to examine areas where instruction might be improved within the four engagement dimensions (Fredericks et al., 2016; Wang et al., 2016). Locally, the MES was useful in analyzing changes in behavioral engagement. On a macro level, emotional, cognitive, and social engagement might be examined. This is particularly foreseeable when connecting educational institutions of a low socio-economic demographic with the emotional dimension and those of a higher socioeconomic demographic, such as a private or charter school, with the cognitive dimension (Valero & Meaney, 2014). Any research regarding math teachers who implement OMI and those who use the MES or similar instruments can be assistive in decisions regarding accommodations and adjustments that provide layout favored by the self-determined student. A caveat is that while the intent of OMI may be to foster heutagogy, some traditional resources should remain to assist the student in making a successful transition to this new relatively unfamiliar theoretical framework (Cochrane et al., 2014). Supplemental research initiatives that are aligned with a mixed-methods study, such as the case with the MSQ, can be used at the discretion of the practitioner for research at the micro level.

Implications for Researchers. The MES data obtained from this study combined with MSQ data is used in determining if the instructional design is sufficient for future instructional practices. However, this only applies to one classroom located in rural Central Kentucky. The opportunities for broader studies with multiple participant groups exist beyond isolated regions with unique stereotypes (Azevedo et al., 2012; Fredericks et al., 2016; Wang et al., 2016). Other research designs can perhaps provide a more comprehensive examination of engagement in math instruction by a larger population. The works of Archambault et al. (2012) is an example of such but corresponds to an educational setting of a Canadian culture.

Even so, their research is assistive to practitioners interested in examining engagement in math delivered through instructional practices that have already been generally accepted. Perhaps further research on designs that foster paradigm shifts – as heutagogy does – can supplement this and other research regarding engagement in math instruction.

As the culture of which students learn has an impact on engagement - especially social engagement – research is further needed to examine ways to improve engagement of other types and dimensions. This is especially true with institutions that accommodate historically lower-achieving and higher achieving demographics. Research on low-achieving demographics can be useful in providing information that supplements or even replaces traditional instructional delivery methods by which students have historically struggled (Wahlberg, 1997; Bradley & Corwyn, 2002). Such research is pertinent to identifying breakdowns in engagement and associated problems thereof. Similarly, research on higher-achieving, merit-based institutions can be significant in providing information that exemplifies a model design of OMI (Cameron et al., 2005)

Implications for Designers of OMI. There are many programs beyond MathXL® that can be classified as a Virtual Learning Environment (VLE) as mentioned in Chapter 2 (Paulsson & Naeve, 2006). These can be found as supplements to instructional material owned by many of the major textbook publishing companies. While the incorporation of VLEs into methods of teaching and learning have existed as long as the VLEs themselves have existed, what is important for designers of OMI is to consider the implications for heutagogy – a theoretical framework made popular in Australia (Hase & Kenyon, 2007).

According to Cochrane et al. (2014), as advancements in technology offer more flexibility and accessibility, it becomes sufficient for educational stakeholders to transition from teacher-centered pedagogies to instructional frameworks that align with self-determined learning theory (Deci & Ryan, 2008; Blaschke, 2012). Among the things to consider is a possible redesign to transition from timelines established by various educational institutions to student-implemented timelines established by the recipients of OMI. This can be a challenge, for to consider such a transition may be regarded as an overwhelming paradigm shift from tradition. Perhaps more studies on heutagogy as implemented in various educational settings in the United States are warranted. There is also the likelihood that instructional designs that foster self-determined learning are already in place, but examinations on these practices are yet to be regarded as heutagogy in American educational institutions (Deci & Ryan, 2008; Blaschke, 2012). From the standpoint of a practitioner, this can be a difficult transition to make. All stakeholders expect teachers to teach, even if research shows to do so in every sense of the word may be counterproductive (Wahlberg, 1997). Without a clear understanding of the many ways a teacher has of delivering instruction, an attempt at heutagogy may face the obstacles of established norms.

