An Examination of a Community College Instructor Who Uses Technologies as Pedagogical Tools to Teach Algebra.

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The use of technology is a vital part of the learning of mathematics. The National Council of Teachers of Mathematics (NCTM) states that technology is a crucial element of teaching mathematics because the use of technology helps teachers demonstrate mathematical concepts easily (2000). Technology will always be changing over time (Ferrara, Pratt, & Robutti, 2006). As the world is approaching a new age of technological innovation, Laxman (2012) indicates that technology could make learning algebraic concepts more exciting and meaningful. According to NCTM's (2000) technology principle, technology is necessary for teaching and learning algebra. However, according to Heid (2003), "The effectiveness of any tool depends entirely on the decisions made regarding its use" (p. 50).

The use of technology opens various doors for instructors to teach and for students to learn mathematics (Heid, 2005). Access to technologies in a mathematics classroom benefits students in learning mathematics. NCTM (2011) argues that "students should have regular access to technologies that support and advance mathematical sense making, reasoning, problem solving, and communication" (para. 1). Technology is changing the way knowledge is shared and changing teachers' roles; institutions need to support educators in making these changes (Kull & Halal, 1998). Thus, NCTM (2000) progresses toward a mathematics curriculum and instruction with technology as an essential part of the learning environment.

Students can grasp higher levels of mathematical ideas when they use properly designed technological tools (Blume & Heid, 2008). The technology must be available to the students for exploration; and the future of technology in mathematics education including algebra are bright (Heid, 2005). However, the appropriate or inappropriate use of technology may affect the development of mathematical concepts in learning and teaching algebra (Heid & Blume, 2008). Therefore, the purpose of this research study is to examine the instructional practices of a two-year-college mathematics instructor who uses technologies as pedagogical tools to teach algebra.

Literature Review

Importance of Learning Algebra

Algebra is the gateway and the foundation of mathematics (Laxman, 2012). Many research studies stress the importance of learning algebra for deeper understanding of mathematics. To that end, Kaput (2000) stated, “students need to develop deeper understanding of algebra as it is the gatekeeper to higher-level mathematics” (p. 2). One of the fundamental pillars of mathematics is considered to be algebra because it is the language of higher mathematics (Trenholm, Alcock, & Robinson, 2012). When students begin to study mathematics, they should develop their algebraic thinking by making generalizations, recognizing and analyzing patterns, and representing relationships (Seeley, 2004). Algebraic thinking helps students to understand symbols, as “algebra encompasses the use of symbols, the modeling of phenomena, and the mathematical study of change” (NCTM, 2013, para. 1).

In addition, algebraic knowledge is essential for college and career readiness. Algebra can be used to solve complex, real-life problems (Wheeler, 1996). The importance of algebra is notable as algebra is part of humankind’s cultural heritage for informed and critical citizenship (Fong Ng, 2010). Algebra is the gateway to college education and careers (NCTM, 2008). While some previous research indicates that over half of the students did not achieve expected performance in college algebra, other research has found that students have positive attitudes toward the value of algebra (a part of mathematics) in their career (Champion, Parker, Mendoza-

Spencer, & Wheeler , 2011; Dunbar, 2003). Also, Nathan (2004) found that algebra is essential for students' career readiness.

Learning algebra with technology is different as Heid and Blume (2008) describe, "Technology affects algebra content, algebra tasks, and opportunities in algebra classrooms for mathematical activity" (p.93). For example, technology enables students to easily visualize graphical representations. Instructors need to think deeply about how to assist students in solving algebraic problems. To be able to do so, instructors need to develop and enhance their Technological Pedagogical Content Knowledge (TPCK) (Saul, 2008).

Technological Pedagogical Content Knowledge (TPCK)

TPCK is a combination of different types of knowledge such as subject matter, development of technology, and knowledge of teaching and learning (Niess, 2005). Instructors' knowledge of how students learn with technology is one of the components of TPCK (Niess, 2005). According to Niess (2005), "Learning subject matter with technology is different from learning to teach that subject matter with technology" (p.1). As a result, instructors need to know how to utilize the technology to create lessons for students which assist them in understanding mathematics (Lee & Hollebrands, 2008).

The development of instructors' TPCK could depend on the focus of their teaching (Lannin et al, 2013). Lee and Hollebrands (2008) have indicated a need for a longitudinal study to observe TPCK in instructors' practices with their students. Some differences were found in TPCK development based on a study that was done on how new teachers' TPCK knowledge develops; one instructor focused on assessment and student understanding, and another instructor focused on curricular knowledge (Lannin et al, 2013).

Some instructors may lack experience with the emerging technology to assist students, as they may solve the mathematical problems different ways with the help of the technological tool (Lee & Hollebrands, 2008). Preparing instructors to teach with technology should be consistent with instructional practices; for example, teaching with technologies using labs and demonstration of various activities should be consistent with the instructional approaches of community colleges (Niess, 2005). Therefore, mathematics instructors need to develop their TPCK to help students if they encounter difficulties in learning algebra with technologies (Saul, 2008). Further, developing instructors' TPCK with respect to teaching mathematics not only will help today's classroom, but the instructors will have knowledge and skills to run tomorrow's classrooms as well (Lee & Hollebrands, 2008).

Instructional Practices or Approaches of Community College Instructors

TPCK is important for the instructional practices of community college instructors. As more and more technology is integrated in today's classrooms, the instructional approaches or instructional practices of the instructor are also changing. As a result, the mathematical studies of any classroom are becoming more and more under students' control and instructors are becoming more like a coaches rather than lecturers (Moses & Cobb, 2001). The instructional approaches of using technological tools combined with a technology-based curriculum can influence the development of algebraic concepts positively (Heid & Blume, 2008). Four teaching strategies or approaches with respect to the integration of technology support student learning: making careful decisions about technology use, integrating technology into the curriculum, restricting the use of technology to a limited time, and monitoring technological work (Ball & Stacey, 2005).

From a historical perspective, Moses and Cobb (2001) wrote, “President Clinton said that while 95 percent of schools and 63 percent of classrooms are wired for Internet access, two out of three teachers with access to a computer say they don’t feel well prepared to use it in the classroom. And the teacher-training programs that exist do not prepare teachers for this kind of work” (p.117). The Mathematical Association of America (MAA) (2007) recommended improvement in mathematics courses in two-year-colleges that support students’ needs. After reviewing literature on mathematics teaching in two-year-colleges, Jordan (2013) noted a need for further study to explore the benefits of standard-based teaching. Seventy-eight percent of two-year-colleges have lecture as their main instructional practice as reported by American Association of Community Colleges, AACC (2005). However, Jordan’s (2013) study revealed that there is a robust relationship between instructor practices in two-year colleges and the standards of the American Mathematical Association of Two-Year-Colleges.

According to NCTM (2000), “Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well” (p.16). Students’ learning styles seem to be changing as Ester’s (1994) study revealed a need for further research to explore the complexity of the interactions between learning styles, and instructional approaches. With respect to technology, Heid (2005) described several points about the future of mathematics instructional practices such as the growth of web-based learning system; students and teachers’ use of Computer Algebra System (CAS) allowing students to test their mathematical ideas; and teachers’ use of technology-based instructions to assist students with their basic mathematics skills.

The instructional practices of educators will be shaped by future research on how students think in a classroom environment with technological tools (Blume & Heid, 2008).

Findings from Jordan (2013) indicated that in meeting students' need, mathematics instructors struggled to change instructional practices. No other school subjects were affected by the integration of technology as much as mathematics; especially with algebraic topics and the way students interact with algorithms and functions (Heid & Blume, 2008). Though few studies identify the relationship between access to technology and its influences on mathematics teaching and learning, instructors need to be educated about the use of technological tools (Blume & Heid, 2008).

Technology needs to be integrated into the mathematics curriculum (Ball & Stacey, 2005). Jordan (2013) found that two-year colleges need improvement in mathematics teaching and learning. Teaching algebra with technologies needs to be aligned with how students learn and the available technology Moses and Cobb stated, "We need a revolution in order to get the teaching of math up to where the technology and the students are" (2001, p.117). Students are not thriving with traditional pedagogical practices; as a result, the National Assessment of Educational Progress (NAEP) results suggested that mathematics instructors need to change their pedagogical approaches. (NAEP, 2005).

Types of Technological Tools in Mathematics Education

There are multiple definitions of *technology*. A general definition of technology is the "application of knowledge, tools, and skills to solve practical problems and extend human capabilities" (Johnson, 1989, p.1). Volti (2006) defined technology from the perspective of society and evolution of technology as "a system that uses knowledge and organization to produce objects and techniques for the attainment of specific goals" (p. 6). In the field of education and for the proposed research study, instructional technologies are computer-mediated education by using technology-mediated instruction (Gifford, 1996). For example, MyMathLab (MML) is a computer-integrated tool that mathematics teachers use for instructional purposes.

The NCTM (2014) recently proposed that all educational institutions and mathematics programs should provide teachers and students with access to instructional technologies such as web-based resources, handheld and lab-based devices with mathematical software and applications, and classroom hardware. However, the NCTM posits that teachers need to have proper training for effective use of these technologies.

There are many types of emergent technologies in our modern world. For the proposed research, the focus will be on instructional technologies that are used in the learning and teaching of mathematics. Technological tools in mathematics education can be categorized as content-specific or content-neutral (NCTM, 2011). Content-neutral tools allow students to have access to information, interactions, and ideas that can assist in mathematical sense making (NCTM, 2011). Examples of content-neutral technologies include web-based digital media and collaboration and communication tools (NCTM, 2011). In contrast, some examples of content-specific technologies are computer algebra systems (CAS), interactive applets, dynamic geometry environments, handheld computation for data collection, computer-based applications, and analysis devices (NCTM, 2011). These content-specific tools help students recognize mathematical concepts and discover mathematical relationships (NCTM, 2011).

Table 1 and Table 2 provide definitions and examples of the different types of content-neutral and content-specific technological tools, respectively. The functionalities of these content-neutral and content-specific technologies overlap with one another. These technologies help to meet the objective to improve teaching and learning in educational settings. These new technologies can reduce the barricades of time and challenge the curriculum based on textbooks

(Pattison, 1999). Thus, many features of these technologies meet the need of teachers and students. For example, the research study results of Porzio (1999) show that instructional technologies such as CAS, graphing calculators, and computer-based courses had positive effects on students' ability to grasp algebraic concepts.

Table 1

Content-Neutral Technological Tools

Type Name	Definition	Examples
Smart phones and tablets	Mobile devices that have advanced operating systems embedded with touch interface (NCTM, 2014).	BlackBerry, Surface, iPhone, iPad, etc.
Word processing and presentation software	Technologies that teachers use in educational settings to assist with lesson delivery and student presentations.	Microsoft Word, Power Point Presentation, etc.
Web-based applications	Software applications that exist on web-sites (University of West Florida, 2015). These are interactive applications to share students' work and presentations through the use of secure Web-based platforms (NCTM, 2014).	Cloud-based shared documents, virtual whiteboards, blogs, wikis, Blackboard, etc.

Table 1 shows three content-neutral technologies. With smartphones and tablets, teachers can make online portfolios and daily blogs by integrating technologies such as taking photos, making notes, and recording audio and video (Parnell & Bartlett, 2012). Also, these tools can be used by teachers and students to gather data, perform calculations, develop problem solving skills, conduct classroom polls, promote visualization, run simulations, and play games for performing mathematical tasks (NCTM, 2014). Thus, smartphones and tablets assist in documenting students' learning experiences by gathering and tracing previously worked mathematical calculations which helps them in learning mathematics (Parnell & Bartlett, 2012).

Even though word processing and presentation software is widely used in educational settings, both can also support teacher and student interactions in mathematics classrooms

(Cohen & Hollebrands, 2011). For example, due to teachers' lessons being delivered with presentation software and prepared beforehand, teachers have more time to interact with students and engage them in instructional activities effectively (Lai, Tsai, & Yu, 2011). However, word processing and presentation software are changing their versions frequently to adapt to different operating systems, and instructors need to familiar with the changes in software available for instruction (Olsen, 1993).

Through web-based applications, a third content-neutral technology, teachers can use online shared pages to extend communication with the students and parents (NCTM, 2014). The features that web-based application resources offer support the teaching and learning of mathematics. For example, blogs, virtual whiteboards, and shared documents assist students in working together on a mathematical task within a classroom as well as virtually (Roschelle et al., 2010).

Table 2 shows several types of content-specific technologies. Geometer's Sketchpad (GSP), an interactive geometry application, is a content-specific technology that allow students to participate in explorations of geometric and algebraic concepts (NCTM, 2014). GSP is not used as frequently to learn algebraic concepts and is mostly used to explore geometric concepts (Nordin, Zakaria, Mohamed, & Embi, 2010). However, by using GSP, students can manipulate variables directly and visualize the behavior of a function (Steketee & Scher, 2012). The use of GSP allows students to describe their mathematical tasks (Heid, 2005). Thus, educators can use GSP as an instructional tool to create lessons that show students the connectedness of mathematical ideas (Contreras, 2011).

Table 2

Content-Specific Technological Tools

Type Name	Definition	Examples
Interactive (dynamic) geometry application	Interactive geometry applications that enable experimentation in learning many aspects of mathematics. For example, Geometer's Sketchpad (GSP) helps students to understand functions and variables and to produce simulations for learning the concepts of algebra (Nordin, Zakaria, Mohamed, & Embi, 2010). GSP can also be used to explore the animation of mathematical models (Mahmud et al., 2009).	GSP, Geogebra, TI-Nspire, etc.
Calculators	A computation tool that is used for basic mathematical calculations in lower grades and for advanced graphical representations in upper grades. Graphing calculators encompass the calculating capabilities of a scientific calculator and include the features of graphical displays of mathematical expressions and data (Waits & Demana, 1988).	Basic elementary calculator such as TI-10, scientific calculator such as TI-30, graphing calculator such as TI-84, TI-Nspire, etc.
Spreadsheet applications	A computer application program for data storage and organization by displaying results of repeated calculations and generating tables for graphical representations (NCTM, 2014). In educational settings, spreadsheets can be used by instructors and students for data collection, calculating the correlation coefficients between different sets of data, and statistical analysis (Cox, 1993).	Microsoft Excel, Screencasts, Gnumeric, Zoho Sheet, etc.

