Short, Medium and Long Term Effects of an Online Learning Activity Based (OLAB) Curriculum on Middle School Students' Achievement in Mathematics: A Quasi-Experimental Quantitative Study

by

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ABSTRACT

Public Mathematics Education is not at its best in the United States and technology is often seen as part of the solution to address this issue. With the existence of high-speed Internet, mobile technologies, ever-improving computer programming and graphing, the concepts of learning management systems (LMS's) and online learning environments (OLE's), technology-based learning has elevated to a whole new level. The new generation of online learning enables multi-modal utilization, and, interactivity with instant feedback, among the other precious characteristics identified in this study. The studies that evaluated the effects of online learning often measured the immediate impacts on student achievement; there are very few studies that have investigated the longer-term effects in addition to the short term ones.

In this study, the effects of the new generation Online Learning Activity Based (OLAB) Curriculum on middle school students' achievement in mathematics at the statewide high-stakes testing system were examined. The results pointed out that the treatment group performed better than the control group in the short term (immediately after the intervention), medium term (one year after the intervention), and long term (two years after the intervention) and that the results were statistically significant in the short and long terms.

Within the context of this study, the researcher also examined some of the factors affecting student achievement while using the OLE as a supplemental resource, namely, the time and frequency of usage, professional development of the facilitators, modes of instruction, and *fidelity of implementation*. While the researcher detected positive correlations between all of the variables and student achievement, he observed that

school culture is indeed a major feature creating the difference attributed to the treatment group teachers.

The researcher discovered that among the treatment group teachers, the ones who spent more time on professional development, used the OLE with greater fidelity and attained greater gains in student achievement and interestingly they came from the same schools. This verified the importance of school culture in teachers' attitudes toward making the most of the resources made available to them so as to achieve better results in terms of student success in high stakes tests.

DEDICATION

To my wife Selina, my one, and only love.

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INTRODUCTION

While the U.S.'s ability to compete in the global economy is decreasing, and the need for more experts in STEM fields is increasing (Couto, 2007; NRC, 2007; U.S. Department of Labor, 2007), the number of students pursuing and completing STEM degrees is declining (U.S. Department of Education, 2001; National Science Board, 2010). Among the factors contributing to this decline are students' poor preparation for, lack of success with and little interest in mathematics (Arizona Department of Education, 2009; Mullis, Martin, & Foy, 2008; Ischinger, 2007).

Data from a number of international, national and state assessments attest to students' poor understanding or lack of recall of important mathematical concepts and skills. On the most recent Programme for International Student Assessment (PISA) of 15-year-olds, administered in 2009, U.S. students' average score was 487, that is, nine points less than the international average of 496 (Organisation for Economic Co-operation and Development (OECD), 2009). On the mathematics portion of the 2011 Trends in International Mathematics and Science Study (TIMSS), the average score for grade 4 U.S. students was 541. By grade 8, the average score decreased to 509 (Institute of Education Sciences, 2011). NAEP, the National Assessment of Educational Progress report revealed that the 2015 average scores in mathematics were 1 and 2 points less in grades 4 and 8, respectively, than those reported in NAEP 2013 (National Center for Education Statistics, 2016). On the 2012 Arizona Instrument to Measure Standards (AIMS) test, the percentage of students passing the mathematics portion decreased from 67% in grade 4 to 57% in grade 8 (Arizona Department of Education, 2012).

Two major documents guiding mathematics curriculum development, the *Principles and Standards in School Mathematics* (National Council of Teachers of Mathematics, 2000) and the *Common Core Standards in Mathematics* (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010) not only specify the big ideas in mathematics and the mathematical practices that must be mastered at the middle-school level, but also point out the centrality of these key concepts and habits of mind to the study of more advanced topics. Acknowledging students' poor performance in mathematics and recognizing the difficulties that they are having with learning mathematics, mathematics educators and researchers, nationwide, are searching for strategies to enhance interest and achievement in mathematics.

Several researchers have studied and demonstrated the relationship between interest in and achievement in mathematics (Fennema & Romberg, 1999; Koller, Baumert, & Schnabel, 2001; Simpkins, Davis-Kean, & Eccles, 2006). Others have experimented with different methods for enhancing interest and thereby achievement, including online learning environments (OLE's) (Bowes, 2010; Nelson and Sassi, 2007).

Research has shown that online learning, a predominant form of computer-assisted instruction (CAI), can be invaluable for teaching and learning mathematics (Fouts, 2000; Kulik, 2002; Handal et al., 2003; Maag, 2004). It is also known that CAI may have a positive impact on student attitudes toward technology use as well as what they learn (Kulik et al., 1991; Aivazidis et al., 2006).

Rationale

Mathematics is crucial to not only success in school studies, but also for being an informed individual, being productive in one's chosen career, and being personally fulfilled. In today's technology driven society, greater demands have been placed on people to interpret and use mathematics to comprehend information and complex situations (Wedege, 2009-2010). The 1997 report from the U.S. Department of Education publication, *Mathematics Equals Opportunity* pointed out that 1) students who take a rigorous K-12 mathematics sequence are more likely to go to college than those who do not; 2) students from all income levels who take rigorous mathematics classes in high school are more likely to go to college; and 3) in the job market, students who have strong mathematics background are more likely to find employment and are paid 38% more per hour than those with insufficient skills in algebra, geometry, measurement, and probability.

As noted by other researchers, success with middle school mathematics is not only closely aligned to achievement with high school mathematics (Wang and Goldschmidt, 2003; Nathan and Koellner, 2007), but also for preparation for careers in science, engineering, and technology (Tai et al., 2006). While the importance of middle school mathematics has been identified, it is the case that during the middle school year, mathematical concepts become increasingly complex and more abstract. Understanding of those concepts necessitates the ability to link across several algebraic and graphical representations (Rochelle et al., 2010).

In an effort to strengthen mathematics education in the U.S., the *Common Core State Standards for Mathematics* (CCSS-M) (NGA & CCSSO, 2010) were created. The standards are designed to be robust and relevant to the real world, reflecting the body of knowledge and skills students should attain to be prepared to study more advanced mathematics, become college and career ready, and ultimately get ready to compete successfully in the global economy. The K-8 standards are organized by grade level in grades K–8 and by concept clusters at the high school level (NGA & CCSSO, 2010).

The CCSS-M identify the following foci for investigation in grades 6, 7 and 8. In grade 6, focus is on: 1) relating the concepts of ratio and rate with whole number multiplication and division as well as solving problems using the concepts of ratio and rate; 2) understanding division of fractions while extending the number concept to include rational numbers, along with numbers that are negative; 3) writing, interpreting, and making use of expressions and equations; and 4) developing an understanding of statistical thinking (NGA & CCSSO, 2010, p. 39). In grade 7, focus is on: 1) understanding and applying proportional relationships; 2) understanding operations with rational numbers and working with linear equations and basic mathematical expressions; 3) using scale drawings and informal geometric constructions to solve problems, and solving problems involving area, surface area, and volume working with two-dimensional shapes and three-dimensional objects; and 4) drawing inferences about populations based on samples (NGA & CCSSO, 2010, p. 46). In grade 8, focus is on 1) reasoning about and formulating mathematical expressions and equations that may incorporate modeling bivariate data using linear equations, and solving linear equations as well as linear equation systems; 2) developing an understanding of the function concept and describing quantitative relationships utilizing functions; 3) using distance, angle, similarity, and congruence to analyze two-dimensional space and figures, three-dimensional space and objects, and understanding and applying the Pythagorean Theorem (NGA & CCSSO, 2010, p. 52). Grades 6 and 7 serve as the prerequisites for the abstract topics of algebra and geometry to be covered in grade 8 (NGA & CCSSO, 2010). This is why grade 6 mathematics is instrumental in success throughout middle school mathematics (please see Appendix A).

Mathematics, being a central component of K-12 education, occupies a huge portion of a typical school day and technology can help upgrade the outcomes as outlined by Western (2003) who also provided examples of various uses of online worksheets, manipulatives and interactive Web tools. Availability of vast amounts of online resources, when employed systematically and properly, can help serve the retention of mathematical knowledge (Nelson et al., 2007; Bowes, 2010).

Many students today have access to the Internet, which permits them to utilize websites that expands their skills, help them in research and spend their free time. A study created by the U.S. Department of Education (2007), investigated the way in which guardians/parents can help their children with mathematical conceptions that are taught in school from primary to secondary levels. A number or activities for guardian/parents are provided in the document that can help them in improving the math skills of their children. It is also stated in the study that guardians/parents should try to trigger the interest of technology in their children. Children must be assisted to use technology; however it should be kept in mind that they should not entirely depend on technology to solve problems. Parents should support their children in learning to use computers and Interned to widen the scope of their learning and discover math related websites and games that can boost the interest of their children in math (Spellings, 2002).

Problem Overview

Since the conception of the idea of CAI as a teaching aid, many online learning environments (OLE's) have been created. However, not every OLE' can present similar positive effects because of lacking few or many of the desirable characteristics essential for effective teaching and learning experience. Most of these features are presented through the findings of cutting-edge research in the literature survey chapter of this document. An Online Learning Activity Based (OLAB) Curriculum is an OLE' for mathematics and science education of middle and high school students. OLAB contains a rich library of learning activities aligned to the standards, that are online, animated and interactive. Also available online are assessments and supplemental materials (e.g. worksheets and glossary), that are printable. Detailed teacher's guides accompany all activities. Teachers who choose to use OLAB can maintain information about their students online, can build individualized lesson plans by selecting from learning activities as well as external online resources, can notify students via email about the availability of lessons adapted to their needs and access information via email, and can track student progress through an online monitoring system.