Studies such as these are also important for future OMI designs by the way they include stakeholder accounts that serve as feedback. This feedback acquired from research instruments such as the likes of the MES and the MSQ serves as information regarding software performance and navigational issues that might exist within VLEs. Participants of this study were apt to express concerns over the learning curves that impede advancements through coursework but were also assistive in offering constructive suggestions on how OMI might be enhanced. This is evident with an MSQ reply from student #86, who wrote: *There are not true teaching lessons, unlike an actual classroom. You just get a vague walk-through of the problem you're stuck on.* This and other similar sentiments are useful in modifying the line of instruction, especially when such modifications are beyond the accessibilities of a practitioner. In other words, these vague walk-throughs may be feasible for a teacher who implements a hybrid design consisting of both OMI and traditional instructional practices. However, those who foster a strict heutagogical design are in need of modifications that include additional learning resources for the self-determined learner; especially at the high-school level with often low-achieving students are learning how to be a self-determined learner in addition to learning the curriculum.

Lessons Learned

In retrospect, it was not wise to essentially turn the class over to the students and have them proceed at their own pace following what they seemed to perceive as their own rules. I never favored a laissez-faire style of leadership, yet that is what my style evolved towards whenever I began to put so much focus on this study and not as much as I should have on teaching. It was neither as wise to rely on the ambitions of the students to achieve a commensurate level of success. About five participants had little or no ambition to complete the course on their own, and their behavior was indicative of students who have eased past other math courses with a minimum D minus. It was the self-determined students who were able to block the less ambitious students out; the self-determined students were the most engaged in the process of learning from online modularized instruction.

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Appendix A

Math Engagement Survey Items (Wang et. al, 2016).

Behavioral engagement
1. I stay focused.
2. I answer questions in class.
3. I put effort into learning.
4. I keep trying even if something is hard.
5. I ask questions in class.
6. I complete my homework on time.
7. I talk about math and science outside of class.
8. I try to learn more about the topics we cover in class.
9. I don't participate in class (Reverse coded).
10. I do other things when I am supposed to be paying attention (Reverse coded).
11. If I don't understand, I give up right away (Reverse coded).

Emotional Engagement
12. I often like to be challenged in math and science class.
13. I look forward to math and science class.
14. I enjoy learning new things in math and science class.
15. I want to understand what we are learning in class.
16. I feel good when I am in math and science class.
17. I often feel frustrated in math/science class (Reverse coded).
18. I think that math/science class is boring (Reverse coded).
19. I don't want to be in math/science class (Reverse coded).
20. I don't care about learning math/science (Reverse coded).
21. I often feel discouraged when I am in math/science class (Reverse coded).
22. I often get worried when I learn new things about math and science (Reverse coded).

Cognitive engagement
23. I go through work that I do for class to try to make sure it is right.
24. I think about different ways to solve a problem.
25. I try to connect what I am learning to things I have learned before.
26. I try to understand my mistakes when I get something wrong.
27. When I am studying, I only review problems I have solved before.
28. I would rather be told the answer than have to figure it out myself (Reverse coded).
29. I don't think that hard when I am doing work for class (Reverse coded).
30. When work is hard, I only study the easy parts (Reverse coded).
31. I do just enough to get by (Reverse coded).

Social engagement
32. I build on others' ideas.
33. I try to understand others peoples' ideas in math and science class.
34. I try to work with others who can help me in math/science.
35. I try to help others who are struggling in math/science.
36. I don't care about other peoples' ideas (Reverse coded).
37. When working with others, I don't share my ideas (Reverse coded).
38. I don't like working with my classmates (Reverse coded).