(continued)

Table 2

Content-Specific Technological Tools

Type Name	Definition	Examples
Graphic applications	Computer applications that have graphic components such as computer imaging, picture or artwork. Graphic applications are used to examine multiple representations by generating graphs, tables, and symbolic expressions (NCTM, 2014).	Kid Pix-graphics, graphic art, animation software, Virtual Manipulatives, etc.
Computer Algebra System (CAS)	A mathematical computational tool, which can be used to compute lengthy mathematical tasks by using symbols. For example, CAS can be used to factor polynomials and rational functions and to find limits in calculus (Worcester Polytechnic Institute, 2015). CAS produces graphs of functions and tables, handles algebraic expressions, and solves inequalities and equations (Pierce & Stacey, 2004).	Maple, Mathematica, MathCAD, TI-Nspire CX, etc.
Computer Assisted Instructional (CAI) Tool	CAI can be defined as use of computer that provides direct instructions (Taylor & And, 1974). CAI is a computer-aided system in which the majority of instruction is designed for the users to perform specific tasks (University of West Florida, 2015).	MyMathLab (MML), MathXL, Wimba, MyMathTest, ALEKS

One widely used technological tool to perform basic mathematical tasks is the calculator. The graphing calculator, such as the TI-83, helps students to understand basic algebraic concepts (Martin, 2008). Similarly, the TI-Nspire CX CAS, the latest graphing calculator technology, also helps students to develop a deeper understanding of various topics in algebra. Specifically, graphing calculators let students see the relationship between graphical and symbolic representations of algebraic concepts (Villarreal, 2003). However, the focus and structure of instruction play an important role because teachers need to consider carefully how to incorporate graphing calculators in learning activities. The use of graphing calculators can improve students' understanding of mathematical concepts and help them to identify mathematical patterns (Martin, 2008).

Spreadsheets and graphic applications are also included under content-specific technologies. According to Tekinarslan's (2013) research findings, the use of spreadsheet applications by undergraduates assisted in improving achievement and increasing knowledge. Microsoft Excel has also been used by college students for modeling, simulation of digital circuits, and solving complex problems (Ibrahim, 2009). One example of graphic application software is Kid-Pix graphics that creates activities for students with pictures, games, graphs, and tables (Abramovich, 2006).

Just as four-function calculators do arithmetic problems, symbolic manipulators in the form of CAS serve the same function for algebra (Trenholm, Alcock, & Robinson, 2012). For instance, CAS can complete algebraic processes such as factoring polynomials and rational functions and finding limits in calculus (NCTM, 2014). Due to the increasing availability of CAS for teaching and learning mathematics, professors worry that students will substitute the learning of algebraic routines with the memorization of calculator-specific keys (Pierce & Stacey, 2004). Heid (2003) added some advanced knowledge to mathematics pedagogy such as students' use of CAS technology for complex and lengthy expressions by manipulating symbols to solve mathematical problems. Thus, incorporating CAS while teaching algebra, teachers must make decisions regarding the focus of algebra lessons as the technology changes the nature and focus of instruction. For example, some college algebra courses in a community college recommend students use CAS rather than using a four-function calculator (Trenholm, Alcock, & Robinson, 2012).

Computer Assisted Instructional (CAI) Tool

Mathematics instruction, specifically instruction in College Algebra courses, is moving toward the increased use of technology, in particular CAI tools. Today's students are expected to be taught in ways that differ from the educational experiences of their instructors; "Education must shift to incorporate computer-based" (Niess, 2005, p.1) technologies. Educational institutions are also using the self-paced nature of CAI tools to meet the needs of diverse students (Moosavi, 2009). For example, with MML, just like in any other lab setting, instructors become initiators of learning rather than authoritative professors (Jeger & Slotnick, 1985).

CAI supports the effort of administrators in education leadership to overcome the problem of low achievement in mathematics (Tienken & Wilson, 2007). The findings of the Camnalbur and Erdogan's (2008) meta-analysis of 78 studies, 124 articles, and 422 master's theses and doctoral dissertations indicated that CAI tools are more effective academically than traditional teaching methods. Similarly, during course sessions in labs where students received CAI, they showed higher success on a practice test than the students who took classes via other instructional methods (Tosun, Sucsuz, & Yigit, 2006). Further, Moore's (1988) research results indicate that low-performing middle school students who used a CAI tool to learn in mathematics class showed more improvement than students who did not.

The study results of Tienken and Wilson (2007) indicated that practice exercises using CAI tools benefited the students; however, the study raised the question of whether the time spent on practice exercises will improve mathematics achievement as a whole for students. With CAI tools, students have more opportunities to practice algebraic homework problems using CAI tool (Jeger & Slotnick, 1985). Students need to spend more time in the computer lab to learn the mathematical concepts when using a CAI tool. The number of hours students spent in the computer lab predicted their achievement (Ningjun & Herron, 2012). Similarly, Ningjun and Herron (2012) found a correlation between the amount of time spent in lab and the score on final exams.

CAI tools help students by providing correct answers, managing problem-solving approaches, providing immediate feedback, and pointing out mistakes (Jeger & Slotnick, 1985). Taylor and And (1974) found that despite the fact that the CAI tool sometimes did not work properly, both the instructors and students were very enthusiastic toward using CAI and it is an effective instructional tool. In addition, overall attitudes of students toward mathematics with CAI were positive, commenting that CAI was necessary, helpful, and useful (Jeger & Slotnick, 1985).

There are several CAI tools available currently, including Winba, Assessment and Learning in Knowledge Spaces (ALEKS), Intelligent Tutoring System (ITS), and MyMathLab (MML). Wimba is used to teach courses such as college algebra and other introductory level of mathematics courses (Lu, 2011). ALEKS, used to teach community college courses, is an online interactive learning system, produced by McGraw Hill that develops student problem-solving skills (Hagerty & Smith, 2005). This tool is also used to assess aptitude in secondary education. The use of ALEKS was shown to improve students' knowledge of college algebra in comparison to traditional instruction (Hagerty & Smith, 2005). Another research study revealed that ITS has the potential via computer application to meet individual students' needs; educators can guide students with weaker skills and others to learn mathematics via the CAI system (Chien et al, 2008).

According to Brewer (2009), instructors provide lectures and assigned homework to students as pedagogical tools in most College Algebra courses. Kwan and Alexander (2013) found that web-based homework plays a significant role in students' learning because of the immediate feedback the tool provides to improve algebraic understanding. However, students with a lack of algebraic skills benefitted more from the use of web-based homework than high performing students due to the opportunity for multiple attempts to solve a problem and feedback for improvement (Wooten & Eggers, 2013). In one study, students who learned with network support outperformed their peers who learned same algebra topics by traditional methods of instruction (Kwan & Alexander, 2013).

MyMathLab (MML)

For the proposed research, the focus was on the instructional technology, MyMathLab (MML), a CAI tool that was used to teach the College Algebra course in the selected community college. Pearson Education created and designed MML, which is an online interactive tool. Like MML, new technology extends dynamic methods to major concepts in algebra in contrast to paper and pencil-based mathematics practices (Ferrara, Pratt, & Robutti, 2006). MML has courses for mathematics ranging from basic mathematics to engineering mathematics to business mathematics. MML's most popular courses include statistics, calculus, and College Algebra (MyMathLab Tutorials, 2015). MML provides homework assignments, animations, videos, a multimedia textbook, study plans, and a discussion board for students to communicate with each other. The descriptions of the available features for students and teachers are presented in Table3.

Table 3

Available Features for the Instructors and Students (MyMathLab Features, 2008)

Features	Descriptions
Homework and Test Manager	This feature has options for instructor to create customized homework exercises and tests or to create online exercises that align with the textbook. Instructor can manage online homework and tests that are automatically graded and have allow time limits for completion or maximum number of attempts.
Custom Exercises Builder	The instructor can create mathematics exercises from scratch through this feature. Also, custom feedback can be created to prompt to students when they enter answers.
Comprehensive Gradebook Tracking	This feature gives instructor control of managing results from homework or tests and calculating grades. The grades can also be exported to other spreadsheet programs like Microsoft Excel. The instructor has the flexibility to calculate or delete results for students individually.
Complete Online Course Content and Customization Tools	MML has all course content to represent a complete online course. However, the instructor can easily add, remove, or modify existing course content. The feature has communication tools such as discussion board, virtual classroom, and chat capabilities.
Copy or Share Courses and Manage Course Groups	The instructor can copy an existing course to coordinate with other sections of the same course. Through this feature, instructor can use same syllabus every semester or department can maintain one syllabus for different instructors teaching multiple sections.
Interactive Tutorial Exercises	MML homework and practice exercises regenerate for students algorithmically an unlimited amount of times so students can practice and master the content of the course. This feature provides helpful feedback when students enter incorrect answers.
eBook with Multimedia Learning Aids	Different multimedia resources are available on the homework screen, examples, and exercise pages. Through these learning features, such as video clips, students can improve their understanding.
Study Plan for Self-paced Learning	MML creates a personalized study plan for students based on their test results. The study plan links directly to tutorial services for unlimited practice. Students can use the multimedia learning aids for extra help.

Both students and faculty benefit from MML. Kodippili and Senaratne's (2008) research indicates that the student success rate with this CAI tool was significantly higher in the MML student group (70%), compared with the traditional paper-based group (49%).Yun (2011) found that the use of a software tool like MML can improve the communication in online mathematics teaching. Research results indicated that e-textbooks were the least helpful resource and the most used MML features were *Help Me Solve This Problem* and *View an Example* (Aichele, Francisco, Utley, & Wescoatt, 2011).

MML can be used as a medium for homework, which benefits both students and teachers (Kodippili & Senaratne, 2008). Ester (1994) revealed that some learners performed well with CAI as an instructional tool, and they needed less assistance from instructors. As a result, instructors had more time to spend with other learners who lacked algebraic skills. Jeger and Slotnick (1985) indicated that as the instructors' role changed through the use of MML, instructors could observe students' learning processes more closely. In addition, instructors could intervene with students' mathematical work more quickly and directly. The findings from one study of MML indicated that students liked the resources that directly assisted them in completing homework problems over in-class lessons (Aichele, Francisco, Utley, & Wescoatt, 2011). On the other hand, as a CAI tool like MML requires students to have computer proficiency skills, some learners felt overwhelmed using the tool (Jeger & Slotnick, 1985).

Overall, MML provides practice exercises, multiple attempts at homework exercises, tutorials, helpful suggestions, instructions, tests, and demonstrations of problem-solving techniques. Stewart (2012) concluded that students who completed their homework with MML were more successful in a calculus course than students choosing the traditional homework option. Through this type of online learning environment, students have the potential to learn many algebraic techniques. Therefore, instructors need to be trained on how to use such platforms effectively for students to benefit from their use (Flory, 2012).

The use of all new technologies will strongly influence the future of mathematics education, particularly the teaching of algebra. Incorporating algebraic technologies into the school curriculum involves a drastic change in ideas and activities (Villarreal, 2003). For example, traditional paper-based homework can be replaced with web-based homework that provides multiple attempts to complete problems. In order to provide instructors with the knowledge and the support they need, further investigation is required with respect to learning and teaching with these new technologies (Mariotti, 2014).

Problem Statement

NCTM takes the position that, “Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students’ learning” (2000, p. 24). Mathematics instructors help students to make important connections that are meaningful by using technology as a pedagogical tool (Jordan, 2013). However, teachers need to understand how each technology can improve the teaching and learning of specific mathematics topics, and when the use of a specific technology could limit the learning of any particular mathematics content (Attard, 2012).

Therefore, according to NCTM (2013), technology cannot take the place of the algebra teacher. A teacher must make practical decisions about when to use technology and ensure that the technology is improving students' algebraic thinking. According Heid and Blume (2008), “Technology both limits and expands opportunities for conceptualizing in algebra” (p.59). Further, teachers should not limit the use of technology because of their own unfamiliarity or discomfort with it (NCTM, 2013). The purpose of the proposed research study was to examine the instructional practices of a two-year-college algebra instructor who uses MML as a pedagogical tool. Therefore, the proposed research study question is: What are the instructional practices of a two-year-college instructor who uses MML as a pedagogical tool to teach college algebra? The researcher will identify how the instructor is incorporating MML into his/her classroom learning activities, homework, and assessments.

Methodology

Design

The present study used a qualitative case study approach. In terms of research design, a case study is “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (Yin, 2008, p.18). For example, the proposed research study will examine how a teacher incorporates CAI in the classroom. Similarly, Merriam (2009) defines “case study” as a detailed description and analysis of a single entity. The final report is “an end-product of field oriented research” (Wolcott, 1992, p. 36).

There are different types of qualitative case studies such as historical, observational, intrinsic, instrumental, and multisite (Merriam, 2009). The present study was an observational case study as the major data gathering technique was observations of class sessions of a College Algebra course (Bogdan & Biklen, 2007). To supplement and support the observations, the researcher also conducted semi-structured interviews with the course instructor and several students.

Further, case studies have several special features such as particularistic, descriptive, and heuristic (Merriam, 2009). A descriptive case study is a complete description of a phenomenon that is being investigated (Creswell, 2007). The present research study design aligns with the criteria of a descriptive case study as the investigation explored a phenomenon in a classroom setting. In particular, the researcher examined how an instructor incorporates CAI into a single College Algebra course.

Ozguc and Cavkaytar (2014) conducted a case study to investigate the use of instructional technologies such as television and video compact disc players by nine special education teachers. The research was conducted in a school for children with intellectual disabilities in Ankara, Turkey. The researchers collected data by interviewing nine teachers and conducting four classroom observations. Twenty students participated in the research study. The participants' ages ranged from 7 to 14. In a similar manner, for the present study, the researcher conducted a case study to observe the instructional practices of a community college instructor who uses CAI as the platform to teach College Algebra. The researcher observed all meetings of one class section to examine how the instructor incorporated CAI into his/her classroom learning activities, homework, and assessments.