Most of the research that studied the effects of online learning investigated the immediate or short term changes in achievement (Bowes, 2010; Nelson and Sassi, 2007); very few have examined medium and long-term retention of mathematical knowledge as an outcome of online learning, which was one of the contributions intended in this study.

On the other hand, a program or approach that has previously been effective in one setting can be ineffective in another if implemented in a way that is far-off from the way it was designed originally. In this respect, researchers have begun to focus on a concept that has received little attention in education: *fidelity of implementation* which is often the missing link between a promising program and positive impacts on students (Kutash, Duchnowski, & Lynn, 2009; Mihalic, Fagan, Irwin, Ballard, & Elliott, 2004, Meylani, et al. 2014). “Fidelity of Implementation” refers to the extent to which an intervention or program is conveyed as envisioned; researchers and practitioners can gain a better understanding of how and why an intervention works and which outcomes can further be improved, only by assessing whether or not an intervention has been implemented with fidelity (Carroll et al., 2007). The degree to which OLAB was implemented with fidelity is another question this study intended to probe.

Purpose of This Study

This study assessed the immediate and long-term effects of an Online Learning Activity Based (OLAB) Curriculum intervention that took place in the 2010-2011 school year at the 6^{th}-grade level at a southwestern urban school district. The teachers who chose to employ OLAB constituted the treatment group whereas the teachers who adhered to traditional instruction created the control group. The immediate and long-term effects are evaluated by students’ scaled scores in 2011, 2012 and 2013 AIMS Mathematics tests using the 2010 AIMS Mathematics scaled scores as a baseline. Refer to Figure 1 for the blueprint of the AIMS Mathematics test.

The research also intended to study the factors that play into the effectiveness of OLAB. The factors of question were: usage statistics which included total time and frequency of usage, as well as the hours of professional development of the facilitators; the manner of usage (whole class, small group or individual instruction); mastery of components, i.e. the knowledge and utilization of the features OLAB had to offer and the fidelity of implementation. The usage statistics were provided by OLAB; results of the AIMS Mathematics Tests were provided by the school district; and the fidelity of implementation was studied through a survey created specifically for this study.

AIMS Mathematics Blueprints (beginning with the 2010 Assessments)

Strand/Concept	Grade 6	Grade 7	Grade 8
1. Number and Operations	**34%**	**25%**	**18%**
1.1 Number Sense	13%	7%	6%
1.2 Numerical Operations	15%	12%	6%
1.3 Estimation	6%	6%	6%
2. Data Analysis/Prob/Discrete	**18%**	**19%**	**18%**
2.1 Data Analysis (Statistics)	6%	6%	6%
2.2 Probability	6%	7%	6%
2.3 Systematic Listing and Counting 2.4 Vertex-Edge Graphs	6%	6%	5%
3. Patterns/Algebra/Functions	**16%**	**19%**	**26%**
3.1 Patterns 3.2 Functions and Relationships	6%	6%	9%
3.3 Algebraic Representations	10%	13%	12%
3.4 Analysis of Change			6%
4. Geometry and Measurement	**19%**	**22%**	**24%**
4.1 Geometric Properties	6%	13%	6%
4.2 Transformation of Shapes			6%
4.3 Coordinate Geometry	6%	0%	6%
4.4 Measurement	7%	9%	6%
5. Structure and Logic	**13%**	**15%**	**15%**
5.1 Algorithms and Algorithmic Thinking 5.2 Logic, Reasoning, Prob Solving, & Proof	13%	15%	15%

Figure 1. Blueprint of the AIMS Mathematics Tests Administered at the 6th, 7th and 8th-Grade Levels.

Operational Definition of Terms

Online Learning: Learning that is completely or partially done through the Internet.

Online Learning Environment (OLE): A learning environment that is accessible through the Internet.

Online Learning Activity Based Curriculum (OLAB): The OLE' which was the medium of intervention in this study.

Control Group: Teachers and students who did not use OLAB.

Treatment Group: Teachers and students who used OLAB.

AIMS: Arizona's Instrument to Measure Standards; the state-wide high stakes test in Arizona taken by students at the end of grades 3 through 8 and grade 10.

Immediate Effects: Results of the 2011 AIMS Mathematics Test that took place at the same school year as the intervention at the 6^{th} grade.

Long Term Effects: Results of the 2013 AIMS Mathematics Test that took place two years after the intervention at the 7^{th} grade.

Usage Statistics: The total time and frequency of using OLAB.

Fidelity of Implementation: A measure of how effectively OLAB was utilized by the treatment group teachers. It consists the hours of professional development of the treatment group teachers; the manner of usage; the knowledge and utilization of the features of OLAB.

Professional Development: The training of the treatment group teachers on how to utilize the features of OLAB and the Learning Activities (LA) to be employed in class.

Learning Activity (LA): An interactive, animated learning activity within OLAB that teaches one mathematics concept.

The Manner of Usage: One or more of the ways of using OLAB as follows: whole class, small group or individual instruction.

Whole Class Instruction: The teacher projects the LA on the board as part of a lecture. This way of using OLAB usually takes place when there is only one computer available in the classroom.

Small Group Instruction: Groups of two or three students use OLAB study the LA (’s) per computer. This way of using OLAB usually takes place when there are few computers available in the classroom.

Individual Instruction: One student uses OLAB and studies the LA (’s) per computer. This way of using OLAB usually takes place when there enough computers available to accommodate all students in the classroom.

Mastery of Components: A measure of how well a teacher knows and how often they use the features of OLAB.

Justification for This Study

The Online Learning Activity Based (OLAB) Curriculum was created in collaboration with a university research facility conforming to the implications of cutting-edge research literature. This study revealed to what extent OLAB helped alleviate students’ poor understanding or lack of recall of important mathematical concepts and skills by looking into medium and long term results. Studies that look into medium and long term effects of online learning are limited. Furthermore, this study investigated how usage statistics and fidelity of implementation played into the effectiveness of OLAB as an OLE' and thereby set an example for similar studies in the future.

Research Questions

The research questions that guided this study intended to 1) compare the control and treatment groups; 2) investigate the factors that affected the difference(s) in treatment group students' mathematics achievement if any; and 3) compare the treatment group teachers with each other. The research questions were as follows:

1. Comparison of the control and treatment groups:

   How did the control and treatment groups compare in students' mathematics achievement based on mean scores:

   a. before the intervention,
   b. immediately after the intervention, i.e. in the short term;
   c. one year after the intervention, i.e. in the medium term;
   d. two years after the intervention, in the long term?

2. Factors in effect for the treatment group:

   a. How did the total time and frequency of usage correlate with the gains in mean score?
   b. How did gains in mean scores correlate with:
      i. total hours of professional development;
      ii. manner of usage, i.e. whole class and/or small groups and/or individual instruction;
      iii. mastery of components in OLAB?
   c. How did the total hours of professional development, manner of usage and mastery of components correlate with one another?

3. Comparison of the treatment group teachers with one another:

   a. How did the treatment group teachers compare in students' mathematics achievement based on gains in mean scores:
      i. immediately after the intervention, i.e. in the short term;

ii. one year after the intervention, i.e. in the medium term;

iii. two years after the intervention, in the long term?

b. How did the intervention affect the differences in students' mathematics achievement in the short, medium and long term for the treatment group teachers with each other in terms of:

i. usage statistics, i.e. the total time and frequency of usage;

ii. total hours of professional development;

iii. fidelity of implementation, i.e. the manner of usage?

c. How did the school culture effect the performance of treatment group teachers if any?

Organization of the Chapters

This dissertation is organized into five chapters. Chapter 1 includes the introduction, rationale, problem overview, the purpose of this study, operational definitions of the major terms to be used throughout the dissertation, justification for this study, the research questions that guide this study, limitations to the study and organization of the chapters. Chapter 2 presents a review of the literature which starts with the operational definition of online learning followed by the dimensions of online learning, a comparison of pure and mixed online learning, the desirable characteristics of online learning, the concept of the *fidelity of implementation,* the need for professional development and how E-learning and knowledge retention relate to one another concluding with a summary of findings through the literature survey. Chapter 3 portrays the methodology used for this dissertation including the district profile and the description of participants, a detailed description of OLAB as the medium of intervention; the intervention process, the instruments used to collect data, description of the data fields and methods of data analysis to answer each research question. Chapter 4 conveys the results obtained from the analyses as well as their interpretation. Chapter 5 rehashes the problem overview, discusses the findings and limitations, provides recommendations for similar studies and presents a conclusion.

Chapter 2

LITERATURE REVIEW

Scope of this Literature Survey

Research has revealed that computer-assisted instruction (CAI) can be an effective method for teaching and learning mathematics (Fouts, 2000; Kulik, 2002; Handal et al., 2003; Maag, 2004). It is also known that computer-based learning usually creates a positive impact on students' attitudes toward using technology in addition to what they learn (Kulik et al.,, 1991; Aivazidis et al., 2006). However, not every Online Learning Environment (OLE') can present similar positive effects.

Therefore, this literature review, aimed to go beyond the effectiveness of technology in mathematics instruction or the attitudes of learners toward the use of technology. It was not limited to any subject area in particular; rather it meant to explore and present the research that explains aspects of online learning and how they play into the educational experiences of students as well as the advancement of teaching practices in general.