Appendix B

Student View of Student View of Math Engagement Survey

The following survey is a reflection of your engagement in math class. For each of the questions/statements below, circle the response that best characterizes how you feel about the statement. A = strongly disagree, B = disagree, C = neither agree nor disagree (neutral), D = agree, and E = strongly agree.

	strongly disagree	disagree	neither agree or disagree	agree	strongly agree
1. I stay focused.	A	B	C	D	E
2. I answer questions in class.	A	B	C	D	E
3. I put effort into learning.	A	B	C	D	E
4. I keep trying even if something is hard.	A	B	C	D	E
5. I ask questions in class.	A	B	C	D	E
6. I complete my homework on time.	A	B	C	D	E
7. I talk about math outside of class.	A	B	C	D	E
8. I try to learn more about the topics we cover in class.	A	B	C	D	E
9. I don't participate in class.	A	B	C	D	E
10. I do other things when I am supposed to be paying attention.	A	B	C	D	E
11. If I don't understand, I give up right away.	A	B	C	D	E
12. I often like to be challenged in math class.	A	B	C	D	E
13. I look forward to math class.	A	B	C	D	E
14. I enjoy learning new things in math class.	A	B	C	D	E
15. I want to understand what we are learning in class.	A	B	C	D	E
16. I feel good when I am in math and science class.	A	B	C	D	E

17. I often feel frustrated in math class.	A	B	C	D	E
18. I think that math class is boring.	A	B	C	D	E
19. I don't want to be in math/science class.	A	B	C	D	E
20. I don't care about learning math/science.	A	B	C	D	E
21. I often feel discouraged when I am in math class.	A	B	C	D	E
22. I often get worried when I learn new things about math.	A	B	C	D	E
23. I go through work that I do for class to try to make sure it is right.	A	B	C	D	E
24. I think about different ways to solve a problem.	A	B	C	D	E
25. I try to connect what I am learning to things I have learned before.	A	B	C	D	E
26. I try to understand my mistakes when I get something wrong.	A	B	C	D	E
27. When I am studying, I only review problems I have solved before.	A	B	C	D	E
28. I would rather be told the answer than have to figure it out myself.	A	B	C	D	E
29. I don't think that hard when I am doing work for math class.	A	B	C	D	E
30. When work is hard, I only study the easy parts.	A	B	C	D	E
31. I do just enough to get by.	A	B	C	D	E
32. I build on others' ideas.	A	B	C	D	E
33. I try to understand others peoples' ideas in math class.	A	B	C	D	E
34. I try to work with others who can help me in math.	A	B	C	D	E
35. I try to help others who are struggling in math.	A	B	C	D	E

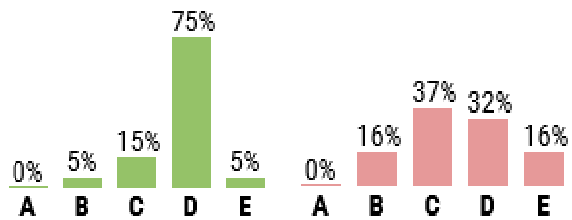
36. I don't care about other peoples' ideas.	A	B	C	D	E
37. When working with others, I don't share my ideas.	A	B	C	D	E
38. I don't like working with my classmates.	A	B	C	D	E

Appendix C

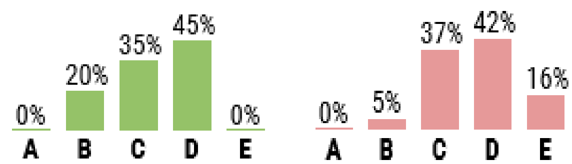
MES Stimulus Data: A = strongly disagree, B = disagree, C = neither agree nor disagree (neutral), D = agree, and E = strongly agree.

Behavioral Engagement Dimension (1-11)

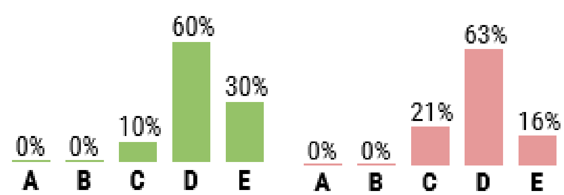
1. I stay focused.