College Setting

The present research study was conducted at a two-year community college in the Southwest United States. According to the selected college's website, the college provides an affordable education and offers 70 disciplines of study. The college has seven large campuses across a large metropolitan area. The enrollment requirements include a valid Social Security number and an active email address. The educational background of the students is diverse including GED, high school, and home school graduates; early and dual credit high school students; non-high school graduates who did not take the GED; and transfer and continuing education students. The present study was conducted on one of the seven campuses.

College Algebra is a three-credit course at the selected community college. As indicated by the course description, the focus of College Algebra is on helping students develop a deeper understanding of the applications of polynomial, exponential, rational, logarithmic, and radical functions and systems of equations using matrices. Some mathematics instructors use technological tools (e.g., MyMathLab) in their classes. According to the college website, the prerequisite courses are non-credit developmental mathematics courses (e.g., MATH 0361 Developmental Mathematics 1). The researcher observed one of the College Algebra class sections, for a total of 11 class meetings.

Participants

The primary research participant was the instructor of the selected class section in which CAI was used as the pedagogical tool. Before teaching at the community college, the instructor taught second to seventh grade in mathematics, science, and social studies in the public schools for 15 years. In order to teach at the community college, the participant instructor needed to have at least a bachelor's degree with 18 or more credit hours of graduate courses in mathematics. At the time of the study, the instructor had been teaching for 14 years at the selected community college. He initially taught part-time in the evening before he started to work full time for the college eight years ago. At the time of the study, he was also a co-chair of the mathematics department and, along with the other department faculty, part of his job responsibilities included ensuring all class sessions were covered in the case of faculty absences. During the semester when the research took place, the instructor was teaching College Algebra and Math for Teachers Parts I and II.

In addition, five students, enrolled in the observed College Algebra course, voluntarily participated in the research study. These five students agreed to participate in a short interview session with the researcher. The majors of the interviewed students study included Psychology, Avionics/Aeronautics, English, Education, and Environmental Science. These five students were not mathematics majors, and they were taking College Algebra to fulfill their degree requirements or to transfer to a four-year institution. All five interviewees completed the course successfully.

The Course

The selected College Algebra course session occurred during a May semester from May 15 to May 29. The class had 11 sessions each starting at 8:30 AM and ending at 12:40 PM. The researcher observed all 11 sessions in their entirety. A total of 25 students were enrolled in the class. Out of the 25 students, three students voluntarily dropped or withdrew from the course after a couple of class sessions. The class was completely computer-based utilizing MyMathLab (MML) as the pedagogical tool. The instructor mentioned during initial interview, "Our department has been incorporating computerized supplemental homework so MML is a common source for that." The students were expected to attend the class every day and work on the homework assignments. All students were expected to complete and submit assigned homework using the online MML system. The instructor did not provide class lectures or activities. Instead, the one instructor and three tutors were available to assist students in completing their homework. The author of the book embedded all associated lesson content for each chapter in videos for demonstration.

During a typical classroom session, the instructor and three tutors walked around the classroom to assist students with developing an understanding of the mathematical content. They also assisted students with related MML issues, explanations, and completion of homework problems. The researcher observed only the instructor and did not focus on the tutors. The students' grade derived from their homework assignments and five unit tests. Students took the tests at the mathematics testing center, which was located inside the emporium lab separated by a glass door (Figure 1). To be able to take a test, students had to first meet the minimum homework requirement; that is, students needed to earn an 80% on each homework assignment. Further, to progress to the next unit, students needed to earn a minimum of 70% on each unit test. The instructor mentioned in the class, "This course is based on mastery level" (Fieldnotes, 5/15/2015). Once students mastered the content in one unit, they could move on to next unit. In the first class session, the instructor explained the emporium lab-based class as follows

> This is an emporium lab-based class. Because of the style of the course, you have to take all unit tests. This is not like another traditional course where if you miss a test, your average goes down, but you can still pass. You have to master each unit. If you miss one test, you will get a "D" in the course even if you have a higher average. Only grades A, B, C, will be transferable. (Fieldnotes, 5/15/2015)

Classroom Setting

The class met in the Math Emporium, a computer lab-based classroom. The lab room was well maintained and organized. The students sat at circular tables with each student having access to a computer. The classroom sitting arrangement and overall setting is presented in Figure 1. There were blackboards all around the room. Two large TV monitors, two printers, two desks, and two cabinets were in both corners of the lab room. There were also two instructor stations with desktop computers with connection to the internet and the TV monitors. In the top right corner of the room, there were some sofas and chairs for casual seating (not pictured). On the other side of the lab room, there were some open tutoring areas where students could come outside of class time to get additional help from tutors. As previously described, the Math

Testing Center was surrounded by glass. In total, there were 19 circular tables in the lab room, and the targeted College Algebra course was located at the six yellow circular tables that are marked in Figure 1. On average four students were sitting on one circular table. Overall, the lab was setup in a way so that multiple sessions could be going on at the same time without too many interruptions.

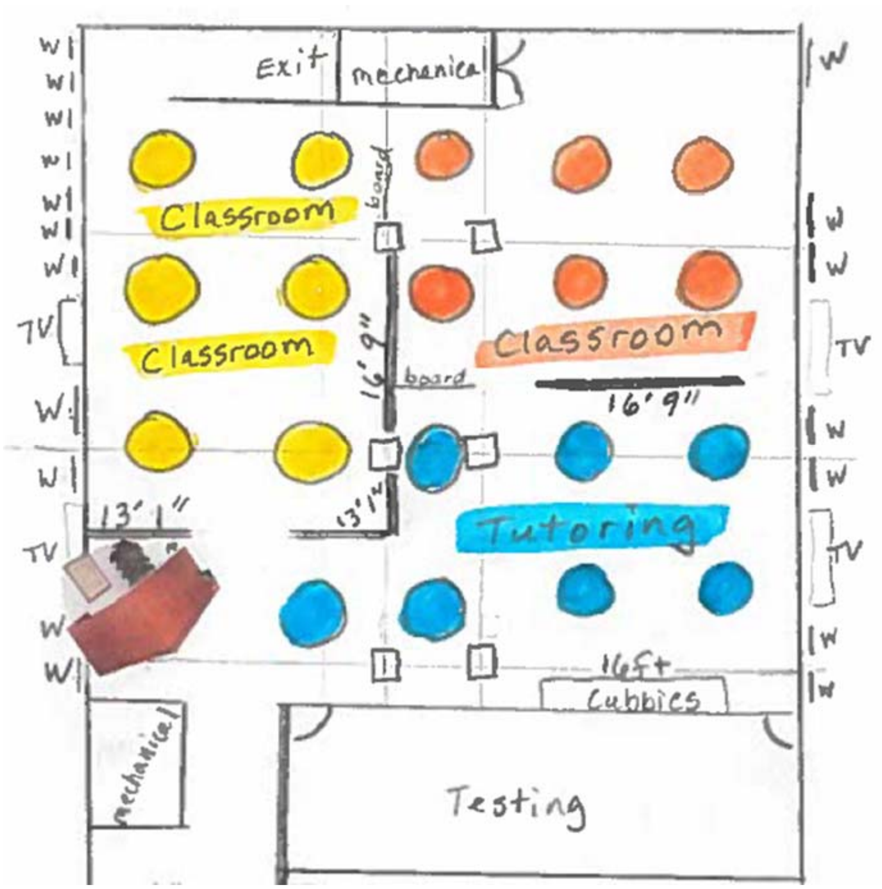

Figure 1. Diagram of the classroom setting.

Study Procedure

The researcher selected the participant instructor using purposeful sampling. Purposeful sampling is a non-probability sampling technique used in qualitative case studies to recruit participants who are relevant to the purpose of the research (Creswell, 2007)**.** In addition, Merriam (2009) stated, “Purposeful sampling is based on the assumption that the investigator wants to discover, understand, and gain insight and therefore must select a sample from which the most can be learned” (p.77). In the present study, the researcher purposefully selected an instructor who used technologies as pedagogical tools to teach College Algebra. In particular, the researcher contacted the mathematics department chair of the selected college to identify instructors who used technologies to teach College Algebra. As the department chair himself used MML to teach College Algebra, he volunteered to participate in the study.

The researcher observed all class sessions of the selected instructor’s College Algebra course focusing on the use MML as a pedagogical tools throughout the semester. The researcher took detailed notes during the observations and created fieldnotes shortly thereafter based on the observation notes. At the beginning of the semester, the researcher conducted one initial interview with the instructor. The purpose of the interview was to gain a deeper understanding about the instructor’s incorporation of MML and his perceptions of students’ interaction with MML. The interview protocol is in Appendix A. The instructor interview lasted about 30 minutes. The researcher also conducted a 15- to 20-minute debriefing session at the end of each of the two weeks of the semester. The purpose of the debriefing sessions was to have a clear understanding of the classroom sessions and to get clarifications on any questions the researcher generated based on the observations. The debriefing interview protocol is in Appendix B. All of the interviews were audio-recorded and then transcribed by the researcher.

Towards the end of the semester, the instructor asked his students to volunteer to participate in a brief interview with the observer. The researcher also explained the study to the interested students and conducted the 10- to 15-minute interviews with the students at a time convenient for them. The student interview protocol is located in Appendix C. The purpose of the students' interview sessions was for students to provide their perceptions about using MML to learn algebra. The researcher also asked students about the advantages and disadvantages of learning with MML and clarified any questions the researcher generated based on the observations.

Data Collection

During the class session, the researcher observed the class instruction documenting the learning and teaching in the College Algebra course and how MML was incorporated into classroom lessons, homework, and assessments. Next, the researcher wrote detailed fieldnotes from the observation experiences. The researcher created a log, indicated as observer's comments throughout the findings, for ongoing data collection while observing the classroom according to the following definition: a "log is the place where each qualitative researcher faces the self as instrument through a personal dialogue about moments of victory and disheartenment, hunches, feelings, insights, assumptions, biases, and ongoing ideas about method" (Ely, Anzul, Friedman, Garner, & Steinmetz, 1997, p. 69). The researcher conducted semi-structured interviews with the instructor during office hours. The researcher also conducted interviews with five students. The data sources were field notes gathered during the observations, observer's comments, instructor debriefing transcripts, instructor and student interview transcripts, and the instructor's MML course shell.

Data Analysis

The researcher analyzed the data from the instructor interview transcripts, instructor debriefing transcripts, student interview transcripts, observer's comments, and observation field notes using the constant comparative method data analysis technique as described by Glaser and Strauss (1967). Specifically, the researcher followed a multi-stage process to analyze the data. The researcher reviewed first what features the technological tool MyMathLab offered the instructor and students of College Algebra course as well as the features utilized by the instructor and students. The researcher then read the interview transcripts and observation fieldnotes to get a sense of the data. The researcher made marginal notes (memoing) on the transcripts and fieldnotes, then identified and labeled data units. Lastly, the researcher listed the labels (codes), merged codes if appropriate, and grouped the codes into themes. Overall, the objective of the data analysis was to identify patterns and meanings in the collected data. The researcher generated various themes emerging from the data to understand how the selected instructor used MML to teach College Algebra. Two categories of themes emerged from the data analysis; one was the perspective of the instructor and the other was the perspective of the students.

Findings

Based on the way the College Algebra course was setup, the main technology used to teach the course was MyMathLab (MML). Also, the researcher interviewed five students and all admitted that MML is used more than any other technology in the classroom to learn College Algebra. Thus, the research findings are based on how the instructor used MML to teach College Algebra. There were six different sources of data: the instructor's MML course shell, five student interview transcripts, instructor initial interview transcripts, instructor first and second debriefing session transcripts, field notes from all observed class sessions, and observer comments from field notes. From the data analysis, different themes emerged with respect to the perspectives of the instructor and student.

Perspective of the Instructor

The instructor plays an important role running a course. During a student interview, one student mentioned, “The instructor role was very important and the way he explained the course materials in the class was easier for student to understand and one cannot successfully pass the course without the instructor’s help.” The themes that emerged with respect to the perspective of the instructor were: managing the College Algebra course, incorporating MML in teaching, facing instructor challenges, assessing students and evaluating student success and providing instructor assistance, and providing suggestions for improvement. Each theme is described in detail in the following sections.

Theme 1: Managing the College Algebra course. This theme addresses how the instructor set up MML to manage the course. The class structure revolved on students coming to class to complete their homework or to take the tests. The instructor used a flagged system for each unit. For example, students could not move on to the homework until they completed the pre-test; they could not take the unit test until they finished all homework from that unit. In addition, under the Homework and Test sections, the instructor assigned various options to guide the students through the material including MML orientation, media files for each chapter, pre-test, homework assignments, and review tests A, B, or C. After completion of all these steps, the students would be allowed to take the unit test. According to instructors’ course syllabus, the final course grade was based on 80% of all five unit test scores and 20% of the average homework score. Thus, reviewing MML orientation or practicing for review test A, B, or C was not part of graded assignments.

Table 4

Available Features for the Instructor (MyMathLab Features, 2008)

Features	Descriptions	Part of the Feature Instructor Did/Did Not Use
Homework and Test Manager	This feature has options for instructor to create customized homework exercises and tests or to create online exercises that align with the textbook. Instructor can manage online homework and tests that are automatically graded and have allow time limits for completion or maximum number of attempts.	The instructor did not customize or use online algebra exercises. He used algebra problems that were already embedded in MML.
Custom Exercises Builder	The instructor can create mathematics exercises from scratch through this feature. Also, custom feedback can be created to prompt to students when they enter answers.	This feature was not used by the instructor at all.
Comprehensive Gradebook Tracking	This feature gives instructor control of managing results from homework or tests and calculating grades. The grades can also be exported to other spreadsheet programs like Microsoft Excel. The instructor has the flexibility to calculate or delete results for students individually.	The instructor used this feature fully and transferred student grades to the college Blackboard system.
Complete Online Course Content and Customization Tools	MML has all course content to represent a complete online course. However, the instructor can easily add, remove, or modify existing course content. The feature has communication tools such as discussion board, virtual classroom, and chat capabilities.	Since it was not an online course and the instructor was always available to assist, the communication tools such as discussion board, virtual classroom, and chat capabilities were not used.
Copy or Share Courses and Manage Course Groups	The instructor can copy an existing course to coordinate with other sections of the same course. Through this feature, instructor can use same syllabus every semester or department can maintain one syllabus for different instructors teaching multiple sections.	This feature was used by the instructor.