Within the context of this literature review, more than 50 independent studies were selected and analyzed such that each study: 1) concentrated on the learning of students, 2) operated on a valid research design and 3) presented sufficient knowledge preferably with effect sizes. This review of the literature begins with the operational definition of online learning followed by the dimensions of online learning that are affect, attitudes, intrinsic and extrinsic motivation. A comparison of pure and mixed online learning was presented prior to delving into the research that elaborate distinct characteristics of online learning desirable for a better teaching and learning experience.

The concept of the *fidelity of implementation* needed to exploit an OLE' to the fullest extent, was accompanied by addressing the need for professional development necessary for implementation with high levels of fidelity. E-learning and knowledge retention come next and the literature surveyed concluded with a summary of findings.

Online Learning Defined

Online learning for this review is defined as learning that is completely or partially done through the Internet. This review studies online learning as: (1) learning directed fully online as a replacement or substitute to face-to-face learning, and (2) online learning mechanisms that are mixed or merged (also known as “hybrid” or "mixed") with face-to-face learning for the provision of learning enhancement.

Dimensions of Online learning

Researchers interested in student behavior and attitudes towards online learning have already started reporting on classroom experiences that utilize educational technology in one or more ways. Affect, attitudes, intrinsic and extrinsic motivation are the four dimensions identified by researchers so as to better comprehend students' enthusiasm and attitudes concerning online learning (Saad et al., 2011, Meylani, R., Bitter, G. G. & Legacy, J. 2015). Research has pointed out that positive attitudes and motivation toward online learning increases long-term retention of knowledge significantly (Naidr et al., 2004).

Affect. Affect refers to the individual feelings of contentment, gladness, dislike, unhappiness, repulsion, etc. regarding a particular behavior (Triandis, 1980). According to Triandis (1980) there is a strong relationship between affect and behavior. Positive affect towards technology leads to positive and enhanced learning experiences along with improved self-efficacy; on the other hand, negative affect creates the inclination to avoid using technology limiting and/or blocking the supplemental value of technology as a curricular support instrument (Arkkelin, 2003).

Attitudes. The theory of reasoned action identifies attitude as one of the primary indicators of behavioral intention. Most of the research literature that focused on students' and teachers' attitudes toward technology has shown that students' attitudes are deterministic in the level of learning they achieve via technology (Marzano and Pickering, 1997; Sunal et al., 2003; and, Saade et al., 2010;). In addition, research conducted to confirm this claim has extended the discussion to include OLE's (Daley et al., 2001; Saade and Galloway, 2005; Saade, 2007; Saade et al., 2009).

Intrinsic and extrinsic motivation. Researchers also examined the perspectives of motivation to better understand student behavior. Davis et al. (1992) have studied the concept of motivation in terms of understanding the behavioral intentions concerning the use of technology so as to predict whether a certain form of technology can be accepted or rejected. These researchers as well as several others found that intrinsic and extrinsic motivation are key aspects for behavioral intentions toward using technology (Davis et al., 1992; Venkatesh, 1999; Vallerand, 1997). Wlodkowski (1999) defines intrinsic motivation as an incentive or a form of internal stimulant or energy that is culturally and personally significant to a person. Intrinsic motivation, now, has its place in learning theories and is being used as a means to measure a person's perceptions toward gaming and multimedia technologies (Venkatesh, 1999; Venkatesh and Davis, 2000; Venkatesh et al., 2002). Extrinsic motivation, conversely, is the execution of a behavior in order to achieve certain pre-defined rewards (Deci and Ryan, 1985). For students, extrinsic motivation for learning may include getting better grades in exams, awards, recognition, social status, etc. Many studies have shown that extrinsic motivation is also an important factor in learning but is not as effective as intrinsic motivation to learn with technology (Saade et al., 2007).

Comparison of Pure and Mixed Online Learning

It has been discovered that effect sizes for studies comparing mixed online learning to face-to-face learning conditions were larger than for studies comparing completely online learning to face-to-face learning conditions (Means et al., 2010, Meylani, R., Bitter, G. G. & Legacy, J., 2015). An additional method to examine the same problem is by carrying out studies that integrate mixed and completely online conditions to allow straight contrasts of their efficiencies. This method of inquiry is elaborated under this heading.

Keefe (2003), for instance, compared a segment of an organizational behavior course that obtained lectures from power point slides online or from a CD-ROM with another segment that obtained lectures and instructions that were face-to-face. Both of these groups had access to threaded discussion forums, e-mail and online chat rooms. The course materials were sent to all the students electronically at one time. In examination the students who obtained lectures completely online scored approximately eight percent less than the students who obtained face-to-face instructions and lectures besides the online learning actions. The study of Keefe discovered a significant decrement in the outcomes for the situation without face-to-face teaching components.

Poirier and Feldman (2004) distinguished between a course that was taught completely online with a course that was mostly taught face-to-face but employed an online discussion board. It was compulsory for the students in the face-to-face instruction version of the course to take part in three online dialogues, post at least two comments per dialogue on a website that hosted the contained matter, assessments and communication tools. On the other hand in the completely online version of the course teacher and students took part in two online discussions every week. The authors discovered an effect that favored the completely online version of the course for examination grades but on the contrary it had no effect on the performance of students in writing assignments.

Campbell et al. (2008) contrasted between a mixed course (wherein the students went for face-to-face discussions but had online access to content) and a completely online course (wherein the students participated in online discussions and had access to instructions online. In both the discussion arrangements the instructors were present. The students had the choice to select the type of instruction they wanted, online or mixed. The average of students who selected the online discussion option was significantly greater than that of the students participating face-to-face discussions.

The combined outcome of these three studies (Keefe, 2003; Poirier and Feldman, 2004; Campbell et al., 2008), is that the comparative effectiveness of completely online or mixed learning methods depends on the instructional component of the two situations. For instance, the teacher in the Keefe (2003) study has included content that was not present in the power point slides of the online lecture. On the other hand in the study of Poirier and Feldman (2004), students communicating with the teacher in two online discussions every week were delivered more instructional material than the students who participated in face-to-face lectures.

Several other studies that compared mixed and completely online situations also did not succeed in finding statistically significant differences in the learning of students (Davis et al., 1999; Gaddis et al., 2000; Beile and Boote, 2002; Ruchti and Odell, 2002; Caldwell, 2006; Scoville and Buskirk, 2007; McNamara et al., 2008). For instance, Davis et al. (1999) tried to associate the material distributed in their three divisions of class (face-to-face, online, or a mixed situation wherein lecturer and students meet face-to-face but employ online instructions). The students of an educational technology course were allocated to one of the three divisions at random. The score of the multiple choice post-test of students showed no major difference among the three divisions.

Gaddis et al. (2000) contrasted student's audience awareness between a mixed course and a completely online course. The teacher was the same for both groups that received the same writing assignments. For communication and writing both the groups used networked computers. The only difference was in the meeting, i.e. the off-campus group met only online whereas the on-campus group met face-to-face and communicated personally. However no significant dissimilarities were found in the outcomes between the two groups. Beile and Boote (2002) differentiated among three groups: Web-based instruction in conjunction with web-based tutorial, face-to-face instruction along with a web-based tutorial and face-to-face instruction only. No significant differences were found among the three situations in the final quiz on the library skills of students.

Ruchti and Odell (2002) contrasted the test results of two groups of students belonging to an elementary science teaching method class, one using an online module and the other receiving lecture face-to-face, along with an online journal and discussion board. No significant differences were found between the groups.

Likewise, Caldwell (2006) didn't find any major disparities in the performance on a multiple choice test, of students of undergraduate computer science majors enrolled in a mixed course and the students of the same course enrolled in the online course. A completely web-based platform for instruction was available for the students enrolled in the online course while a face-to-face lab element was available for the students enrolled in the mixed course.

Scoville and Buskirk (2007) inspected whether or not the use of virtual or traditional microscopy would have an effect on the results in a medical histology course. Four groups were created and each student was randomly allocated to one of them, (1) a completely online situation, (2) a completely face-to-face situation, (3) a mixed situation with virtual learning and a practical face-to-face exam and (4) another mixed situation with face-to-face learning and a virtual exam. Scoville and Buskirk discovered no significant differences in unit test scores among the four groups.

McNamara et al. (2008) examined the efficiency of diverse methods of teaching a weight-training course. For this they created three groups, (1) a completely online group, (2) a group that was given completely face-to-face instruction and (3) a mixed group that received a combination of face-to-face and online instruction. No statistically significant differences were found.

Lastly, Delialioglu et al. (2008) used the Model for Learning and Teaching Activities (MOLTA), to design, develop and implement a new technology enhanced hybrid instruction and compared the effectiveness of the hybrid instruction with respect to students' achievement, knowledge retention, attitudes towards the subject and course satisfaction was in comparison to traditional classroom instruction. The authors employed an experimental study with pre-test, post-test and control group design. The sample of the experiment included 50 university students enrolled in a “Computer Networks and Communication” class. The control and treatment groups consisted of 24 and 26 students respectively, and the experiment lasted for 14 weeks. The outcomes of the study indicated no significant differences between the hybrid course and the traditional course in terms of students’ achievement, knowledge retention, satisfaction, and attitudes.

Desirable Characteristics of Online Learning

A number of empirical studies on online learning can be found through a methodical investigation of the research literature since 1995. The findings of these studies reveal the desirable characteristics of an ideal OLE'.

Computer tutorials and online learning activities. Online learning activities and computer tutorials grant students the advantage of learning at their own convenience regarding pace and level of knowledge. They also receive instant feedback while working in a student-centered learning environment (Inan et al., 2010).