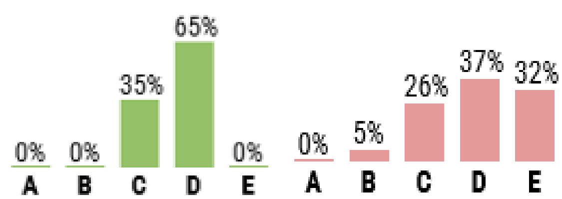
2. I answer questions in class.



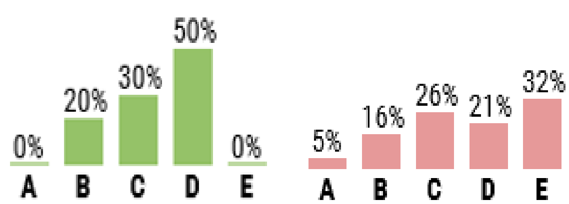
3. I put effort into learning.



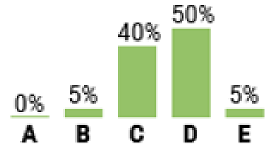
4. I keep trying even if something is hard.

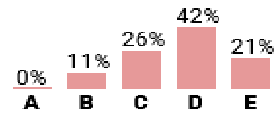


5. I ask questions in class.

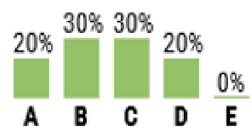


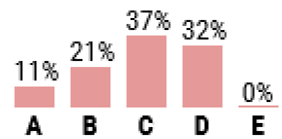
6. I complete my homework on time. \



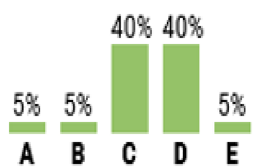


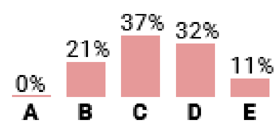
7. I talk about math outside of class.



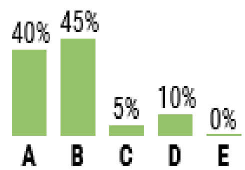


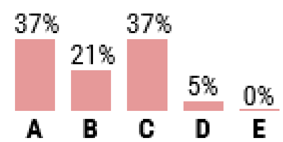
8. I try to learn more about the topics we cover in class.



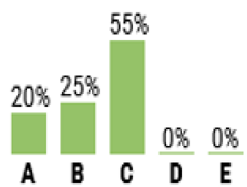


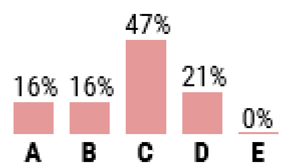
9. I don’t participate in class.



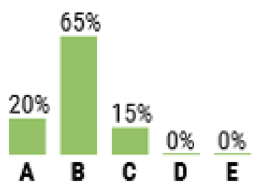


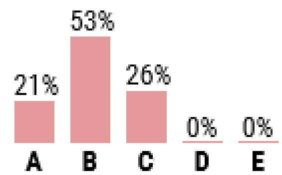
10. I do other things when I am supposed to pay attention.





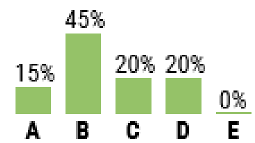
11. If I don’t understand, I give up right away.

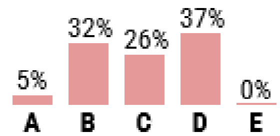




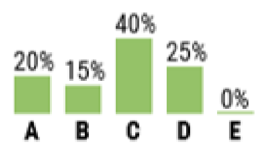
Emotional/Affective Engagement Dimension (12-22)

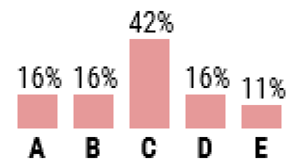
12. I often liked to be challenged in math class



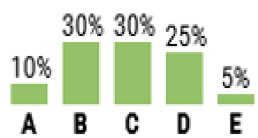


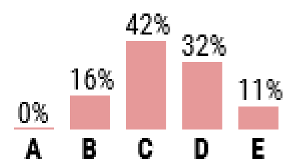
13. I look forward to math class.