Table 4 presents the features available in MML for the instructor to manage the course and contains a brief description of each feature. Not all of the features or whole portions of the features were used by the instructor. Even though the course was computer based, and mathematical tasks could have been completed outside of class, students were required to attend the class every day. The instructor emphasized in the first class that attendance was important. He mentioned, “If anyone leaves early or comes to class 30 minutes late, he or she will be counted absent for that day. Students who miss 15% of the class meetings and do not keep up with class assignments can get dropped from the course” (Field notes, 5/15/2015). The instructor was present in the class to assist the students in completing assigned homework problems. Thus, the instructor did not set up many communication tools or features for the students to use.

MML orientation. The instructor setup a mandatory video that MML offers known as “MML orientation” for students to watch. Without watching this video, students were not allowed to move forward to the next task for the course. By watching this video, students became familiar with MML’s available features and options, the use of these features and options, and the methods for submitting answers in MML format. The instructor mentioned during the class, “MML tutorial orientation sections are a big thing for students to know how to enter answers in MML” (Fieldnotes, 5/29/2015). However, the orientation does not cover all aspects of entering correct answers in MML. During the first debriefing session with the instructor, he mentioned, “MML orientation does not cover all of the areas. There are different math concepts to cover in one orientation.” The students did not spend that much time watching the orientation as according to the syllabus; it did not count for any grades. From the observer’s comments, “students watched the MML orientation very fast as it did not count for any grades (Fieldnotes, 5/15/2015). However, MML orientation could have covered more on how to enter answers that have multiple representations. For example, in one scenario recorded in the Fieldnotes (5/15/2015), one student raised her hand to ask the instructor why MML was not accepting her answer. To simplify $\sqrt{1/100}$ student entered the answer in MML as $\sqrt{1}$ /10. The instructor explained that MML did not accept the answer because of the square root of 1. The student was unaware of this issue, and the MML orientation did not cover this. Thus, from the observer's comments, "MML orientation could not cover all these small issues" (Fieldnotes, 5/15/2015).

Media files. There were several media files for each chapter known as *media chap 1*, *media chap 2,* and so on. Each media file contained video lectures, materials from the electronic textbook, and PowerPoint slides. Further, some of the sections contained some animation files. The amount of video lectures, textbook materials, PowerPoint slides, or animation files varied depending on the number of the sections in each chapter. The PowerPoint slides and video lectures were compiled by the author of the book. From the observer's comments, "The media files were very useful, but this feature was used less frequently. I have not seen that many students reviewing PowerPoint slides either" (Fieldnotes, 5/29/2015). However, students were not required to review the media files. The instructor included these options to guide the students in completing their homework. Every chapter contained video lectures, but, in the actual homework screen, not every problem had a video file embedded. From an observed class session, "One student was watching the media file. The video was providing step-by-step solutions to all exercises from the textbook chapter exercises. The student was practicing those exercises from the textbook" (Fieldnotes, 5/29/2015). As another example, "one student was reviewing a PowerPoint slide to see how to find radical and rational expressions but not writing it down" (Fieldnotes, 5/15/2015). Although students were not using many media files much later in the semester, several students did watch some PowerPoint slides without taking any notes in the beginning of the semester.

Pre-test. The instructor had the option to select the lessons for the course and the pre-tests for those particular lessons. He set up a flagged system for students to take a pre-test before they started working on the assigned sections of the homework. The goal of the pre-test was to see how much each student knew about the specific algebra skills from that section. If students answered questions correctly, MML was set up to remove those questions from their uniquely designed homework assignment. The instructor explained during the first class session, “If students make 90% or better on the pre-test, they will be allowed to skip homework for that unit, otherwise they need to finish homework not mastered from that unit” (Fieldnotes, 5/15/2015). However, the questions could reemerge on the unit test. During class, to respond to one student who asked the instructor whether the pre-test would be graded, the instructor mentioned, “The pre-test will not be graded. The pre-test is to measure where you are with your mastery level in this course. If you do well on the pre-test, the areas you do well, the MML system is setup to skip those problems for your homework assignment” (Fieldnotes, 5/15/2015). During the first debriefing session, the instructor mentioned, “If a student gets a question right on a pre-test, similar concept questions will be removed. For example, if a student answers a specific question on factoring, only that concept of factoring section will be removed from the homework assignment but not from the unit test.” Since there were many concepts per section, the instructor’s idea was to remove the questions that students already knew from the homework assignment. According to the instructor’s first debriefing session, “Even though students make 80 on the pre-test, they still have to do a large amount of homework because there were only 25 questions removed.”

Homework. Students worked on their homework assignment that the instructor assigned during class time and were expected to complete their homework by an assigned date. Homework had to be completed and submitted online using the MML system. As previously described, the homework questions varied from student to student since the questions were generated based on the students' performance on the pre-test. The instructor also setup MML to have the homework flagged so that students could not start working on the homework problems without taking pre-test for that section. From the observer's comments, "the randomly generated homework problems removed cheating or copying homework from another student as much as we see in traditionally based courses" (Fieldnotes, 5/28/2015). The instructor mentioned in class, "All homework problems will be flagged, which means you cannot start working on them until you finish taking a pre-test. After you finish taking your pre-test, there will not be any flags for the homework" (Fieldnotes, 5/15/2015).

Students prepared themselves for the unit test as they finished practicing the assigned homework problems. The instructor mentioned in class, "Students will be able to take the unit test once they meet the minimum homework requirement which is to make 80% on each homework assignment" (Fieldnotes, 5/15/2015). Students could use the embedded features that are on the homework screen to attempt their homework problem multiple times. From the observer's comments, "the features that are mostly used by the students are embedded in homework sections" (Fieldnotes, 5/29/2015). The instructor set up the system to allow three attempts for each problem, and then the system automatically changed the question to a similar homework question. Students could redo any assignment to increase their grade and/or practice the algebra problems an infinite number of times. During the initial interview, the instructor said,

> I have MML homework set up in a way where students can do infinite number of times until they complete the problem correctly. Even if they finish homework problem, they can always go back and redo the problems they get wrong to improve their grade. This way they can continue to practice mathematical problems.

The students could also get help from the instructor and utilize the whole class time to complete their homework. He also suggested to the class, “Make completing homework a priority. Math is a skill that you must practice” (Fieldnotes, 5/15/2015). In addition, from the observer’s comments, “the mathematical homework questions that are multi-step help to develop students’ algebraic thinking. The instructor played a very important role in these multi-steps problem by allowing the student to think and reflect on their earlier lessons” (Fieldnotes, 5/21/2015).

Review test. Students were required to complete a review test before they advanced to the testing center to take the unit test. Since the course was a mastery-based course, students, who earn a high score on review test A, were allowed to skip review test B and C. The instructor explained during the first class session, “For the review tests, students need to make 80% for review A, 85% for review B, or 90% for the rest of the review in order to take the actual unit test” (Fieldnotes. 5/15/2015). Students perceived the review test options as very helpful, as they prepared the students to take the actual unit test. During one student interview, the student said, “I like having extensive review options such as being able to practice 40 test review questions and the original unit test questions were only 20.” Also, the instructor guided students to use available MML features to practice review test problems. Through practicing those exercises, students demonstrated mastery of certain topics and prepared themselves to take the unit test.

Unit test. The instructor set up the same unit test for all students and optional pre-tests for each unit test under the quizzes and test section of MML. Therefore, the students did not need to take these pre-tests to take the actual unit test. However, if they did, and scored above 90%, they did not have to take the actual unit test. The instructor mentioned during the first debriefing interview, “The way I set up the unit test, it will be the same concept and will cover same sections. I want to make sure students learned the materials from the course.”

The unit test questions contained multi-step problems, but, unlike homework problems, the unit test did not have any options to assist the students in solving the problems step-by-step. One example if this type of support from the classroom observations was: “multi-step problems to graph polynomial function are designed to prepare students to draw a graph. But prior to drawing a graph by using the MML graphing tool, students need to figure out some information” (Fieldnotes, 5/19/2015). Similarly, during the first debriefing session, the instructor mentioned, “The test does not have multi-step questions like homework problem. For example, one of the questions could say, ‘find the equation with point slope form of the intercept’ so they have to write point slope then next question could be, ‘find the answer in intercept form’, which means students have to know to simplify that.” In contrast, the test questions did not provide any hints about the correct answer, and the instructor expectation was that students should already know how to figure these problems out.

Students could not take the unit test from home. The instructor mentioned in class, “Students cannot take the test from home or any other place. He managed to setup a password for students to take the test only in the math testing center” (Fieldnotes, 5/29/2015). During the first class session, the instructor explained to the students, “Students need to prove mastery for each unit test which is to make 70% before they can proceed to the next unit. The students are allowed to retest on the unit tests that they don’t make 70” (Fieldnotes, 5/15/2015). On the retest, the questions changed slightly so that students did not memorize the answers to the previous test questions. Students could also take the unit tests as many times as they wanted to improve their grade. The instructor mentioned in one class, "If any students want to increase their grade point average for the overall course grade, they can re-take any other unit test as long as they are done with all five unit tests first" (Fieldnotes, 5/29/2015). Also, during the second debriefing session, the instructor clarified, "The re-test questions are the exact same questions and same format in the same order but with different numbers. MML automatically generates the re-test but sometimes two out of twenty questions could be the same." Many students decided to take the test again if they saw that they had a low score. The score is visible immediately after they finish the test. Classroom observation indicated, "MML is providing the score immediately after students finish the test, and the test will be automatically graded through MML" (Fieldnotes, 5/16/2015). During the second debriefing interview session, the instructor mentioned, "I set the re-test in MML to be randomly algorithmically re-generated at the beginning of the semester." Once students are successful in passing the test, they move on to the next unit.

Theme 2: Incorporating MML in teaching. This theme describes the various ways incorporating MML helped the instructor teach College Algebra. With the use of a CAI tool, the instructor's role changed, as he did not have to provide any actual class lessons or grade homework and tests manually. Several points emerged from the data analysis to identifying how incorporating MML helped the instructor in teaching the College Algebra course including (1) immediate feedback for the instructor, (2) lack of grading, (3) homework completion monitoring, (4) pool of example problems, and (5) active role of the instructor.

MML provided immediate feedback to the instructor about whether the students were doing the homework correctly. According to the initial interview with the instructor, he recognized, "MML certainly is a tool that provides immediate feedback for me and great features for students by providing immediate feedback whether they were doing their homework correctly." According to the instructor, before students were using MML to do homework, they would practice the homework incorrectly for a week until they came to the class and consulted with the instructor to find out that they had done the work incorrectly. During the initial interview, the instructor said, "Without technology, students were doing the homework incorrectly two days, sometimes four days, over the weekend before they can get clarification from the instructor."

The instructor also did not have to grade homework with the MML technology in use. The MML system graded homework and posted the grades automatically and immediately for the instructor and students to view. Thus, the instructor did not have to spend time collecting homework, grading homework, posting grades, or returning homework papers. In contrast, during the initial interview with the instructor, he mentioned, "With other traditional classes students had to wait at least around forty-eight hours to get back graded homework with feedback." In the case of MML, the instructor had more time to teach rather than to grade students' papers. During the first debriefing session, the instructor mentioned, "It is different styles of instruction. It supports students because of immediate feedback and it helps me because I am not having to grade homework every night to know if the students are on right track."

MML made it convenient for the instructor to gather data about whether students completed various sections of the homework for the class. The instructor could look online in the MML system and be able to tell whether students were doing homework and which sections of the homework students were working. The instructor was able to see how different students progressed at different rates with respect to the homework activities. This phenomenon was indicated in the observer's comment, "Different students are working on different sections of the homework today" (Fieldnotes, 5/16/2015). Before MML, the instructor could not tell if students had finished homework until the due date. He mentioned during the initial interview, "I could not tell whether students were doing their homework until they asked the questions in next class meeting."

Another feature of MML was the instructor's ability to pull questions from MML to provide examples for students. The instructor did not have to write question since the questions were available in MML. If students had a problem with any specific question, the instructor could pull the same problem from MML and demonstrate the problem to the whole class if needed by using the projector. During one scenario (Fieldnotes, 5/16/2015), one student was working on finding the *x* and *y* intercept and could not find *y* value. The instructor then explained to the student that she needs to really understand the meaning of the *x* and *y* intercept. The instructor then pulled an example from the *View an Example* feature to help the student understand intercepts. In addition, for graphical algebraic problems, having an embedded graph helps the instructor explain since students can see the graph. From the classroom observation, "Different images of the graph helped the instructor to explain to the student what happens to the graph for certain *x* and *y* values rather than drawing on piece of scratch paper" (Fieldnotes, 5/20/2015). As a result, from the observer's comment, "This minimized time on the instructor's end by not drawing the graph and spending more time on teaching the concept" (Fieldnotes, 5/20/2015). Ultimately, the instructor was very active in the classroom.

> The instructor was reaching each student and monitoring their work as the students were trying to resolve the mathematical problems in their notebooks. The instructor did not wait for the students to raise their hand; he went each student's working station and explained the math problems as they were struggling. (Fieldnotes, 5/15/2015)

The instructor's involvement with the students was also indicated from the observer's comments, "The instructor was very active and moved around the class to ensure all students are understanding the mathematical tasks" (Fieldnotes, 5/16/2015). To that note, during the initial interview, the instructor mentioned, "In this emporium-based style of classroom, you cannot be sitting down behind the computer hoping students will grasp the mathematical concepts by themselves; the instructor needs to see what kind of knowledge students gain from their specific questions." He also mentioned in the initial interview, "The computer with MML features is the first delivery and the instructor is there to assist with the explanation." During the second debriefing session, the instructor mentioned, "I move on to assist students from one to another. If I see students are confused with something, I make sure I intervene quick enough to correct them."