Feedback is utterly significant for a learner’s brain. When a learner is given feedback on an incorrect answer, a chain of neural processes and brain activities are initiated. The comments given by the feedback provide reinforcement to correct the inaccurate knowledge. In addition, a positive feedback indicates learning has taken place encouraging the student to keep working on the material irrespective the level of difficulty of the concept being studied. A curriculum structured in this way challenges without frustrating the students (Marzano et al., 2004; Luo et al., 2005).

Moreover, online learning has long been recognized as a strategy of enhanced practices of teaching and learning (Marzano et al., 2004). Interestingly, computer-based training programs have been shown by longitudinal studies and meta-analyses increase students performance' particularly on standardized testing programs (Sivin-Kachala et al., 2000).

The existing knowledge on the synaptic connections inside the human brain and how they enable learning is confirmed by the phenomenon described above. For instance, through rigorous practice using online tutorials, mathematical facts are remembered easily and performed almost automatically. Thus the brain has more energy to move on to the next level in terms of acquiring mathematical skills and knowledge that are new to the learner. In all, computer tutorials have a positive impact on the retention of old knowledge and acquisition of new knowledge (Salimpoor et al., 2010).

The use of multimedia components, simulations and manipulatives. Numerous studies investigated the influence of multimedia components, simulations and manipulatives within OLE's (Schmeeckle, 2003; McKethan et al., 2003; Maag, 2004; Schroeder, 2006; Zhang et al., 2006; Schnitman, 2007; Schutt, 2007; Tantrarungroj, 2008). These studies exposed two important properties of multi-media components within an OLE': (1) Incorporating media components may contribute to knowledge retention, but is not sufficient by itself to enhance learning and instruction; (2) the manner of integrating media components is a key aspect that positively influences student learning, e.g. when they are used to create interactivity.

Adding extra media to online instruction was found by Schnitman (2007) to create no added effects on learning; the researcher aimed to investigate whether or not text with graphics, improved coloring, and extra navigation options would affect learning outcomes. The researcher used two versions of the same OLE and allocated students randomly to each one. The control group accessed the OLE through a plain text-based interface, whereas the treatment group accessed it via an interface that incorporated an enhanced color scheme, additional navigational options and graphics. No significant differences in learning outcomes were discovered between the control and treatment groups (Schnitman, 2007).

Regardless of type, the sole purpose of media elements is to act as a transmission medium of information. Majority of studies that probed the effects of media types did not really found any significant differences in terms of learning. Therefore it is doubtful that media elements improve learning (Clark, 1994,1983).

Tantrarungroj (2008) did find positive effects caused by added media components either; the researcher examined two teaching approaches for a neuroscience course taught at an undergraduate level computer science program. The researcher utilized a controlled situation where the students in the control group were not given access to streaming video whereas the treatment group students were instructed using online text with static graphics and embedded videos. A post-test administered immediately after the class did not reveal any significant differences between the two groups. However, the treatment group performed significantly better on a knowledge retention test administered four weeks after the intervention, proving that added media indeed had a positive influence in terms of knowledge retention.

As emphasized by Zhang and colleagues (2006) the process by which a medium is used has more relevance as compared to the ability to access it. For example, studies indicate that videos can help facilitate learning where the target learner can actually interact with such videos, through for instance interactive videos . These videos have been known to impact positively on learning. The researchers considered different situations in their study, including three online situations with non-video settings, non-interactive video and interactive videos alongside face-to-face scenarios. Students have been generally given tasks and other groups also had their assignment tasks. The authors were able to note how students were usually randomly settled in one of the groups. It was established that the efficiency of students in the interactive video group was much better than the student's performance in other scenarios. There was however no significant difference for the other groups.

Mixed results were found by three studies that explored the outcomes of involving various kinds of online simulations. One of the studies discovered no significant differences from involving online simulations, whereas another depicted positive outcomes. In the study by Castaneda (2008), the author differentiated between two simulated scenarios for college psychology students under an online course. In one situation, the relations of students were assisted based on simulations. The other situation did not have much of a simulatin aspects. Castaneda also revealed how he manipulated the presentation of instructional processes, in terms of the interface in simulation seen before or after securing expository knowledge within the teaching course. The gains were considered statistically significant within the pre-test to post-test setting.

In another study, the author found contradictory results in the case of nurse practitioners in relation to their analytical as well as their problem solving skills. There were a couple of groups of students included in the study and each group were given similar instructions. The study yielded no significant differences between the groups.

No significant differences were However, using manipulatives seem to motivate and encourage mathematics education students (Battle, 2007). Using virtual manipulatives during lectures can help promote significant accomplishments for math students (Battle, 2007). In this case, students can take part in a more functional and creative thinking using the hands-on activies as they then consider and understand the concepts related to math (Waite-Stupiansky and Stupiansky 1998). The jump from students meaning and on to doing is related to guided discovery. One's words and acts are coordinated with each other in order to establish an effective synergy as they try to remember their a priori knowledge in years to come. Through hands-on activities in math, lectures can help students derive meaning from numbers and promote multisensory learnin. Using manipulatives can lead to a chance which can affect different students. . Using mnemonic resources has been the option used to manage facts on math; however, students have experienced difficulties in remembering. Skills seen in the use of manipulative assist to help students remember what they actually did and why they did it. g Students are more likely to observe relationships and patterns if they are engaged in guided discoveries using manipulatives on paper, hands-on or online resources (Simpson 1998).

Some students also focused on manipulating different elements in the context of online learning; these studies. The authors also assessed the effects of learning experience as well as control. These studies indicate provisions for some control over online resources.

Other authors support the hypothesis that teacher-associated conditions do not have as much impact on learning as compared to direct control. It has also been noted that direct control may soon be the ones giving orders (Gao & Lehman; Zhang, 2005; Zhang, et.al., 2006; and Dinov, et.al., 2008). Other studies did not point out a similar effect (Smith, 2006; Cook et al., 2007). In the studies by Zhang (2005) and Zhang, et.al., (2006), the authors set out to differentiate between active learning and expository learning. The authors were able to establish that there seem to be better results in active learning. In the study by Zhang (2005), the author used two situations and controlled the activities within the online course. There were specific studies which differentiate between these two types of learning. Their outcomes were more towards active learning. To prepare the two scenarios (Zhang (2005) had a strict control of performance in relation to a web-based study. There are specific orders within the contorl group relating to the videos used, later recovered from the web. There had to be a viewing of the whole video. Rewinding or forwarding the video was prohibited.

The group being treated on the other hand was not held back in this context; they could actually consider the videos in any form, access these randomly, and later forward or rewind the material. In general, the favorable results were seen in terms of web functionality (Zhang et al., 2006).

For Gao and Lehman (2003), students who evaluated static web pages only did not do as well as students who did a generative activity coupled with an evaluation of a static Web page. In another study, authors used apparatus sourced online to compute statistical figures in various subjects related to statistics and probability.

There were a couple of groups which were established to cover the courses. The groups were then compared. In one group, a high intensity situation was was assigned and they were able to use dufferent online applications to compute facts and figures to address their situation; the other group was assigned a low intensity situation and could not use online resources. In the different courses, the students assigned the high intensity situation using online resources manifested major improvements in their outcomes and comprehension. This was seen in their midterm and final exams where their results were compared with other students who were assigned other situations and given other resources.

There is an equal number of studies which indicate favorable results in non-didactic and learner controlled styles in teaching and those with presented negative results following the use of additional actions in learning.

In one study, nurses who were skilled in online pain management were randomly allocated to separate groups (Smith, 2006). The author used different methods of instruction in order to differentiate between an instructional method plus participant inquiry with problem-solving plus a text-based design (Smith, 2006). There were no significant differences in the learning. Also in the study by Cook and colleagues (2007), no significant differences were also observed in the use of expository end-of-module and the use of active response end-of-module review styles.

Students in a health care ethics class were assigned to either the experimental group (using text-based tools before online options) or the control group (those who were given online instructions with no access to better organizing tools, or the experimental group which assessed a better Flash-based concept mapping tools before participating in online training (Chen, 2007). The author was under the assumption that the concept map plus the organizing toll would help students access relevant data and improve commitment on latest materials or data. The research study did not unearth any significant difference in the learning outcomes for all three groups (Chen, 2007).

The impact of using assisting questions in relation to the ability of students to create a high-class educational website was studied by Suh (2006). The study contextualized the project based on the use of online technology modules. Through an electronic discussion board, students were asked to read questions and then to answer them. Through the postings and emails, the students thought of the assisting questions while they were working on their assigned problem. As the students were working alone, the assisting questions helped them improve their performance; however the questions did not impact on the outcomes for the students working in groups. Suh (2006) believed that this may be because of the fact that students in teams may have scaffolded each other’s assignments and this may have compromised the benefits coming from questions which were released ahead.

Online quizzes. In terms of also including quizzes in the online learning process, both favorable and not so favorable results have been seen. Some studies which studied how efficient online quizzes were presented mixed results (Tselios et al., 2001; Lewis, 2002; Maag, 2004; Stanley, 2006)

There were also no additional benefits in using online quizzes as established by Maag (2004) and Stanley (2006). Online quizzes included in experimental scenarios were studied by Maag (2004). . In this study, the students were assigned different online tools including animation, online images, as well as texts. Then the group was compared with other groups in relation to the use of online quizzes and media applications in quizzes. In one group, text only was applied, another group applied images only and the last group used images and text.. The researcher did not see any major differences in the groups that did not apply online quizzes and the group which used online quizzes. Stanley's study (2006) also established no statistically significant differences in the outcomes from students participating in weekly quizzes and those using regular assignments

Other studies also claim that the efficacy of quizzes is mostly based on the presence of dynamic elements (Lewis, 2002); as in the presence of both online discussions plus online quizzes. Interactions in online discussions between students can improve learning and reduce failures in online quizzes. Tselios and colleagues (2001) point out that the software settings applied in online quizzes are also likely to impact on the performance of students. They further discuss that students participating in quizzes using IDLE did not do as well as students using the WebCT in their quiz. . These software programs had similar materials and worked in a similar manner, but their user interfaces were different.