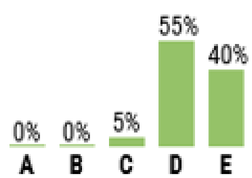


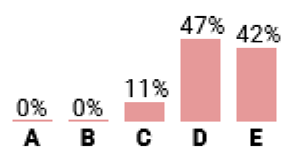
14. I enjoy learning new things in math class.



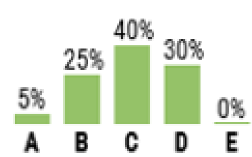


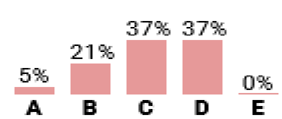
15. I want to understand what we are learning in class.



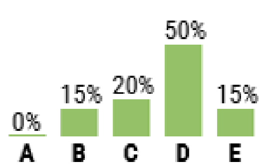


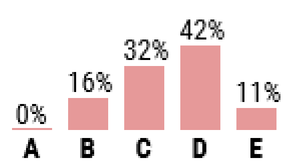
16. I feel good when I am in math and science class.



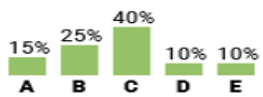


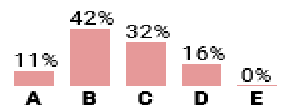
17. I often feel frustrated in math class.



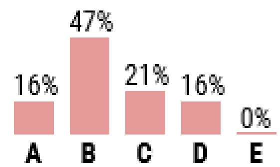


18. I think that math class is boring.

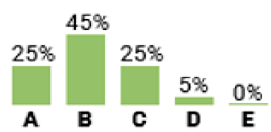


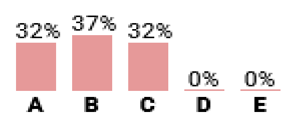


19. I don't want to be in math class.

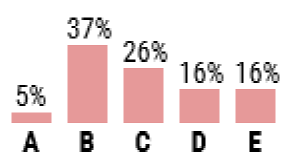


20. I don't care about learning math.

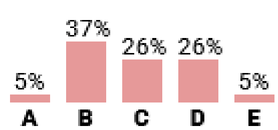




21. I often feel discouraged when I am in math class.

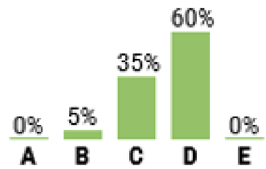


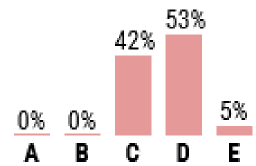
22. I often get worried when I learn new things about math.



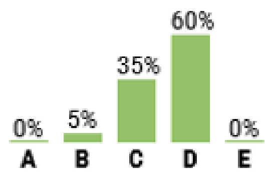
Cognitive Engagement Dimension (23-31)

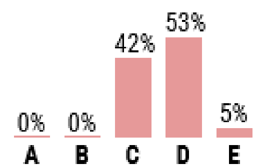
23. I go through work that I do for class to try to make sure it is right.



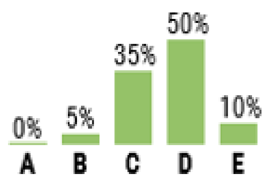


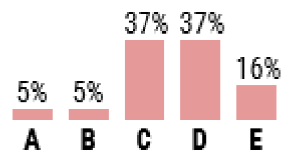
24. I go through work that I do for class to try to make sure it is right.



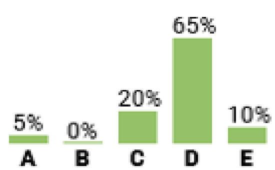


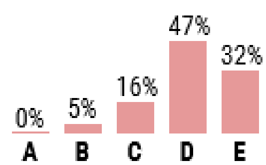
25. I think about different ways to solve a problem.