Theme 3: Facing instructor challenges. This theme provides information on challenges and concerns that the instructor faced while utilizing MML in the classroom. The use of technology introduced new challenges for the instructor. The instructor also had some concerns with respect to teaching College Algebra with MML. The challenges and concerns included (1) access to MML, (2) properly trained tutors, (3) retention of concepts learned, (4) gaps in understanding, (5) use of graphing calculators, and (6) development of conceptual understanding.

In order to do anything for the course, students needed to have a computer system that supported MML. The lab computer supports MML, and the lab is maintained to support this type of class. However, according to the initial instructor interview, "The biggest problem we might have is whether a certain browser and plug-in are up to date for all computers in the lab. Whether students who use different platforms such as iPhone, tablet, surface, or different PC support MML." As a result, having a computer-based course sometimes became challenging and created confusion or issues for the students. According to the instructor, some students indicated frustration with the browser in the classroom and moved from one browser to another. One browser seemed to be good at displaying the examples, whereas another browser was only good at displaying the tutorial videos. During the second debriefing interview session, the instructor mentioned, “As an instructor, I use Internet Explorer (IE) almost all the time, but I do sometimes jump from Chrome to IE. MML has some browser supporting issues, and it depends how updated some of these browsers.” At the beginning of the course, these types of browser-supporting issues caused some delays for some students to start working with the course materials. During an interview with one student, the student mentioned that, “It’s concerning that MML is having browser issues.” In addition, not all students were familiar with a CAI course and not everyone had online access at home. Students, who were not computer literate, would have difficulties managing the course. Thus, during the initial interview, the instructor mentioned, “It is already mentioned in the course registration catalog that this is a computer-aided course, so I am hoping that we weed out some of the students who are not computer-literate. I am only targeting students who at least can operate basic computer systems.”

A second challenge was having tutors in the classroom who were not properly trained to support student learning. The instructor usually asked the students different questions to encourage them to think and try to identify students’ mathematical understanding. For example,

> One student was trying to find *g(5)* from a given graph and was confused. The instructor then posed the question to the student, “You understand what it is asking you to find?” The student remained silent. The instructor then asked, “What is our *x* value here?” The student thought for a while and then said “5?” The instructor said, “We are looking for where does the point for y stand when the *x* value is 5?” The instructor did not provide

> the answer; rather, he directed the student to look on the graph that MML displayed to see if he could figure it out. (Fieldnotes, 5/18/2015)

The tutors, in comparison, did not have a sufficient level of training or teacher knowledge to be able to ask students any kind of questions to help further their mathematical thinking. To that note, during the second debriefing session, the instructor mentioned, “Tutors definitely have the knowledge of the mathematical content to explain certain things but don’t understand how to explain a certain way to develop students’ thoughts rather giving them the answer or encouraging a shortcut or MML pattern.” The students could get good assistance from the tutors with respect to any kind of MML issues but not with the actual mathematical concepts. During the second debriefing session, the instructor elaborated, “Tutors don’t need training; they just need to get exposed to the kind of questions that are being asked, and they already have experience with MML.” However, from the observer’s comments, “Tutors need training as well to meet instructor expectations with respect to not providing unnecessary shortcuts or showing graphing calculator tips. Tutors need training in terms of how to approach the student to help them develop their algebra skills” (Fieldnotes, 5/22/2015).

The use of technology is helpful for students with shorter attention spans. According to the instructor, students who could not listen to a lecture for one hour and 20 minutes, utilized the MML features well. For example, a student could watch a short tutorial video and then work on homework problems, utilizing the different features of the technology-based system. The instructor mentioned during the initial interview, “I certainly can see that the MML tool would have great benefits for these types of shorter time span students.” However, students would not have long-term retention of the algebraic concepts. Since the class was compacted into an eleven-day schedule, the students learned the material in a short period of time and they tended to forget what they learned. During the second debriefing interview session, the instructor mentioned, “Because of the shortened period, students will not have long-term memory for actual algebra concepts.”

MML was not able to support the gap in students’ learning. The MML system did not have any options or features that supported students with poor algebraic skills. In other words, the system did not contain any practice tasks that could assist students in filling some of their gaps and deficits. The instructor mentioned during the initial interview, “Students who have weaker algebraic skills have a harder time being successful in a computer-based course.” Further, the instructor mentioned during initial interview, “If a student is missing some algebraic skills, the system is not going back and fill those skills so these student will be deficient and have harder time being successful.” Thus, a student with low algebraic skills would need to spend a lot of time outside class watching non-MML tutorial videos and practicing prerequisite skills. Also, the instructor spent more time with these students to assist them with the mathematical tasks. Students with low algebraic skills needed a lot of clarification on some of the mathematical topics and many times did not understand the MML explanations due to their lack of pre-requisite skills. For instance, “When the instructor simplified the process and provided shortcuts to a student who was trying to solve a quadratic equation, he helped the student to better understand than following MML’s step-by-step demonstration” (Fieldnotes, 5/18/2015).

The instructor also voiced concerns about allowing students to use graphing calculators. During the second debriefing, the instructor mentioned, “Students are not required to have a graphing calculator for the course; they can be successful in the course without using a graphing calculator.” From the observer’s comments, “Some students had graphing calculators, so those students are more advantaged than students who don’t. These students can compute the problem faster on the test.” For example, some students could find the answer to a synthetic division problem by using a graphing calculator, whereas others had to find the answer manually in their notebook, which was a time-consuming process. In addition, some students, who had graphing calculators, did not know how to operate them. In one example from the class, “One student had a TI-83 calculator but could not figure out how to find $\sqrt[3]{512}$. The student knew how to calculate it manually but wanted to learn the calculator function. The instructor assisted her by showing the calculator button” (Fieldnotes, 5/18/2015). Another student was struggling with order of operations while trying to use a calculator. The student entered -1^5 instead of $(-1)^5$ so the instructor assisted the student in understanding the difference between entering a negative sign inside versus outside the parentheses. Then “the instructor wrote on her notebook paper the order of operation saying, ‘please excuse my dear aunt sally’ which stands for parentheses, exponent, multiple, division, addition, and subtraction” (Fieldnotes, 5/18/2015). However, from the observer’s comment, “The instructor wants students to know how to compute using paper and pencil and not just being able to find the answer by using a graphing calculator” (Fieldnotes, 5/22/2015).

The instructor found it challenging to teach students algebraic concepts by utilizing MML, which has many features for this purpose. The instructor mentioned during the second debriefing session, “With any technology, students can end up mastering in this case the MML process where they learned the patterns that the software system used.” The instructor added, “They don’t have to understand mathematics if they understand the pattern that the technology software is producing. Students are able to learn what the system wants them to answer.” The instructor believed that the students were learning the system rather than the actual mathematical concepts. He mentioned during the initial interview, “I don’t want my students to outsmart the computer system, rather to be able to do the math, to learn the concept and I want them to have those learning outcomes." Most of the time, the students did not understand the underlying concepts of the mathematics. The instructor helped the students by posing questions to encourage the student to think and develop algebraic skills. From the observer's comments, "It was obvious that students knew how to find the answer, but had no idea about the meaning of the answer." During the initial interview, the instructor mentioned, "When I help, I ask questions to the student, 'what does that mean? How does it happen?' To see if they have a bigger understanding or just doing the pattern." However, according to the instructor, a certain percent of the students were just mastering MML system to get through the course, which could not be done in a traditional class.

Theme 4: Assessing students and providing instructor assistance. This theme looks into how the instructor assessed students by incorporating technology and assisted students in understanding the algebraic concepts. Data analysis revealed that the instructor took different steps to assess and assist students in different ways to improve class performance. The instructor mentioned in the class, "Blackboard is going to be the official grade, not your MML grade. I am using MML to assess you, but that is not going to be your final official grade" (Fieldnotes, 5/19/2015).

Partial credit policy. Since the MML system automatically graded students' homework and tests, students had to practice entering their answers in MML format. In order for MML to mark the answer correct, students needed to be very careful in entering their answer choice. The instructor mentioned during the initial interview, "I don't give partial credit but the students who receive below 70, I counsel them to see where they made mistakes, correct and explain them, and help them to prepare for another chance of re-testing." The instructor set up the tests in a way that a test could be taken as many times as the student wants to get a passing grade of 70% or higher before moving on to the next unit. The instructor also used a flagged system, which means a student could not move on to the next unit until they had a passing grade on the current unit test. However, sometimes the instructor made exceptions. If students got correct answers on the unit-test scratch paper but somehow missed entering the answer in the system according to MML format, the instructor gave partial points. From a debriefing session with a student who made a sign mistake on a test review, the instructor told the student, “If you missed something in MML, for example, to put a sign, forgetting to put square root, making mistakes with bracket in interval notation, I will give you partial credit” (Fieldnotes, 5/20/2015). During the second debriefing, the instructor mentioned, “Just barely a few cases some partial credit was provided to a few students when MML marked the answer wrong because of extra space or misuse of comma.”

The instructor reviewed students’ scratch paper for tests. The main goal of reviewing students’ unit-test scratch paper was not to provide them partial credit but rather to see the type of mistakes they made on the test. Students used scratch paper to work on the problems during the test at the testing center and turned in the scratch paper to the instructor. The instructor mentioned during the first debriefing session, “It’s only for correction I am looking at the test scratch paper. It’s kind of like, ‘why did you do that mistake’ and what you should have done and not to give the student any partial credit.” In a debriefing a student remarked, “The instructor worked the problem out that the student made a mistake on the test and wrote the solution on the students’ scratch paper.” From the observer’s comments, “The instructor was suggesting to the students based on their test performance or the test scratch paper whether the student should move on to the next unit, re-take the test, or complete more homework practice.” (Fieldnotes, 5/19/2015). The instructor reviewed scratch paper to counsel students in preparing for the re-test.

From the observer's comments, "This individual debriefing session with the instructor will assist the students in performing better on the next test" (Fieldnotes, 5/19/2015). Some students went back to the testing center to re-take the test after the debriefing session with the instructor.

The instructor provides own explanation. The instructor provided his own explanation to assist students in solving the algebra problems. From the observer's comments, "Almost half of the time the instructor did not follow MML examples." Instead, the instructor showed the students a different method to help them understand as he found students to be confused with the step-by-step approaches demonstrated through MML. From classroom observations, "The instructor provided students with some arithmetic and geometric sequence series formulae to support solving geometric and arithmetic series problem and posed questions allowing enough time for students to reflect" (Fieldnotes, 5/28/2015). From the observer's comments, "Sometimes the students needed more explanation from the instructor to understand the algebraic rules and properties. The instructor's role was to simplify the rules and express the ideas in the way students would understand, which plays a very important role in students' algebra development" (Fieldnotes, 5/26/2015). The instructor sometimes corrected student's notebook paper and wrote many solutions to problems to explain. From the classroom observation, "The instructor wrote on students' notebook paper" (Fieldnotes, 5/22/2015). During the first debriefing session, the instructor mentioned, "If students are doing the math on their notebook paper, it is easier for me to explain to them. If students are confused with something, I make sure I intervene quick enough to correct them." From the observer's comments, "The instructor explained and guided the student to solve problem and he seems to have great patience in finding students' mistakes" (Fieldnotes, 5/29/2015). During the second debriefing, the instructor revealed, "I usually explain to the students more than half of the time on my own, to make it easier for students to understand or grasp the material." From classroom observations, "The student was having issues in finding real and complex roots. The instructor assisted the student by providing hints: 'If C is positive, the factor sign would be ++ or - - but if C is negative then the factor sign would be + - .' He also suggested that everything did not always factor; the student needed to practice working with quadratic formula" (Fieldnotes, 5/16/2015).

The instructor provided individual attention. With computer-based teaching, the instructor had more time for the students, since he did not have to grade homework or tests. The instructor was able to spend more time with the students in class to meet their individual needs. For example, "One student told the instructor in the class that she can solve an equation but making an equation from the word problem is an issue for her. The instructor worked with her and provided an example from MML and explained to her by writing the equation on her notebook paper" (Fieldnotes, 5/22/2015). From the classroom observation,

> The instructor encouraged one student for her neat and organized notes as the student was preparing herself for a unit test by reviewing her notes. The student's notebook was very organized and she computed all review and homework problems in her notebook which made it easy for her to review for the test. (Fieldnotes, 5/28/2015)

Also, from the observer's comment, "Even though MML contains media files, some of the students still needed extra help from the instructor to direct their thinking" (Fieldnotes, 5/16/2015). In addition, the instructor had debriefing sessions with most of the students after their unit tests. From a classroom observation, "The instructor sometimes even went back to teach basic math to the individual students in need" (Fieldnotes, 5/16/2015). During the second debriefing interview session, the instructor mentioned,

> Being able to provide all students attention is easier with MML than a traditional-based class. While students are working on the math, I can point out where mistakes are happening. I make contact with everybody to ensure they are on correct pace.

From the observer's comments, "The instructor is providing one-to-one interactions with the students and is spending a long time making sure they understood the concept" (Fieldnotes, 5/21/2015). Also from the observer's comments, "Instructor guidance is vital for students to be able to successfully complete this course" (Fieldnotes, 5/26/2015).

Theme 5: Evaluating student success and providing suggestions for improvement. This theme mainly identifies students' class performance and the instructor's suggestions for improving teaching with technology. The instructor said during the second debriefing session, "I think my success rate before technology and after technology are about the same." However, according to the instructor, he could not support statistically whether teaching was more effective by utilizing the technology, he definitely thought students could manage the course better if they were able to see if they were doing the homework correctly. The instructor said during the second debriefing session, "The success rate for this type of class about 65%." From the observer's comments,

> It's a very good strategy to provide students a chance to see how much they know by giving them a pretest, opportunity to practice, and finally a posttest to measure what they learned. It was very good educational assessment, and the instructor managed it in such a way that students will not be able to pass the course without mastering the algebraic concepts. (Fieldnotes, 5/18/2015)

According to the instructor, even though the students who sign up for the 11-days course are mostly highly motivated to complete the course, the success rate for this class is less than 60%.