The use of post-unit quizzes were studied by Grant and Courtoreille (2007) in terms of how they gave students the chance to secure extra practice on items which had the wrong answer. The authors also studied the use of post-quizzes having fixed items which only gave responses on correct or incorrect answers. More improvements on pre and post test outcomes revealed that the response-sensitive software was not as effective as the fixed-item software. **Customized instruction.** The results of using customized and computer-based instructions have been considered in this study in order to ensure that the online learning would be able to sufficiently assess the performance, as well as the needs of the student. Kulik and colleagues (1991) for example indicate how computer-assisted instructions were able to decrease by about a third the time by which instructions were given. This translates to improved efficiency in time management, very much important for the non-traditional students who need to create a balance between schooling, home life, and employment.

In the study by Nguyen (2007), the author set out to assess the results in using customized instructions. Their study revealed favorable outcomes. The researcher also assessed the academic activities of individuals in a tax course. . The participants were under an online training system and could opt to use customized training (with context sensitive advanced features, plus expert systems (textual and audiovisual). Nguyen (2007) indicated a positive effect resulting in statistically significantly higher outcomes as a result of this blend of enhancement.

Assistance for learner reflection. Several studies evaluated the point to which promising elements of learner reflection within the web-based setting improved learning outcomes (Chung et al., 1999; Cook et al., 2005; Wang et al., 2006; Saito et al., 2007; Nelson, 2007; Chang, 2007; Crippen et al., 2007; Shen et al., 2007; and, Bixler, 2008). These studies evaluated the use of OLE which caused students to consider their learning. Improved results were seen because of these prompts. Chung and colleagues (1999) evaluated how computer prompts were established to understand how the students' use of self-monitoring and self-explanation options affected their learning. -The authors set out to understand how capable students are in including views from the instructions they received in their assigned activities. The authors established that in the control group there was a statistically significant incorporation of fewer concepts in the control group of students as compared to the experimental group which had computer guidance.

In the quasi-experimental study by Wang et al. (2006), the authors studied students in a Taiwanese middle school using a biology web-based module. The authors established that students who used traditional methods of taking tests (paper and pencil) did not do as well as students who used online self-evaluation options. For the online option, where the answer was wrong, the student was informed and was allowed to review other resources to consider a right answer. This result is also similar to the results in the previously mentioned Grant and Courtoreille (2007) study.

The effect of including self-evaluation option at the end of modules were studied by Cook et al. (2005). The study used crossover and randomized structures where each student evaluated different courses (two with and two without self-evaluation options). The order of the course was randomly indicated with tests being carried out soon after each course. There was a statistically higher result in students with self-evaluation tests. The authors believed this is because of the reflective process which usually comes with self-evaluation. However, this result was not apparent in a final test conducted at the end of the course.

Students who did and those who did participate in self-regulated learning activities were evaluated by Shen et al. (2007). Study time and goal setting parameters were used. The self-regulated group seemed to perform significantly better in study time and goal-setting.

The study by Bixler (2008) set out to evaluate the impact of prompts which would ask students to think on their problem-solving abilities. . The impact of using prompts in defining the work of students in relaiton to problems and solutions were studied by Crippen and Earl (2007). Chang (2007) went on to use a self-assessing standard for students to allow them to assess their learning situation, their study habits, learning outcomes, and would later allow them to use self-assessment and to present possible results. . The impact of students and their manifestation activities in online learning processes were studied by Saito and Miwa (2007). Nelson (2007) included a learning assistance system in order to support the establishment of hypothesis and testing elements exclusive of presenting specific responses on how correct the answer of students are or how decisions are created based on the actions of students. The other reflective elements defined in these studies improved the online learning of students.

In general, results gained from research indicate how self-control, self-evaluation, and self-regulation can help improve the outcomes of learning. Self-explanation as well as prompts during reflection processes seem to present better online learning outcomes (Meylani, R., Bitter, G. G. & Legacy, J. 2015).

Scaffolding for online learning. Scaffolding which would refer to support gained in the learning process which is based on the needs and gaps in the student's learning. This can help students improve their learning outcomes (Sawyer, 2006). Different studies have assessed human control replaced by online processes or scaffolding in order to establish clear online communication. In the different studies assessed, three indicate that the presence of scaffolding to facilitate communication between groups studying online does not seem to have a significant impact on learning outcomes (Hron, et.al. 2000; Ryan 2007; Choi et al., 2005). The result in Weinberger et al. (2005) indicated opposing results.

Hron and colleagues (2000) used experimental methods to present differences between the three groups. The first group secured managing questions as well as argumentative policies; the second group was the control group which did not secure guidelines on one-hour arguments; and the last group secured questions to support in establishing and improving online communication. Argumentative policies indicate how group members have to consider only the managing questions and the other argument on one question has to be addressed before the next question would be presented Other possible perspectives have to be considered and other members have to have their turn in order to manage the argument and ensure that the rules would be strictly followed. Hron et al. (2000) established that there is a statistical difference in the different situations also in terms of how consistent the student postings are. However, not other differences in the three groups in terms of how knowledge is acquires has been presented based on the outcomes of the multiple-choice test.

Similar results were also seen in Ryan’s study (2007). Ryan (2007) believed that collaborative resources would affect the performance of students. Ryan also indicated that for the two groups being studied (middle school students), one group had exposure to online learning and a control group was also studied. Ryan established that there was no statistical difference in the performance of the two groups in the online educational setting. .

Choi, Land and Turgeon (2005) carried out their time-series control group analysis in order to understand the results in the use of online scripts in the creation of questions to colleagues within group-based online considerations. . While the scripts seemed to improve the different questions presented, they did not impact on the outcomes and value of the questions presented.

On a contrary note, the study by Weinberger and colleagues (2005) indicated positive results seen in learners who were allowed scaffolding. There were two types of scaffolding allowed. The first one was a social scaffolding where the students were free to communicate with each other using different techniques of communication. The second one involved the use of epistemic scripts. These scripts indicated the style by which learners must move forward in their assigned task. It also helped learners to manage specific concerns and issues. In this study, the authors saw statistically significant results where students who were exposed to social scaffolding (in contrast to those who were not exposed to any scaffolding) had better outcomes in their tests. In other words, scripts or scaffolds in online communication for student groups have been seen to present positive results in terms of how these students use online information and how these students interact with one another. However, no clear results have been seen to support such results. Nevertheless, it has to be acknowledged that, peer communication, indirectly helps facilitate cooperative learning which has been seen to present a positive impact on learning, making use of the overall information and the dynamics which exist among learners (Adami-Bunyard et al., 1998; Bernero, 2000).

Medium of delivery. Online learning can actually solely be facilitated within the mobile setting, alongside the World Wide Web and the electronic mail system. Studies indicate that the medium of learning has no significant impact on learning. Shih (2007) point out that students who used online content using mobile devices presented a diverse learning outcome as compared to groups who used computers with internet access. Still no significant results were seen between the two groups in terms of learning outcomes. Kerfoot (2008) also distinguished results in securing mobile information and and knowledge using e-mails with the use of online content using the usual website searches. No statistically significant difference were detected between the two groups. In general, the available studies which assessed how online content is presented do not support a specific style of delivering or accessing information over other styles.

Distance learning. There were benefits noted by Bernard et al. (2004) seen in the use of asynchronous distance learning when compred with the use of online delivery over synchronous learning. Asynchronous distance education research by authors indicated different advantages in relation to the usual teacher-focused classroom education methods. . The authors also established how distance-learning situations were likely to present better results when computer-mediated discussions were considered.

Benefits of mixed learning (combined elements of face-to-face and online learning) in relation to total online learning were seen in the study by Zhao et al. (2005). It was observed by Zhao et al. teachers have a very significant and powerful arbitrating variable. Distance learning plus high teacher involvement had a significantly greater impact on the student as compared to limited teacher involvement. Also, Zhao et al. established how learning outcomes further increased where there was peer-to-peer learning. In all instances, using digital tools significantly helped improve learning outcomes for students.

Cooperative learning. The options in cooperative learning can be incorporporated to improve the motivation of students in learning math and improving their math skills. As such, students can improve their social skills which would be essential for other activities. Through cooperative learning, group communication is also facilitated especially in terms of assigned tasks where the members become accountable for their work and their work within the group. Cooperative learning ensures mathematics awareness and establishes a good experience for teachers as well as students. The use of cooperative learning also allows people to experience collective math learning. It also helps secure knowledge from other people in order to promote effective learning (Bernero, 2000).

Adami-Bunyard and colleagues (1998), different courses which used cooperative learning was assessed. The researchers considered the activities of cooperative learning for primary school students with the participants able to experience a more peer-learning experience supported by various rubrics and self-made tests. The researchers focused on the relevance of mentoring and tutoring. Instructions have to be focused on stduents and teachers have to be facilitators. . In using these tools, a bond would be established among students as they work with each other, eventually improving academic learning within the educational setting (Adami-Bunyard et al., 1998).