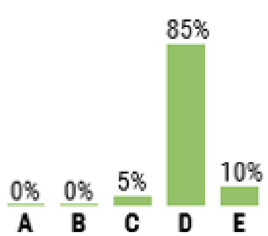


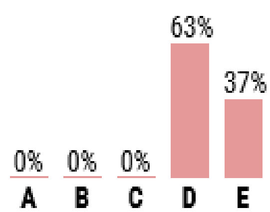
26. I try to connect what I am learning to things I have learned before.



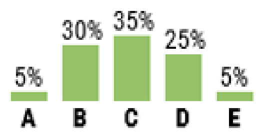


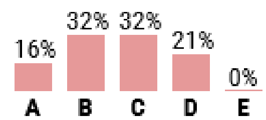
27. I try to understand my mistakes when I get something wrong.



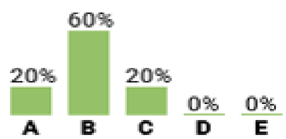


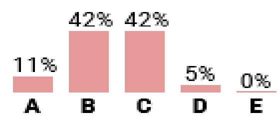
28. I would rather be told the right answer than have to figure it out on my own.



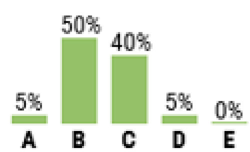


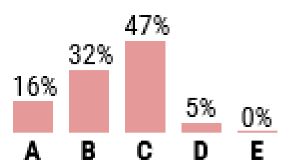
29. I don't think that hard when I am doing work for math class.



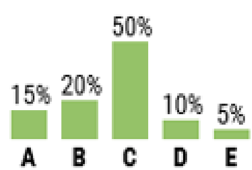


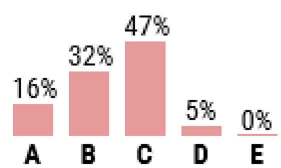
30. When work is hard, I only study the easy parts.





31. I do just enough to get by

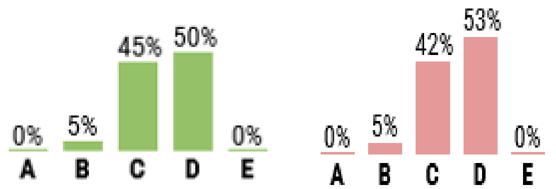




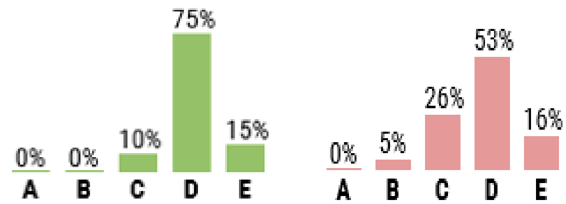
Social Engagement Dimension (32-38)

32. I build on others' ideas

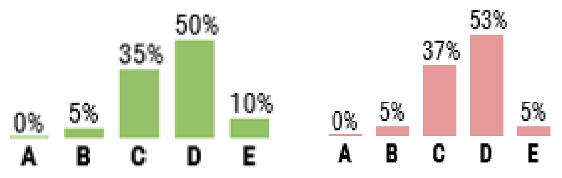
33. I try to understand others peoples' ideas in math class.



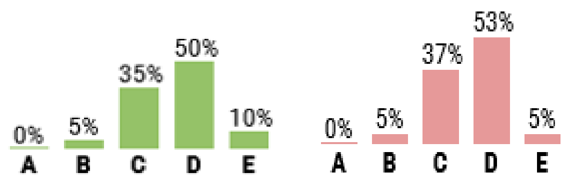
34. I try to work with others who can help me in math.



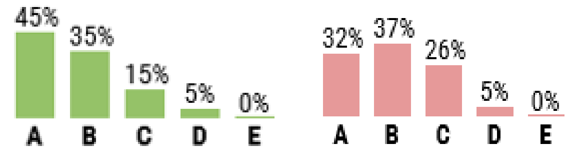
35. I try to help others who are struggling in math.