During the second debriefing session, the instructor mentioned, “The success rate for this class is 57-58%. Twelve students passed out of twenty-two students and ten did not pass. Three students voluntarily dropped from the course.”

The instructor suggested that a combination of MML and traditional lessons would be better. Even though MML has some very beneficial features through which students can learn, there are some areas in which it can be improved. During the second debriefing session, the instructor suggested, “We can use MML to do the homework, but we can learn to take the test with paper and pencil, a different method so students do not have to learn pattern rather than the actual concepts.” However, according to the instructor, to do this, the instructor needs to make sure the test format is the same and consistent to minimize confusion for students.

Perspectives of the Students

The instructor mentioned during the initial interview, “The way our society is going, the more technology we incorporate, the better our students will be.” Different themes emerged with respect to students’ perspective about using MML in the College Algebra course. The themes are available features of MML, utility of technology, challenges for students, suggestions for improvement, and perceptions of MML.

Theme 1: Available features of MML. There are two kinds of features in MML. The first type is the overall features that MML provides to students, and the second is a list of features of MML that are embedded on homework screen to provide students assistance with the problems. Table 5 presents the overall features that MML provides to support student learning. The table includes the description of each feature and the aspects of each feature that the students used to manage the course. Figure 2 indicates the student use of each feature available on the homework. These features include *Help Me Solve This Problem, View an Example, Show Similar*

Exercises, Watching Tutorial Videos, Ask My Instructor, Print, and E-Textbook. Students could utilize these available embedded MML features to help them solve the homework problems. The researcher interviewed a subset of five students to find out which MML features they used most of the time. Each of the features had a unique way of helping students solve the mathematical problems. The description of the features is described in each of the following subsections.

Table 5

Available Features for the Students (MyMathLab Features, 2008)

Features	Descriptions	Part of the Feature Students Did/Did Not Use
Interactive Tutorial Exercises	MML homework and practice exercises regenerate for students algorithmically an unlimited amount of times so students can practice and master the content of the course. This feature provides helpful feedback when students enter incorrect answers.	The students used all parts of this feature to practice and complete their homework problems.
eBook with Multimedia Learning Aids	Different multimedia resources are available on the homework screen, examples, and exercise pages. Through these learning features, such as video clips, students can improve their understanding.	Students used many video files to make their own notes on their notebook paper and to complete homework.
Study Plan for Self-paced Learning	MML creates a personalized study plan for students based on their test results. The study plan links directly to tutorial services for unlimited practice. Students can use the multimedia learning aids for extra help.	There was no evidence based on the data sources that students used any study plan feature or any other learning aids for extra help.

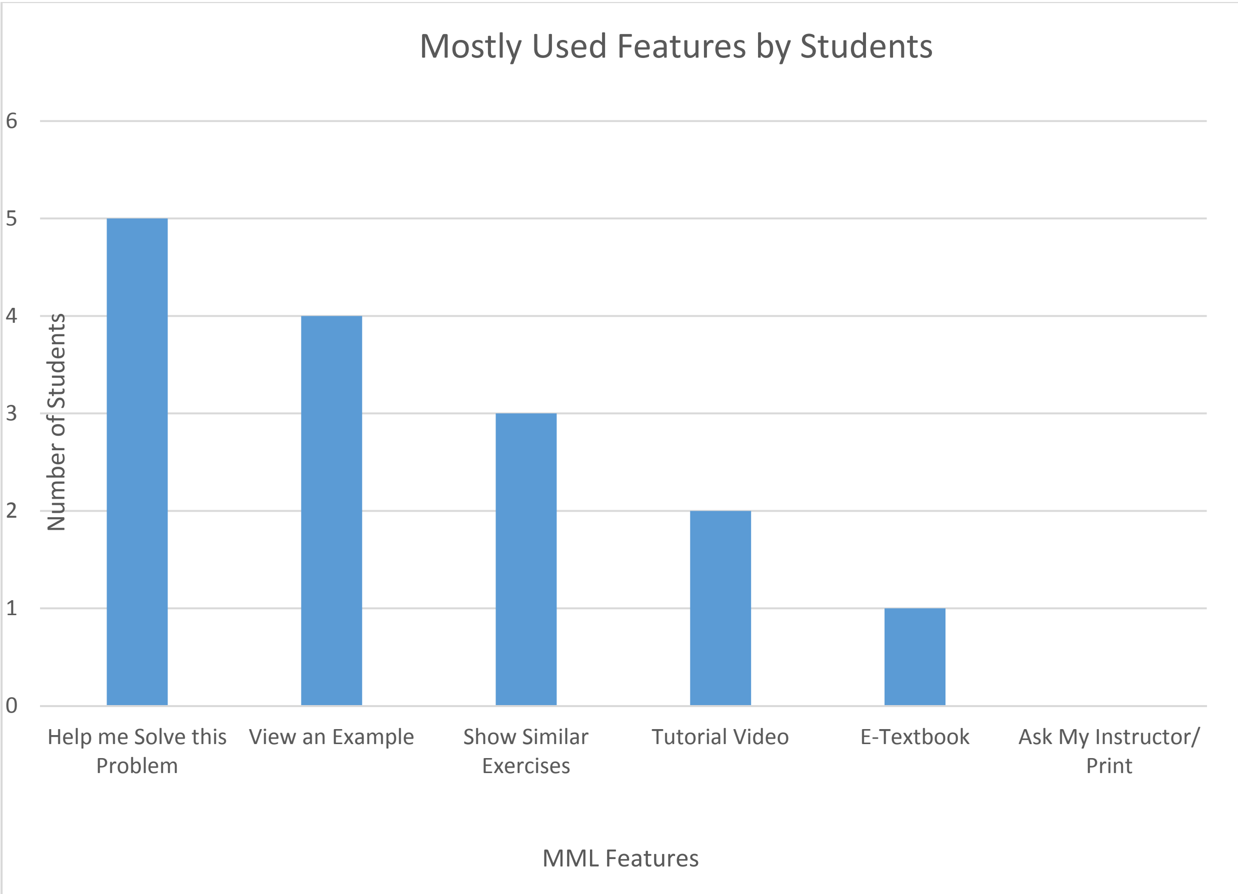

Figure 2. Most used MML features.

Help me solve this problem. *Help Me Solve This Problem* was one of the available features that the instructor suggested for the students to use the majority of the time. From the observer's comments, "*Help Me Solve This Problem* is a great feature that MML offers" (Fieldnotes, 5/21/2015). This feature helped students to complete their homework without the instructor's help. From a classroom interaction, "The instructor was explaining and guided the students to solve the algebra problem and referred the students to '*Help Me Solve This Problem'* to ensure students knew how to help themselves" (Fieldnotes, 5/29/2015). To that note, during one debriefing session, the instructor mentioned,

> Students did not need to wait two to four days even with the weekend to ask the instructor how to solve a specific mathematical homework problem. *Help Me Solve This Problem* feature can assist them in solving the algebra problem through a step-by-step process.

The instructor also did not need to help the students in class with solving a problem when the student was following this MML feature to understand the problem. One scenario which presented in the fieldnotes (5/21/2015) was:

> One student had the MML feature *Help Me Solve This Problem* window open and told the instructor by pointing to the algebra problem on the MML screen, ‘I don’t know how to use transformations.’ MML was displaying step-by-step tasks for the student introducing how to perform the transformation by following orders such as horizontal shifting, stretching or shrinking, reflecting, and vertical shifting. The instructor was watching as the student was answering the MML questions that displayed and prompts with a hint for students to think about and select an answer. The instructor was standing there to ensure whether the student understood the steps. The student was able to do the last steps to select the transformation of the graph.

During a student interview, one student said, “The MML feature *Help Me Solve This Problem* provide hints to solve homework problems.” However, another student stated a concern that, “The feature *Help Me Solve This Problem* asks students step-by-step questions to which students do not have answer.” One tutor described an additional aspect of this feature to a group of students: “After this feature shows how to solve a problem, MML prompts students with another similar homework problem to work on; the MML system doesn’t allow them to work on the same homework problem” (Fieldnotes, 5/15/2015).

View an example. *View an Example* is another feature through which students could view a demonstration of how to find solution to a problem that is similar to their homework problem. A tutor explained this option to a group of students as well, “If you choose *View an Example*, MML will demonstrate similar problems step by step how to solve, then you can do your homework problem. It will not generate another new problem for you” (Fieldnotes, 5/15/2015). The students could learn the process or steps or mimic the steps to do their original homework problem. From the observer’s comments, “Examples that MML provides on how to solve problems are self-explanatory and that’s why students are moving ahead with their homework activities by following the examples” (Fieldnotes, 5/21/2015). Sometimes the instructor worked with a student to address questions or confusion while the student was working with *View an Example*.

> The instructor helped a student with an MML example and explained by writing the equation and necessary notes in her notebook. The instructor most of the time encouraged the student to follow the MML example, and explained by using the example. (Fieldnotes, 5/22/2015)

In contrast, the tests did not have the *View an Example* option. The instructor mentioned during the first debriefing session, “On the test, students don’t have *View an Example* option so students either have to solve from memory or at least being able to compute from the stuff they learn.” Students utilized this feature mostly to understand and complete their homework as the feature helps to solve algebra problems. During a student interview, one student mentioned, “*I find View an Example* feature helpful because it has a step-by-step demonstration of how to solve problems.”

Show similar exercises. This option was often used by the students, who did not understand the concept related to specific homework problems. The students wanted to watch further demonstrations of solving similar exercises to work on that specific homework problem:

> One student told the instructor, 'I don't know what Descartes Rule of Sign is.' Then the student clicked on MML to view the demonstration of solving a similar exercise. The instructor then said, 'Yeah, it is good to view that to understand how to solve the problem.' (Fieldnotes, 5/27/2015)

One student said during the interview, "I try out at least three similar exercise to ensure I understand that type of mathematical problem." Another student said, "I practice similar exercises until I understand that I will know how to do the homework problems." However, another student said during an interview, "Viewing similar examples are sometimes too technical like the textbook. I had to read over and over again to understand." On the other hand, another student mentioned, "I find this feature helpful because it has a similar exercises option for each homework." From the observer's comments, "Students managed to help themselves by viewing similar examples from MML" (Fieldnotes, 5/26/2015). In contrast, during a student interview, one student said, "I want the similar exercises a bit different and increase the explanation in different way. I just don't want to learn solving similar problems."

Watching tutorial videos. Another feature students used to understand the algebraic topics was watching video media files embedded in MML. All videos are embedded in the package that came from the textbook publisher; the instructor did not select or manage any video files. During the first debriefing session, the instructor mentioned, "College Algebra with author Blitzer is doing most of the videos for some specific lessons. So how he explains it depends on how he structured his book and when he wrote that particular concept." Even though students could have looked online for other tutorial videos, such as videos from Khan Academy, to get clarification on some mathematical lessons, a debriefing session with the instructor indicated that the students did not go to any other source for assistance. He mentioned, “Students will not look for sources outside of MML because it requires more time to do this. So looking at videos already implanted into MML, students will definitely look.” All tutorial videos were self-explanatory. For example, during one interaction between the instructor and a student, “The student said, ‘I never learned any of the basics being in the military for so long, I forgot.” The instructor then asked whether the video that she was watching helpful to her. She said, ‘Yea, it was pretty self-explanatory’” (Fieldnotes, 5/16/2015). While students watched the tutorial videos on specific topics, they sometimes wrote down notes in their notebook. However, sometimes those notes were not enough for the students to understand the topic. From a classroom observation,

> One student was watching a tutorial video on how to find all of the zeros of a function. The instructor was watching the student writing the video notes in her notebook as the video was showing step-by-step synthetic division. The student sometimes paused the video to catch up with her notes. (Fieldnotes, 5/20/2015)

From the observer’s comment, “Even though most of the students had notes from MML videos in their notebooks, the instructor had to re-explain the notes so that the students could follow them to solve the algebra problems” (Fieldnotes, 5/22/2015).

Ask my instructor, print, and e-textbook. *Ask My Instructor* is a feature through which students could send the algebra problems they were working on electronically to the instructor. The instructor could then view the problem and see where the students had questions and could guide the students by responding back to them via email. The *Print* feature simply allows students to print the current page with algebra problems they are working on. There was no evidence that students had to use *Ask My Instructor* or the *Print* feature. Because students came to class each day, they were able to ask questions of the instructor in class while they were working on their homework problems. Also, students did not need to print the algebra problems, since they were able to access the problems anytime they wanted. Also, students had difficulty following the examples from the electronic textbook, the *E-Textbook* feature that is embedded in MML. The publisher Pearson Education makes textbooks available to the students electronically through *E-Textbook* feature. For instance, during an interview, one student said that, "*E-Textbooks* are sometimes too technical." Another example from classroom observations revealed how the electronic textbook materials were sometimes confusing to the student: "The instructor was standing next to the student while he was reviewing the electronic textbook materials; the student seemed confused, so then the instructor walked her through the steps to solve the problem" (Fieldnotes, 5/20/2015).

Theme 2: Utility of technology. This theme is about student perceptions about whether the MML technology was useful for learning during the College Algebra course. Since the class style was less instructor led and more student focused, the conversation with the instructor from the first debriefing session indicated that, "Students will recognize their mathematical task quicker if they are doing math all the time rather than the instructor talking about math." During the initial interview, the instructor mentioned, "Having students work on the math most of the time, students will recognize their mathematical mistakes and will be able to clear the issue while they are doing the problem so that any confusion can get addressed right way." During the student interviews, all five students admitted that technology was useful in learning algebra because they could follow the available features that MML offered to understand the mathematical problems. One student said MML was useful because “I am being able to log on in MML any time of the day to work on a math problem.” Another student said during the interview, “MML was useful since you can proceed or continue at your own pace.” As a result, “After one class session, different students were working on different sections of the homework activities” (Fieldnotes, 5/16/2015). A third student said, “MML was useful because I was being able to not spend that much time for the things that you already understand rather spend more time on the materials that you do not understand.” A fourth interviewee remarked, “MML was useful because I am able to go back and forth to correct and complete homework. I guess the reassurance of whether you are doing something right or wrong.” Another student said, “It is useful because of having the combined help of tutorial videos, instructor, and tutors.”