Addressing multiple intelligences. There are seven different intelligences which each person is said to possess (Howard Gardner. 1985, 1993).. These intelligences have acknowledged teaching and learning within the context of multiple intelligences (Campbell et al., 1996). The concept of current stduents gravitating towards technology is the foundation of using technology as a teaching tool. At present, stduents are very much different from students from centuries ago. The present students are now living in the 21st century, a century which is dynamic and which uses the internet and other related technologies. Under these conditions, technology can be incorporated in classrooms in order to manage the different styles in learning including the presence of various intelligences (McCoog, 2007).

Bednar and colleagues (2002) set forth various interventions to motivate students in math using multiple intelligences. Researchers acknowledge the difficulties of students in understandign math concepts and this may be due to the unfavorable attitude which students have against the subject. These students may also have trouble linking the real world and math. Researchers understand how allowing students to use their early knowledge as well as their multiple intelligence can help secure a better educational experience (Bednar et al., 2002).

Conforming to educational standards. The policy No Child Left Behind Act (NCLB, 2001, ECAA 2015) acknowledges the use of standards-based education reform in the U.S.. This is founded on the premise that establishing high educational standards and measurable goals can help improve educational outcomes for students. This policy calls for states to establish criterion-referenced assessment tests that assess basic skills for use to all students at various grades. . These yearly tests are a significant part of the research utilized to establish whether schools are actually meetign the standards they should be meeting (Linn, 2000; Braden, 2002). If standards are not secured, schools would not be funded and the state would take over. In effect, any OLE which seeks to promote curricular support in the U.S. K-12 educational system has to be considered in relation to state and national standards. This need can be used in any country which also applies a similar standards-based curricula.

Fidelity of Implementation

The term fidelity of implementation is fast becoming part of the educational vocabulary due to its inclusion in discussions about response to intervention (RTI). According to the The National Center on Response to Fidelity of Implementation is:

> "the delivery of content and use of instructional strategies in the way they were designed and intended to be delivered: accurately and consistently. Although interventions are aimed at learners, fidelity measures focus on the individuals who

provide the instruction." (National Center on Response to Intervention, n.d.) Teachers need to admit that implementing the system is not an event, but it is a mission-focused process which covers different decisions as well as corrections (Fixsen, 2006). This would place educators in a more active role. They must sufficiently assess how programs are implemented in schools and implement necessary adjustments. This is important because according to Wallace, Blase, Fixsen, and Naoom (2008) implementation and student learning is very much connected with each other. This means that better results in education come about because of effective improvements and quality implementation. Fixsen (2006) also points out the risks seen where effective programs are not implemented properly. An implementation gap appears. Such gap can be seen where the program and its implementation is not secured properly. This gap may also be seen when with the passage of time, the implementation is not as good as originally intended. Fixsen (2006) highlights the importance of effective implementation of educational programs.

The Need for Professional Development

Lindstrom and Speck (2004) presented how professional development consists of a life-time process of collaborative learning, one which supports the professional growth of individuals and teams, as well as schools using within the context of a learner-centered approach. Professional development also relates to consistent learning opportunities accessible to teachers as well as other parties in the educational sector via schools and districts. They have two specific goals, 1) to meet the needs of the learning participants, and 2) to improve student learning and success (Stiles et al., 2009). Majority of professional development opportunities are attended on a volunteer basis (Bobrowsky, Marx, & Fishman, 2001). Research also suggests that school teachers are often prepared to invest additional time in such professional development programs if this provides them with immediate benefit for their teaching (Bolam *et al*., 2005; Duncan-Howell, 2010).

E-learning and Knowledge Retention

The issue of knowledge retention has been investigated by a number of researchers from various points of view. A number of such researchers particularly concentrated on the relationship between e-learning and knowledge retention (Tang, 2002; Naidr et al., 2004; Greiner et al., 2004; Bell et al., 2008).

Naidr et al. (2004) set up a study that tested knowledge retention among a group of 38 students who went through a distance online course that consisted of 10 lessons. At the end of the course the students sat for a final test that contained 60 multiple-choice test questions each of which had only one correct answer. After 12 months, 31 of the students in the original group sat for the same test without any review of the material learned in the original course. Meanwhile, the students were not aware that their knowledge would be re-tested after 1 year. Results showed that the average retention of knowledge expressed as a percentage of the students' performance in the first test was 66.8% and knowledge retention correlated significantly with (1) the positive attitudes and motivation towards the course and (2) the number of weekly hours spent while taking the distance course. There is also improved retention in knowledge which can be seen where the students are motivated and responsible and when they can easily use the available informational technologies.

As online and e-learning increase din demand, Greiner and colleagues (2004) observed that educators have to establish other instructional methods to be more responsive to the needs of learners. The researchers established the Iterative Instructional Model to facilitate the development of knowledge within the web-based setting in order to promote a cumulative effect and ensure responsive information management alongside long-term knowledge retention.

In relation to a training program applying a production system simulation software for the Theory of Constraint (TOC), the impact of collaborative learning and after training feedback representation method on skill acquisition and skill retention were investigated by Tang (2002). The researcher conducted an experiment with two training protocols: individual and triplet; two options to use following training lecture: face-to-face with the teacher and the use of a digitized video image; and three skill retention stages: soon after the end of the training, following a week of training and then following a month of training. The results show that training protocol affects both training performance and skill retention while methods to present after-training lecture affect training performance, both with statistical significance, thereby suggesting that the media selection and instructional representation need to be carefully carried out for an e-learning environment.

Bell et al. (2008) conducted a randomized educational experiment among resident physicians to assess knowledge retention after an online tutorial. They found that education that appears successful based on immediate post-tests and learner evaluations reveal knowledge that usually fades and is not remembered over the subsequent days and weeks. The researchers indicated that in order to achieve longer-term retention, physicians should review or otherwise reinforce new learning after as little as one week.

Summary of the Literature Review

This review of the literature compared, pure and mixed online learning, elaborated the twelve distinct characteristics of online learning for a better teaching and learning experience, explained the concept of the *fidelity of implementation* needed utilize an OLE' effectively and that professional development is essential for high levels of implementation fidelity. It is also elucidated that E-learning may improve knowledge retention by employing innovative instructional models. The following results can be deduced based on the findings of the studies depicted in detail within this literature review:

1. Online learning, defined as learning that is completely or partially done through the Internet has four dimensions: affect, attitudes, intrinsic and extrinsic motivation. These can be used to better understand students' motivation and attitudes toward online learning (Saad et al., 2011) and positive attitudes and motivation toward online learning has been shown to increase significant long-term knowledge retention (Naidr et al., 2004).
2. It has been shown that mixed online learning is superior to completely online learning to improving learning significantly (Means et al., 2010).
3. Tutorials in front of the computer and the use of online learning tools can help students gain expertise based on their pace and level of learning. This can impact well in retaining original knowledge and accessing new information (Salimpoor et al., 2010).
4. A number of studies discovered two important aspects regarding multi-media components within an OLE': (1) Using media elements only would not be enough in improving teaching and would positively impact on learning as they affect

retention of knowledge and (2) how such media elements are used do have an impact on stduent learning where interactive processes are available (Schmeeckle, 2003; McKethan et al., 2003; Maag, 2004; Zhang et al., 2006; Schroeder, 2006; Schutt, 2007; Schnitman, 2007; Tantrarungroj, 2008).

5. Gao and Lehman (2003), Zhang (2005), Zhang et al. (2006), and Dinov et al. (2008) indicate information which indicate that directions and conditions based on teachers do not have as much control over learning as compared to conditions where the learners would have direct control.
6. Post-unit quizzes provide students with the opportunity to do extra practice on the type of items that were not answered correctly. Fixed-item version of post-unit quizzes were found to be more effective than the response-sensitive version of such quizzes (Grant and Courtoreille, 2007).
7. Customized instruction may present positive results in online learning (2007).
8. Reflection in a Web-based environment, i.e. in self- control better learning outcomes can be seen. This Can incldue qualities like self-explanation as well as self-control which can ensure reflection and can promote better online learning outcomes (Chung et al., 1999; Cook et al., 2005; Wang et al., 2006; Nelson, 2007; Shen et al., 2007; Chang, 2007; Saito et al., 2007; Crippen et al., 2007; and, Bixler, 2008).
9. Scaffolding which is founded on student qualities and preferences can help the student learn better (Sawyer, 2006). A study by Weinberger et al. (2005) revealed enhanced test performance for learners who were provided with scaffolding.

10. Online learning can be secured mostly via mobile devices, emails, and the World Wide Web; studies have indicated no major differences in the method of delivery Shih (2007), Kerfoot (2008).
11. Distance-learning can improve the learning process where digital tools including computer-mediated processes are used (Bernard et al. (2004).
12. The use of cooperative learning allows individuals to enjoy the collective learning of the group; it can secure knowledge from other people and allow others to learn from the group (Bernero, 2000).
13. Howard Gardner (1985, 1993) presented seven distinct intelligences which a person uses. Teaching within these intelligences therefore has to be acknowledged (Campbell et al., 1996). Technology can be applied in classrooms to manage various styles in learning as well as various intelligences (McCoog, 2007). Allowing students to use their own knowledge and intelligence can help promote a better meaning for the educational experience. This can eventually improve math learning (Bednar et al., 2002).
14. Any OLE' which seeks to ensure curricular support for the U.S. K-12 educational system has to be managed in relation to state and nationwide learning standards. This would cover also the Common Core Standards.
15. Improved outcomes in education are the products of effective innovations and implementation efforts. Researchers Wallace, Blase, Fixsen, and Naoom (2008)
16. Professional development which refers to ongoing learning opportunities available to educators is absolutely essential for facilitating online learning with

high levels of implementation fidelity so as to meet the needs of the learning participants, and to improve student learning and success (Stiles et al., 2009).