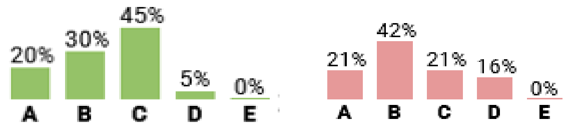
36. I try to help others who are struggling in math.



37. I don't care about others peoples' ideas in math class



38. When working with others, I don't share my ideas.



Appendix D

MathXL® Satisfaction Questionnaire

MathXL® Questionnaire

Directions: Please answer each question completely and accurately. Your responses will be used for future instruction in Pre-College Algebra.

1. Do you feel like you learning math more or less from MathXL® than from the way you learned it in the past? Explain your answer.

2. What do you like most aboutMathXL®?

3. What do you like least aboutMathXL®?

4. How is this approach to mathematics the same as your previous math learning experiences? Give an example.

5. How does this approach to mathematics differ from your previous math learning experiences? Give an example.

Appendix E

MSQ Replies and Dimension Indicators

Question 2 Replies

ID	Comment	Engagement Dimension
80	*"You can work at your own pace and move ahead"*	Behavioral
81	*"It's Online"*	Behavioral/Cognitive/Social
82	*"The freedom to move on"*	Behavioral
83	*". . . I can learn at my own pace"*	Behavioral
84	*"The 2nd chances"*	Cognitive
85	*"Test Retakes"*	Cognitive
86	*". . . let's me go back through and perfect my scores . . . and that you can see where you are and what you need to do in class"*	Cognitive
87	*"The 'question help'"*	Behavioral/Cognitive
88	*"The examples"*	Cognitive
89	*"The ability to work as long as I need to and be able to redo assignments until I understand"*	Cognitive
90	*"Having the examples to help me if I need it"*	Behavioral /Cognitive
91	*"The way you can learn independently"*	Behavioral/Cognitive
92	*"I like that it shows examples . . . I can fix my grade by doing better . . . fast, easy access . . . can do it anywhere"*	Social
93	*"That you can go at your own pace"*	Behavioral/Emotional/Cognitive
94	*"That I get to be control my grade and the time I take doing it"*	Behavioral
95	*"The availability you can work on it"*	Behavioral/Cognitive
96	*"That you can access the entire year's work!"*	Behavioral/Emotional/Cognitive
97	*"Do on own time"*	Behavioral
98	NO REPLY	N/A

Question 3 Replies

ID	Comment	Engagement Type
80	*"Not being able to move on to the next level until you get a 65% so you can come back"*	Behavioral
81	*"The due date"*	Behavioral
82	*"It can be easy to fall behind."*	Behavioral
83	*". . . the little positive reinforcement when you correctly answer"*	Emotional
84	*"The 8 lessons in a chapter"*	Behavioral
85	*"Lack of walking through the question"*	Cognitive/Social
86	*". . . no true explanations to your assignments . . . it shows you what to do, but doesn't always explain why you take those steps within a problem"*	Cognitive
87	*"Having to graph things"*	Behavioral/Cognitive
88	*"How much longer it takes for me to learn things than if I were taught"*	Behavioral/ Cognitive/Social
89	*"The test are difficult."*	Emotional/Cognitive
90	*"If you don't understand and the example don't help I have to figure it out on my own"*	Behavioral/Emotional/Cognitive/Social
91	*"How fast it moves"*	Behavioral/Cognitive
92	*"It's not student-teacher contact, like a teacher isn't teaching me in person . . . doesn't tell me what I am doing wrong. . . doesn't have videos"*	Social
93	*"That there's no instruction, so when you're stuck on something you're kind of out of luck"*	Emotional/Cognitive/Social
94	*"You have to put in a certain way to get the correct answers and I don't feel like I am learning/understanding enough to be prepared for college"*	Behavioral/Emotional/Cognitive
95	*"When I fall behind"*	Behavioral
96	*"Not enough multiple choice."*	Behavioral
97	*"Doesn't always explain well"*	Cognitive
98	*"Its online and I just like paperwork better."*	Behavioral/Emotional