Theme 3: Challenges for students. This theme identifies the challenges and concerns that students faced with using MML to learn algebra. Data analysis indicated that students faced several challenges while using MML. One of them was not having an actual person to provide lessons in class. During a student interview, one student said, “The most challenging issue was to lose human-to-human contact, which is I think is very important.” The students who faced the most challenges were the ones who had not taken a mathematics course for a long time or had a long break in their education. For example, one student said during an interview, “This course is challenging as I have a longer gap in taking math courses like College Algebra.” Another student said, “I was working with MML alone at home and the challenge I faced is not having an actual person to help.” Additional challenges emerged with respect to entering answer choices in MML format, using the graphing tool, and spending time with MML outside of class.

Entering answer choices in MML format. One significant challenge was frustration with entering responses in MML. One student said during an interview, “To enter a period instead of a comma or if I had extra space between answer choices, then MML marks the answer wrong." MML restrictions on answer choices caused frustration among students. For example, in one scenario from the class observations, "For a specific algebra problem, the student wrote the answer in her notebook as 12i + 36; MML did not accept the answer. In MML, answers needed to be written in a + bi form with the imaginary term second" (Fieldnotes, 5/18/2015). Students could grasp how MML would accept answers over time as they were practicing homework daily and test review questions and entering answer according to the MML format. Further, the teacher said to the class, "There is a notation feature embedded in MML that students can use to enter answers in MML" (Fieldnotes, 5/29/2015). However, students needed to pay attention to the details for entering answers in MML. In one scenario,

> The instructor was reviewing a student's notebook paper and verified that the answer was correct, but the student was frustrated because MML was not accepting the entered answer. The instructor later realized that the student put an extra space between two answers, which caused MML to reject the answer. (Fieldnotes, 5/19/2015)

In another instance,

> The instructor was looking at a homework problem where the student believed he entered the answer correctly in MML, but MML prompted the message that the answer was incorrect. The instructor investigated the problem and found out that the student entered an apostrophe instead of a comma in between two answers, which in turn caused MML to reject the answer. (Fieldnotes, 5/18/2015)

Similarly, another student shared with the instructor during class that MML was not accepting his answer as he had put a period instead of comma while typing the answer for a homework problem and the instructor did agreed that MML is pretty picky about answer choice format

(Fieldnotes, 5/18/2015). MML also marked the answer wrong if students had extra space. During the first interview session with the instructor, he also admitted that

> I like that the MML program wants students to enter the answer in mathematical terms. I don't like that it sometimes becomes so sensitive that if a comma is in the wrong place it marks it wrong or if an extra space was put in between commas. It can be frustrating.

In addition, from a classroom observation,

> The students were having difficulties entering the base and exponent in MML to able to accept the answer as correct. To enter the base, students had to click on subscripts and for powers students had to click superscripts. MML does not have buttons for Log and Ln. These words are reserved in MML to be able to work without a capital L. (Fieldnotes, 5/26/2015)

From the observer's comments, "Several students were frustrated by the amount of time they were spending on entering the answer in MML for complex looking answers, such as answers that deal with log, base, fraction, and square root" (Fieldnotes, 5/28/2015).

Using the graphing tool. MML has a graphing tool feature which students could use to graph functions and get various answers. From the observer's comments, "Having a graphing tool feature eliminates the lengthy process of graphing on a graph paper or regular paper which is time consuming and creates error" (Fieldnotes, 5/18/2015). However, the graphing tool was challenging for student to use to solve the algebra problems. From a classroom observation,

> One student was working on a multi-step problem, which required the use of the MML graphing tool to represent a function. The student drew the graph wrong so the instructor assisted in using the graphing tool by showing what types of lines she needed to select to draw the graph. The student was then able to draw the graph. (Fieldnotes, 5/21/2015)

The instructor mentioned in the class, “The graphing tool feature was the most challenging feature, and students have a hard time using it. I encourage students to review this feature two to three times before the students start doing their homework” (Fieldnotes, 5/29/2015). For a graphical algebra problem, “The instructor directed the student to watch a video on how to use MML graphing tool and provided instruction to sketch the graph” (Fieldnotes, 5/18/2015). However, manipulating or working with the graphing tool feature of MML caused much frustration among students. From classroom interactions, “One student came out from the testing center and shared with the instructor that he did not even score 50. The instructor asked, on which part he had the most trouble. The student responded that it was the graphical part” (Fieldnotes, 5/18/2015). From the observer’s comments, toward the end of the semester, “Some students still needed further assistance from the instructor on some of the algebraic concepts, mostly the algebra problems with graphical representations” (Fieldnotes, 5/21/2015).

Spending time with MML outside of class. Some students developed strategies to independently learn the algebraic concepts and to do well in the course. In order to succeed in the course, some students spent out-of-class time to complete the mathematical tasks. During the second debriefing session, the instructor mentioned, “The students who are not successful did not spend that much outside-of-class time, but the students who did meet the goal of finishing all unit tests on time did spend outside-of-class time.” The instructor did not know the average amount of time that students worked outside of the class but did mention, during the second debriefing, that an instructor could access that data by looking at MML. He said, “In MML, you can actually see how much time students spend on each test or homework assignment or overall for the course. By subtracting the class hours, four hours [per day], you can actually figure out how long they spend." Also, during a student interview, one student admitted, "I like to spend, for every hour of class time, 30 minutes at home. So, then I spend at least two hours at home."

Theme 4: Suggestions for improvement. This theme reveals the different suggestions that students made to improve MML**.** According to the majority of the students interviewed, MML could be improved by adding new options and more complex algebra problems. During one student interview, the student mentioned MML could be improved "by having better viewing capability of textbook chapter materials in MML for easier navigation." Another student said, "If MML math problems would have been more complex, it would have been more challenging." A third student said, "MML can be improved by adding more challenging and a variety of similar exercises and by having tutorial video options for each mathematical problem." One student explained how MML should add more definitions and admitted that he did not like to encounter the exact same questions on the re-take test. During the interview, he said, "MML can be improved, by adding explanation for the mathematical terms and providing examples for the definitions. And by not repeating test questions on the re-take test." Also, as previously discussed, a majority of students interviewed were frustrated with the graphing tool feature as it was not easy to work with. To improve MML, one student mentioned that, "By updating the graphing tool feature so that it is easier to work with." In addition, a majority of students interviewed mentioned that MML could be improved with more videos. For example, one student stated, "MML can be improved by having more tutorial videos with demonstrations of how to solve math problems; this would be better since there is no actual person providing lessons."

Students also had suggestions for formatting answers in MML format. One student mentioned during the student interview,

> If there were a quick button on the side or an easier way to enter some key functions as sometimes I have to delete the whole answer just to put the answer back in fraction format because MML wanted the answer in fraction format.

Another suggestion was revealed in the observer's comments, "MML should not generate a message saying only, 'You have an incorrect answer.' Rather, an optional message should say the answer is correct but there is some syntax error" (Fieldnotes, 5/19/2015). Students were going through "solving the problem" again and again to find mistakes and were getting frustrated even though their solutions was correct (Fieldnotes, 5/18/2015).

Theme 5: Perceptions of MML. This theme identifies how students view the use of MML as a technological tool for the College Algebra course. The goal was to find out how students viewed the technology in terms of learning. In an interview, one student said, "I have improved because I was able to make better connections by using the MML tool and able to understand math better." Another student said, "I like MML because of immediate feedback, it was more my pace and moving up, I did not worry about classmate influence." In contrast, in a regular traditional classroom setting, some students think they are behind and do not know anything whereas others may be held back. For example, one student said during the interview, "Through MML, you can be in control of what you are learning as opposed to traditional courses where you can spend four weeks on chapter one and then take the test." From the interviews, all students admitted that they used the opportunity to practice mathematics problems multiple times including outside-of-class time, and spend as much time as they needed to complete homework. These practices helped them to develop better algebraic skills. One student said, "MML is helpful, for the fact that there was so much information that MML offers that you could gain from the course."

Students also shared different opinions about the online homework submission. According to the students, doing online homework through MML and submitting online was beneficial and saved paper. Homework prepared them for the test as it was applicable to the test. However, completing homework was more challenging without viewing the available features that MML offered. During the interview, one student said, “I like being able to come to the class to finish all of the homework I can and not just what instructor assigned.”

The instructor mentioned during the first debriefing session,

> MML is not being used as it is supposed to, and, with MML, students are in control of what they are learning in comparison with traditional courses. MML is more structured, more transferrable to other things, and knowledge can be shared to other courses.

However, during the student interviews, most students acknowledged that by taking this course, they were less anxious about mathematics now and ready to face upper level mathematics courses. Still, some students preferred the guidance of the classroom instructor rather than a computer-based sequence with embedded videos.

Conclusion

This was a qualitative research study designed to examine the instructional practices of a community college instructor who used a CAI tool, MyMathLab (MML), as the main pedagogical approach to teach College Algebra. The purpose of the study was to identify how the instructor was incorporating MML into his classroom learning activities, homework, and assessments. Therefore, the researcher examined how the instructor utilized MML in class sessions, how the instructor adapted MML and students responded in the selected course, and how the instructor assessed the students with MML.

The research took place in a community college located in the Southwest United States. The College Algebra course was offered in the May semester for 11 days, and each class session lasted four hours. The course was not designed to include lectures from the instructor during the class sessions. Instead, the instructor required students to attend the class every day to work on their assigned mathematical tasks. Students used MML to do homework problems, to submit homework, to practice review tests, and to take unit tests. The instructor was available during the class sessions to assist students to meet their individual needs. He used the MML flag system to prevent students from moving from one assigned task to the next without successfully completing the prerequisite task. For example, students needed to complete homework with 80% accuracy and unit tests with 70% accuracy to move forward to the next unit. The final course grade was based on all five unit-test scores (80%) and the average homework score (20%).

The main data-gathering technique was class observations of the selected College Algebra course. The researcher observed all class sessions in their entirety every day for one semester, and the data sources used were field notes, observer's comments, instructor's initial interview transcript, instructor's two debriefing interview transcripts, five student interview transcripts, and the instructor's MML course shell. The researcher used the constant comparative method, as described by Glaser and Strauss (1967), to code the data and to generate themes to understand how the instructor utilized MML as a pedagogical tool to teach algebra. Based on the data analysis, two categories of themes emerged from the research findings; one was the perspective of the instructor and the other was the perspective of the students.

Findings from the Instructor's Perspective

One of the findings with respect to the instructor revealed how the instructor managed the course using MML. The instructor controlled or managed the course set up by using the available features of MML. The features that MML offers are *Powerful homework and test manager*, *Custom exercise builder, Comprehensive grade book tracking, Customization tools*, and *Manage course groups*. Though MML offered various features for the instructor to manage his course, the instructor did not use all features or entire portions of particular features. For example, MML has a feature for complete online course content and customization tools, but the instructor did not use the communication tools such as the discussion board, virtual classroom, and chat capabilities. Yun (2011) found that the use of a software tools such as MML can improve the communication in online mathematics teaching and recommended educators to adopt MML. Nonetheless, the present research findings indicated that the instructor did not need to use these communication tools; he took an active role and was always available during class sessions to assist the students.

Without completing a pre-test, students could not start working on the assigned homework problems for that section. Based on students' performance on pre-tests, MML randomly generated homework problems for the students, so the problems varied from student to student. As a result, this type of CAI tool-based course seemed to discourage cheating. Based on the field notes, the observer commented, "Randomly selected homework problems seemed to prevent cheating in this selected course." Further, the findings align with those of Moore's (1988) research that middle school low-performing students who used a CAI tool to learn in class, showed more improvement than students who did not.

The instructor acted as a coach in the classroom and provided guidelines for students to follow such as watching a mandatory MML orientation video, taking mandatory pre-tests, completing homework, practicing review tests, and then finally taking unit tests. As a result, these add to the evidence compiled in the literature that mathematical studies are becoming more and more under students' control, and instructors are becoming more like coaches than lecturers (Moses & Cobb, 2001). MML resources embedded in the system were available for the students to use, such as the lesson videos, PowerPoint slides and electronic text books. Results indicated that students used those resources to complete their homework, which supports the findings from one study on MML that concluded students liked the resources that directly assisted them in completing homework problems over in-class lessons (Aichele, Francisco, Utley, & Wescoatt, 2011).

Furthermore, several points emerged from the data analysis to identify how incorporating MML helped the instructor in teaching the course. One advantage of having MML was being able to grade online homework automatically and keeping a record of students' results. The instructor admitted during the initial interview that "MML certainly is a tool that provides immediate feedback for me and great features for students by providing immediate feedback whether they were doing their homework correctly." These findings agree with those of Kwan and Alexander (2013), who found that web-based homework plays a significant role in students' learning because of the immediate feedback the tool provides to improve algebraic understanding.

Findings of this study indicate that as MML grades and posts homework automatically, that instructor had more time for teaching and meeting individual students' needs. Spending less time grading and more time teaching benefits both parties. This also agrees with the research findings of Kodippili and Senaratne (2008), who stated that MML can be used as a medium for homework, which benefits both students and instructors. The instructor can look online in MML and tell whether students worked on homework problems, which is not possible in traditional classes until students submit homework assignments. In this context, the teacher mentioned during an interview, “With other traditional classes, student had to wait at least around forty-eight hours to get back graded homework with feedback, and I could not tell whether students were doing their homework until they asked the questions on next class meeting.”