17. In relation to the shifting and increasing demands in online learning Greiner et al. (2004) indicate that educators have to present different intructions to promote consumer needs. Various models in instruction which promote efficient learning within the online setting allow for long-term retention of learned information.

Figure 2. Desirable Characteristics of Online Learning.

Desirable Characteristics of Online Learning

This review of the literature concentrated on one central theme; the effectiveness of an OLE' in terms of knowledge retention. In this respect the desirable characteristics of an OLE' have been identified as shown in Figure 2. Based on the findings of this literature survey, an ideal OLE' (Meylani, R., Bitter, G. G. & Legacy, J. 2015):

- Applies computer tutorials as well as online learning tools;
- Applies multimedia tools elements, simulations as well as manipulatives interactively;
- supports different types of learning experiences, i.e. purely online or mixed;
- presents online quizzes and allows feedback for results;
- allows for custom instructions;
- provides assistance for learner reflection;
- provides scaffolding for online learning;
- is accessible anywhere, anytime;
- enables distance learning;
- supports cooperative learning;
- addresses multiple intelligences; and;
- conforms to educational standards.

Finally, in order for an OLE' to create the desired effects by providing what it has been designed for, it must be implemented with high fidelity and this can happen if and only if continuous professional development is present.

Chapter 3

METHODOLOGY

Setting

The different students were enrolled in the same school district. About 94% of the population is Hispanic. About 99% were allocated free lunch. This implies that most of the students were in the low SES. All schools are presented in Table I.

The setting is a southwestern urban school district in Phoenix, Arizona and encompasses 6.8 square miles with 13 schools, 8 elementary and 5 middle schools; this study was conducted at the middle schools only. Table 1 gives the middle schools that participated this study and their populations.

Table 1

The schools in the school district and their populations

School_ID	Population
School1	678
School2	444
School3	796
School4	630
School5	677

Participants

The intervention was based on OLAB learning activities (LA's) aligned with the district's mathematics curricula. The treatment group received two quarters of web-based intervention based on OLAB parallel to their mathematics curriculum which took place in their usual school setting whereas the control group received traditional instruction only. The participants were all 6th-grade teachers and students. Table 2 shows the participating students by school and control-treatment status. Table 3 shows the participating students and teachers by school and control-treatment status.

Table 2

Students participating the study by school and control-treatment status

School_ID	Control_Treatment	
	Control	Treatment
School1	50	0
School2	8	88
School3	142	65
School4	32	45
School5	63	98

Table 3

Participating students and teachers by school and control-treatment status

School_ID	Control_Treatment	Teacher_ID	Number of Students
School1	Control	13	27
		24	23
School2	Control	18	8
	Treatment	1	20
		5	18

		14	20
		17	14
		20	16
School3	Control	3	21
		4	17
		10	13
		12	22
		15	21
		21	26
		22	22
	Treatment	6	20
		19	18
		26	20
School4	Control	29	32
	Treatment	2	14
		25	16
School5	Control	8	23
		11	16
		27	24
	Treatment	7	31
		9	31
		16	21

	23	14
	28	16

A number of 6th-grade students participating the study in the 2010-2011 school year, left the district in the 2011-2012 and 2012-2013 school years. The participating students who stayed in the school district in the subsequent middle school years are given in Table 4.

Table 4

Participating students with their control-treatment status in the 2010-2011, 2011-2012 and 2012-2013 school years

School_ID	Participating Students in 2010-2011		Students Continuing to Participate in 2011-2012		Students Continuing to Participate in 2012-2013	
	Control	Treatment	Control	Treatment	Control	Treatment
School1	50	0	41	0	38	0
School2	8	87	7	70	5	62
School3	142	65	125	57	114	49
School4	32	45	26	33	21	29
School5	63	98	50	77	44	64
Total	295	295	249	237	222	204

OLAB, the Medium of Intervention

OLAB is a rich library of online learning activities which employ technological tools and are built upon a project-based learning approach. What really stands out about OLAB is the fact it possesses most of the desirable characteristics set forth by the research literature, suggesting that it is a candidate for being classified as an ideal OLE.

Characteristics of OLAB

OLAB provides an abundant library of math Learning Activities that possess the following properties:

1. Each Learning Activity is a complete lesson aligned to the state, NCTM Math Standards.
2. The Learning Activity provides realistic visualizations; clear and engaging simulations based on real-world scenarios within a thematic focus.
3. The Learning Activity utilizes three-dimensional graphics and a high level of interactivity.
4. The Learning Activities are accessible from anywhere with Internet connectivity and they can operate on Windows, Mac OS and Linux through any standard Web browser without the need for installing any other software.
5. The Learning Activities can be incorporated to a whole group, small group or individual instruction.
6. Each Learning Activity comes with end-of-activity assessments that track student progress and report results to teachers. The assessment provides immediate feedback on user performance.

7. With each Learning Activity, an activity sheet and an independent practice is provided for further enrichment. The answers and solutions to these are also provided.
8. The Learning Activity can be used via interactive whiteboards, at a single computer or a multiple computer class setting.
9. The Learning Activity contains modules that provide instruction in an ideal sequence. However, each module can be played in any order.
10. When the modules within a Learning Activity are played in the suggested sequence, students are given feedback on whether or not they have completed the module successfully. The successful completion of a module depends on completing a pre-determined number of practice problems within that module.
11. Any video, animation or simulation can be played, replayed, rewinded, fast-forwarded or skipped.
12. Learning Activities generally include between two and five of the following sections: *engagement*, *exploration*, *guided inquiry*, *guided practice*, *explanation*, *examples*, *create questions/graphs*, and, *closure*
13. Finally, the Learning Activity includes further supplemental materials such as objectives, glossary, and teacher guide.

The Learning Activities are accessible through a central console that enables the user:

1. to search any keyword and see lists of the related LA's;
2. to list an annotated guideline that provides a brief content description and buttons to add to a lesson plan or play the LA;

3. to display the usage scenario, the corresponding standards and performance objectives, the estimated learning time, the prerequisites, and teaching suggestions;
4. to establish and indicate lesson plans to students;
5. to manage students in groups and monitor their progress anytime and anywhere;
6. to index the LA's by standard and grade level, which enables locating an activity specifically for a particular curriculum;
7. to mark the web resources and apply them in lesson plans with the LA's;
8. to consider the related outcome objectives an LA by choosing NCTM, NSES, or a specific state;
9. to plan lessons by organizing the selected LA's and other resources;
10. to assign each lesson plan to a class, group of students or an individual student;
11. to monitor students' progress and achievement in the learning activities; see their right and wrong answers in detail.

Types of LA's

The LA's specifically designed for mathematics can be classified into five distinct types as Concept Development, Problem Solving, Skills Application, Visual Proof, and, Interactive Exercise activities. Please see Table 7.

Table 5

Types of LA's in OLAB

Type	**Goal**

Concept Development	To impart the concepts which are hard to understand using simpler and engaging instructions
Problem Solving	To improve student's problem-solving abilities. This is founded on the Polya's Problem-Solving Cycle (Polya, 1945, 1957): 1. Consider a real-life problem 2. Understand the problem 3. Make a plan to solve it 4. Implement the plan and evaluate results 5. Draw a conclusion
Visual Proof	To develop the concept of formulae, theorems, special relationships, and other mathematical constants with visual explanations
Dynamic Modeling	To apply mathematical concepts by shifting variables and considering results based on real time
Interactive Exercise	To use mathematical concepts based on different guide questions

Modules within OLAB

The modules associated with the Online Learning Activity Based Curriculum online learning setting have been meant for easier and better usage. The modules are presented in Table 6.

Table 6

Description of the Modules Within OLAB

MODULE	FUNCTION
Search	To evaluate keywords and assess lists related to the Learning Activities.
Learning Activity	This refers to an annotated list which indicates brief descriptions and options to support lesson plans or to participate in the Learning Activity.
Learning Activity Details	The Details window indicates the usage setting, and the related elements including the learning objectives, learning period, and learning suggestions
My Lesson Plans	To establish and present lesson plans to students.
My Students	To evaluate students in groups. Assessment of student progress can be assessed at any time.
Assignment Report	To evaluate student progress.
Catalog	To manage Online Learning Activity Based Curriculum Activities using standard and grade levels. This can ensure that finding activities for a specific curriculum would be easier.
Other Resources	To mark the web resources and apply them to lesson plans alongside the Learning Activity.
Corresponding Standards	By choosing NCTM, NSES, or a specific state, viewing specific performance objectives in Learning Activity is made possible.

Lesson Planning	To manage lessons by organizing the chosen Learning Activity as well as other tools.
Assignments	To indicate each lesson plan to a specific class or group or a specific student.
Report	To evaluate the success of students based on the Learning Activities; to consider theirright and wrong answers. .

The OLAB Based Intervention Process

The process started when a district employee suggested that OLAB could be a valuable teaching aid for math and science classes in the district at the beginning of the 2010-2011 school year. This was followed by the introductory meeting organized by OLAB officials at the district that took place toward the middle of the first quarter. The decision to adopt OLAB throughout the district was made toward the end of the first quarter. The district did not mandate the teachers use OLAB; those who chose to use it in their classes attended a mandatory training that took place in the first week of the second block. The teachers and students who used OLAB in their classes constituted the treatment group and they did so as part of everyday instruction employing OLAB as a teaching aid; no additional time was allocated to OLAB outside regular class hours. The treatment group teachers were encouraged to attend the weekly on-site professional development sessions moderated by OLAB officials and/or two university professors; these professional development sessions, however, were optional. Included in the professional development series were lesson plan development, technology support, whole class, small group, and individual student instruction approaches, and review of the LA's to be used in the following week. Teachers had the choice to use whole class application; small group supported instruction, and individual computer supported instruction or any combination of the three. Teachers were also encouraged to assess students' grasp of the material through an online assessment provided after each LA. For further practice, printable activity sheets and independent practice problems accompanied every learning activity (LA) and teachers were recommended to make use of these.