Question 4 Replies

ID	Comment	Engagement Type
80	*"You learn the same types of things just different ways to solve them."*	Behavioral/Cognitive
81	*NO REPLY*	N/A
82	*"Still have tests that teach you and still take tests over what we learned."*	Behavioral
83	*". . . The content is relatively similar. I am seeing things that I have seen before."*	Behavioral/Cognitive
84	*"Learning just as fast and efficient"*	Behavioral
85	*"Different. I am used to teachers teaching me."*	Social
86	*"It's the same in the sense that there is homework and you're given quizzes."*	Behavioral
87	*"I'm self-learning kind of like my math class last year because my teacher had a different learning style."*	Behavioral/Social
88	*"I would not compare this to many math classes I have taken"*	Emotional
89	*"It still gives you problems to learn how to do and teaches you the formulas to use."*	Cognitive
90	*"Asking for help and looking at examples."*	Behavioral
91	*"Study Island from Elementary"*	Behavioral
92	*"It reminds me of this site we used in Middle School Study Island."*	Behavioral
93	*"It's not"*	Emotional
94	*"I have done other computerized math courses like Edgenuity, so it is similar in that manner"*	Behavioral/Cognitive
95	*"It has a deadline"*	Behavioral
96	*"Sort of reminds me of when we would take all our test!"*	Emotional
97	*"Never done math online other than mathgames.com"*	Behavioral
98	*"I understand that they are trying to find a better way for us to learn but it's not for me. Online courses are more difficult."*	Emotional

Question 5 Replies

ID	Comment	Engagement Type
80	*"You are on a computer solving problems on your own."*	Behavioral/Cognitive/Social
81	*NO REPLY*	NA
82	*"I don't always have someone to explain every step."*	Social
83	*". . . it allows the student to self-teach at their own pace."*	Behavioral/Cognitive/Social
84	*"I have to teach myself."*	Behavioral/Cognitive/Social
85	*"I have to go to the teacher to learn."*	Behavioral/Cognitive/Social
86	*"There are not true teaching lessons, unlike an actual classroom. You just get a vague walk-through of the problem you're stuck on."*	Emotional/Cognitive/Social
87	*"It is fast pace just because of how easy it is to learn but there is still a lot to do"*	Behavioral/Emotional
88	*"There is a lot more confusion and few to no notes which I normally take but the amount of time and effort to write down notes compared to the three or four problems I would use it on doesn't seem worth it."*	Behavioral/Emotional/Cognitive
89	*"You have to learn on your own without someone showing you unless you ask for help or view an example."*	Behavioral/Cognitive/Social
90	*"Helping students that don't understand."*	Emotional/Social
91	*"It's more independent so the student will learn to problem solve on his or her own."*	Behavioral/Cognitive/Social
92	*"Diff. because it's all online, no pencil no paper."*	Behavioral
93	*"You're teaching yourself and going at your own pace."*	Behavioral/Cognitive/Social
94	*"I feel like I have more direct control over my grade and I am able to tell if I am on track more easily than with other computerized courses."*	Behavioral/Emotional/Cognitive
95	*"Self-teaching"*	Behavioral/Cognitive
96	*"Used to working from a book or paper"*	Behavioral/Emotional/Cognitive
97	*"Other was with a person!"*	Emotional/Social
98	*"It's more difficult and it's overwhelming for me personally."*	Emotional

VITA

Donovan M. Hawkins

EDUCATION

May, 2003	Bachelor of Science Murray State University Murray, Kentucky
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2014-2018	Teacher Spencer County Schools Taylorsville, Kentucky
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2010-2014	Assistant Professor Madisonville Community College Madisonville, Kentucky
2006-2009	Teacher Lyon County Schools Eddyville, Kentucky

HONORS

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