Likewise, MML has built-in graphical images for algebra problems that helped the instructor with explaining rather than spending time to draw a graph from scratch. To that note, the observer commented, “This minimized time on the teacher’s end by not drawing graphs and spending more time on teaching the topic.” As a result, the instructor’s role changed, and he had more free time. He was able to move around the classroom and assist the students by correcting their mathematical work. Similarly, Jeger and Slotnick (1985) indicated that the instructor role changes through using MML; instructors can observe students’ learning processes more closely correct students’ mathematical work more quickly and directly.

Furthermore, the instructor needs to ensure each student’s development of understanding. Findings indicated that MML does not support the gap in some students’ learning. For example, according to the instructor, MML does not have any features to support students who have weak algebraic skills and does not offer any practice tasks to mediate some of those gaps or student deficits. The instructor worked with individual students to teach basic algebraic ideas. The instructor sometimes taught basic mathematics skills to individual students in need. Students used scratch paper during unit tests to compute problems before posting their answers in MML. The instructor reviewed students’ test scratch papers and individually counseled the students, who received low scores on the unit test, by identifying their strengths and weaknesses, correcting the students, and assisting them with how to perform better on the next test. These findings corroborate another research study using a similar CAI tool, Intelligent Tutoring System (ITS), which enabled the instructor to meet individual students’ needs guiding students with lower mathematics skills while others learned via the system (Chien et al., 2008). Also, Ester's (1994) study revealed that some learners performed well with CAI and needed less assistance from instructors; as a result, instructors had more time to spend with other learners who were lacking algebraic skills. Similarly, another research study found students with weaker algebraic skills got more benefits than high performing students from the use of web-based homework due to the opportunity for multiple attempts to solve a problem and feedback for improvement (Wooten & Eggers, 2013).

Though the instructor could not say for sure whether teaching was more effective by utilizing MML, he definitely thought students could manage the course better if they were doing the homework correctly. The instructor said during the second debriefing session, "The success rate for these type of class is about 65%." However, according to the second debriefing session, the instructor mentioned, "The success rate for this class is 57-58%. Twelve students passed out of 22 students, and 10 did not pass. Three students voluntarily dropped from the course." These results counter Kodippili and Senaratne's (2008) research, which indicated that the student success rate is significantly higher in the MML student group (70%), compared with the traditional paper-based group (49%). Though this research study did not draw any comparison on success rates with traditional-based classes, the instructor's overall suggestion was that combining MML with traditional-based lessons and assessment is better. Based on the present findings, CAI is not necessarily a solution in and of itself to support the effort of administrators in education leadership to overcome the problem of low achievement in mathematics as proposed by Tienken and Wilson (2007).

Findings from the Students' Perspective

Several themes emerged in regard to the students. MML offered different features for students to use such as *Interactive tutorial exercises*, *E-books with multimedia learning aids, and Study plans for self-paced learning*. Though MML offered study plans for self-paced learning, there was no evidence based on the data sources that students used any study plan feature or any other features outside of MML's extra learning aids. The researcher interviewed five students to determine which MML features they used most of the time to complete their homework. The most frequently used features chosen by the five students were *Help Me Solve This Problem* and *View an Example*. Also, by having these features, during one of the debriefing sessions, the instructor mentioned,

> Students did not need to wait two to four days, even with the weekend, to ask the instructor how to solve specific mathematical homework problems. *Help Me Solve This Problem* and *View an Example* features can assist students in solving the algebra problem through step-by-step process.

These findings align with those of another study in which 82.3% of the students reported that the most used MML features were *Help Me Solve This Problem* and *View an Example* (Aichele, Francisco, Utley, & Wescoatt, 2011). Although students had mixed perspectives about the value of the *View an Example* feature, the findings of the present study indicated that the instructor encouraged the student to follow the MML example most of the time and explained the mathematical tasks to the student by using the MML examples.

Students did find the *Show Similar Exercises* feature helpful because it offers options to practice similar exercises for each homework problem. These findings corroborate the study results of Tienken and Wilson (2007), who indicated that practice exercises using CAI tools benefited the students; however, that study raised the question of whether the time spent on practice exercises will improve mathematics achievement as a whole. Students also reported that by practicing exercises and practicing review tests, they performed well. Another study also agrees with these findings that during course sessions in labs where students received CAI, they showed higher success on a practice test than the students who took classes via other instructional methods (Tosun, Sucsuz, & Yigit, 2006). Similarly, another study showed similar a pattern that students had more opportunities to practice algebraic homework problems using CAI (Jeger & Slotnick, 1985).

Since MML employs embedded tutorial videos for assistance, students did not go to other sources for assistance. However, findings indicated that the instructor had to re-explain the notes that students got from the embedded videos. However, other studies revealed that the students who learned with network support outperformed their peers in comparison with those who learned the same algebra topics by traditional methods of instruction (Hagerty & Smith, 2005; Kwan & Alexander, 2013). Similar to the tutorial videos, the examples from the electronic textbook were sometimes difficult to follow, as students thought the textbook was too technical at times. This finding supports another study that indicated *E-Textbooks* were the least helpful resource for students (Aichele, Francisco, Utley, & Wescoatt, 2011).

In addition, students found that the technology was useful to learn College Algebra as students worked within MML to practice more algebra problems rather than listening to instructor lecture about algebra or watching the instructor computing the algebra problems. During student interviews, all five students admitted that technology was useful to learn algebra because they could follow the available features that MML offered, in order to understand the mathematical problem and to complete homework problems. This supports Stewart's (2012) study on another CAI course in calculus in which students who completed their homework with MML were more successful than students choosing the traditional homework option. Also, one student said, “MML was useful for being able to not spend that much time for the things that you already understand rather spend more time on the materials that you do not understand.” The majority of students found MML useful because of the reassurance it provides whether students are doing the mathematical problems correctly. These findings support others which reported overall perceptions of students toward a CAI tool like MML as positive, necessary, helpful, and useful (Jeger & Slotnick, 1985).

Despite the positive feedback, date analysis indicated that students did face several challenges while using MML. One of the significant challenges was the restriction in MML with respect to accepting answers for homework or test answer choices. MML rejected answers that were entered in different formats such as having extra space between two answers, not entering numbers as an equation, entering an apostrophe instead of a comma, and entering a period instead of a comma. These issues resulted in differences between the instructor’s grading and the MML system automatically grading the test or homework answer. During the first interview session with the instructor, he also admitted that,

> I like that the MML program wants students to enter the answer in mathematical terms. I don’t like that it’s sometime become so sensitive that if a comma is in the wrong place, MML marks it wrong, or if extra space was put in after a comma. It can be frustrating.

These findings of frustration among instructors and students align with the findings of Taylor and And (1974) , who reprted that, though the CAI tool sometimes does not work properly, both the instructors and students were very enthusiastic toward using CAI and found it an effective instructional tool. Another weakness was the graphing tool, which also caused some level of frustration among students. Though this feature eliminates the lengthy process of graphing on regular paper, students had a difficult time manipulating or working with the feature, as it was not easy to navigate. Sometimes students felt stress working with the tool, paralleling results in Jeger and Slotnick's (1985) study which revealed that a CAI tool like MML required students to have more computer-proficiency skills, and some learners felt overwhelmed using the tool.

In addition, findings indicated that in order for students to be successful in the course, they needed to spend time studying outside of class. According to the second debriefing with the instructor, the students, who spent more time outside of class, were able to successfully pass the course in comparison to the students who did not. According to the instructor, students also needed to spend more time in the mathematics computer lab to learn the concepts when using MML. These findings yielded similar results to Ningjun and Herron's (2012) research, which revealed that there is a correlation between the amount of time spent in the lab and the score on final exams; that is, the number of hours students spent in the computer lab could predict their achievement. However, the instructor believed a few students were more interested in learning the patterns of MML rather than the actual mathematical concepts as a certain percent of the students appeared to master MML patterns to get through the course, something that could not be done in a traditional class.

Students made different suggestions for ways to improve MML, such as more embedded tutorial videos, updated graphical tools, explanations for the mathematical terms, provision of examples for definitions, and addition of more complex problems. Another important suggestion involved the improvement of the MML display messages that provided feedback or hints to students while solving algebra problems. For example, some students had to compute an algebra problem multiple times to evaluate an answer entered in MML in an incorrect forma; that is, MML rejected the answer even though the answer was correct. If MML had displayed a message explaining that the answer was correct but not expressed in correct mathematical format, then the students would not have to re-calculate the problem again. These suggestions align with the findings in prior research indicating that CAI has the potential to help students with providing correct answers, managing correct problem solving, providing immediate comment, and pointing out mistakes (Jeger & Slotnick, 1985).

In addition, findings revealed mixed views about what kind of instructional methods was preferred by both students and the instructor. Some students preferred classroom instructor guidance rather than computerized steps with embedded videos, and others preferred traditional-based lessons. The instructor admitted that the combination of MML and a traditional lesson is better than just using MML for instruction. He preferred MML for homework practice but said that to assess students for testing, the traditional method is better. In contrast, other research disagreed with these findings as indicated in the Camnalbur and Erdogan (2008) meta-analysis, which revealed that CAI tools are more effective academically than traditional teaching methods.

Study Limitations

Several limitations exist due to the nature of the study. The research study was limited to one instructor and one section of the College Algebra course. Further, the research was conducted based on one CAI tool and during a short May semester. The student interviews were conducted with only five students. In addition, the researcher did not use random sampling to select students for interviews, which minimized the possibility of talking to a diverse subset of students from the class. Since the study was based on observation of one instructor, one section of the course, one CAI tool, and a few student participants, these findings cannot be generalized to all College Algebra courses utilizing CAI.

Study Benefits and Implications

The findings of the present study have implications for mathematics instructors, publishers, mathematics departments, and students. Other instructors can improve their pedagogy and be prepared to face the challenges of MML by reviewing the present study. Instructors will learn from this study that the CAI tool has numerous advantages but also some disadvantages. The detailed analysis of the use of CAI in a College Algebra course allows mathematics instructors to reflect on teaching strategies, their personal TPACK, usages of technologies in teaching algebra, and technology incorporation into classroom learning activities, homework, and assessments. Instructors would be better prepared to teach a CAI course by having knowledge of the challenges that the MML system presents for the instructor and students. The study encourages instructors to rethink how to teach a College Algebra course efficiently and effectively using MML. Similarly, the study findings could also help the publisher of MML, Pearson Education, to improve the MML system for their next production release. Mathematics departments can analyze the course offerings to identify whether the MML system would be a good fit for various courses. Administrators will be aware that some students and instructors may benefit from using MML; thus, they can decide to possibly select to utlilize this tool in other courses as well. The study findings would also help advisors and students determine whether a CAI course is a good fit. Findings indicate that courses utilizing MML would benefit students who are self-motivated and independent learners. Otherwise, students might need to reconsider registering for this kind of course. Overall, educators and students can learn more about MML, compare CAI with traditional classroom instruction, and consider ways to use technological innovations to teach mathematics.

Future Study

According to the instructor of the selected course, the college district has conducted a couple of studies that indicated students who took developmental mathematics classes with MML do better in Statistics and College Algebra. However, there is no data on how these students perform beyond the introductory courses. According to students who were interviewed, they took College Algebra to meet part of their degree requirements and to exit out of the college. Also, the instructor mentioned during interview, “Only 10% of College Algebra students will take the Pre-calculus or Calculus sequence. It’s hard to see students’ success rate since College Algebra is the last class students take.” As a result, according to the instructor, determining whether students who took College Algebra with MML are just as successful in subsequent mathematics courses as students who took a traditional course is difficult. As the instructor suggested during the interview, “Another research study can be done with the students who take the next level of math class to see how they performed. If they are successful, identify to see if their previous class was traditional-based or CAI tool-based. The study should be able to reveal if those options have any effect in completing the math course successfully.”

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Appendix A: Initial Interview Protocol for targeted Algebra instructor

Texas Christian University
Fort Worth, Texas

1. What are your current roles in this college? What courses are you teaching this semester?

2. How long have you been teaching in this selected college? Do you teach any other places as well?

3. Please tell me about your algebra teaching experiences in a two-year college.

4. Please tell me about the Mathematics Department and what the department thinks about the use of technologies in the classroom.

5. What type of technology do you use as a pedagogical tool? Why did you select this particular tool(s)?

6. How you are incorporating technology (MyMathLab) into your class lessons?

7. Please specify how you are using technology as a pedagogical tool to teach algebra.

8. Have you ever taught this same class, or a similar class, in the past without incorporating technology? If yes, what is the difference?

9. Does the use of technology help you to teach algebra more effectively? Why or why not?

10. What kind of impact do you think using technology has on students in terms of learning?

11. What are the challenges in using technologies in the classroom?

12. What is your biggest concern about using technology? How do you address it?

13. Do you think algebra can be learned more effectively by using technology? If yes, how?

14. How do the students respond to classroom-learning sessions, which incorporate technology?

15. How do you assess students to make sure that they are learning the concepts of algebra?

Appendix B: Debriefing Interview Protocols after class observation

Texas Christian University
Fort Worth, Texas

1) For this lesson _________________, why did you use ________technology to introduce the topic in the class?

2) How did the use of _______________ technology impact the students' learning?

3) How did the use of _____________________technology support your instruction?

4) Could you elaborate why by using ________________________ technology into the __________ algebra topic helped student to understand the topic better?

5) The students seemed to ask questions on this topic ________ where there is no technology involvement. What other technology could you have incorporated in this lesson?

Appendix C: Interview Protocol for student

Texas Christian University
Fort Worth, Texas

1. What is your area of study?
2. Why are you taking this algebra course?
3. What technologies are being used in your algebra course?
4. Do you find this technology useful in learning algebraic concepts? Why or why not?
5. What are the challenges of using this technology?
6. What do you think about homework activities that you are doing with the technology? Please explain.
7. Which aspect of the technology you find difficult? Please explain.
8. Which aspect of the technology you find most helpful? Please explain.
9. How do you think the use of this technology can be improved to help you learn the concepts of algebra?
10. Would you like to add some information with respect to using technology to learn algebra that you think is essential to know?