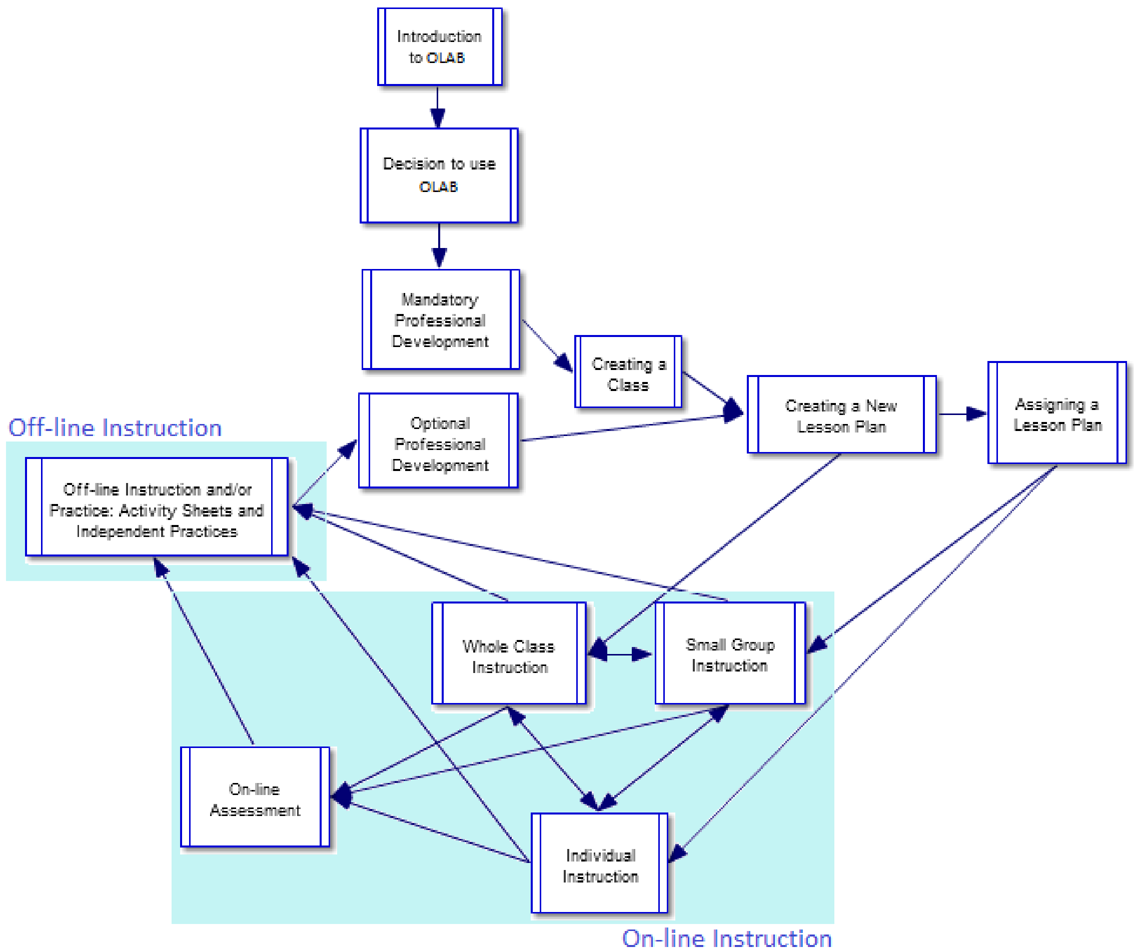

Figure 3. A Typical OLAB Intervention Process

The intervention continued until the administration of the AIMS 2011 tests that took place toward the end of the third quarter in mid-April 2011. Effectively, the intervention lasted for two quarters. During the intervention, usage statistics, i.e. the time and frequency of usage for each student and teacher in the treatment group were collected. A snapshot of the process is illustrated in Figure 3.

Data Sources

Conforming to the No Child Left Behind (NCLB) Act of 2001, the state of Arizona used specific testing system, Arizona's Instrument to Measure Standards (AIMS, 2010) in order to assess how students perform in relation to state standards. Grades 3 to 8 students take the AIMS in mathematics, reading and writing. The test was based on the Arizona state standards, which define what students should be learning each year. The AIMS results showed the level of proficiency a student demonstrated in the different subjects assessed. For the differnet students taking the test on a specific subject, their different scores were reported. In this study, the instrument predominantly used was the scaled scores on the statewide AIMS Tests which was a number between 100 and 600 and was calculated based on the mean and standard deviation of the scores of all test-takers. The data sources that were used are as follows:

- the AIMS 2010 Mathematics Scaled Score;
- the AIMS 2011 Mathematics Scaled Score;
- the AIMS 2012 Mathematics, Scaled Score;
- the AIMS 2013 Mathematics, Scaled Score;
- usage statistics, i.e. the total time spent in minutes while using OLAB and the total frequency of using OLAB during the 2010-2011 school year for each student and teacher in the treatment group;
- a survey on treatment group teachers' OLAB experience (see Appendix B)

Research Design

The research design can schematically be described as follows:

Treatment Group:	O1	X	O2	O3	O4
Control Group:	O1		O2	O3	O4

In the diagram above, X denotes the treatment; observation O1 denotes the AIMS 2010 test; observation O2 denotes the AIMS 2011 test; observation O3 denotes the AIMS 2012 test, and observation O4 denotes the AIMS 2013 test.

Data Fields

Following are the data fields used in the analyses in this study.

- Control Treatment: A numeric field indicating control or treatment status; takes the value of 0 for control and 1 for treatment.
- School_ID: A numeric field indicating school attended; takes on values from 1 to 5.
- Teacher_ID: A numeric field indicating the teacher; takes on values from 1 to 29.
- AIMS_2010_Math_Scale: A numeric field that represented the AIMS 2010 Mathematics Test Scaled Score.
- AIMS_2011_Math_Scale: A numeric field that represented the AIMS 2011 Mathematics Test Scaled Score.
- AIMS_2012_Math_Scale: A numeric field that represents the AIMS 2012 Mathematics Test Scaled Score.
- AIMS_2013_Math_Scale: A numeric field that represented the AIMS 2013 Mathematics Test Scaled Score.

- Total_Time: A numeric field representing the total time spent in minutes while using OLAB
- Total_Freq: A numeric field representing the total frequency of using OLAB
- Gain_2010_2011: A numeric field representing the gain in the AIMS mathematics score from 2010 to 2011 calculated by the formula Gain_2010_2011 = AIMS_2011_Math_Scale - AIMS_2010_Math_Scale.
- Gain_2010_2012: A numeric field representing the gain in the AIMS mathematics score from 2010 to 2012 calculated by the formula Gain_2010_2012 = AIMS_2012_Math_Scale - AIMS_2010_Math_Scale.
- Gain_2010_2013: A numeric field representing the gain in the AIMS mathematics score from 2010 to 2013 calculated by the formula Gain_2010_2013 = AIMS_2013_Math_Scale - AIMS_2010_Math_Scale.
- Average_Gain: A numeric field representing the arithmetic average of Gain_2010_2011, Gain_2010_2012 and Gain_2010_2013
- PD_Hours: A numeric field representing the score awarded to the reported number of professional development hours attended by the teacher (i.e. the response to question 1 of the Teachers' OLAB Experience Survey given in Appendix B); takes the value of 0 for no hours; 5 for 0-5 hours; 10 for 5-10 hours; and 15 for more than 10 hours.
- Manner_of_Usage: A numeric field representing the score awarded to how OLAB was used by the teacher (i.e. the response to question 3 of the Teachers' OLAB Experience Survey given in Appendix B); 1 points awarded to whole class

instruction; 1 points awarded to small group instruction; and 1 points awarded to individual instruction. This field can take the values of 1, 2 or 3 only.

- Fidelity of Implementation: A numeric field awarded to the mastery of components. This field represents the scores calculated by averaging the total scores obtained from the responses to Question 3 of the Teachers' OLAB Experience Survey given in Appendix B.

Chapter 4

RESULTS

In this study, the effects of a new generation Online Learning Activity Based (OLAB) Curriculum on the mathematics achievement of middle-grade students was investigated in three different categories, immediately after a one-year intervention which the researcher called short term effects, one year after the intervention which the researcher called medium term effects and finally two years after the intervention which the research called long term effects. To be more specific, the intervention was carried out at the sixth grade; the short term effects were assessed toward the end of the sixth grade, the medium term effects were assessed toward the end of the seventh grade and the long term effects were assessed toward the end of the eighth grade. The assessment instrument used was the statewide high-stakes AIMS test each time. The effects were measured in terms of time and frequency of usage; the number of professional development hours, the manner of usage and fidelity of implementation. As an additional parameter, the effects of school culture was also assessed.

Analyses

All comparative analyses were conducted, and all observed powers were computed at the significance level of 0.05. The norms for η_p^2 (partial eta-squared) used are as follows: small = 0.01; medium = 0.06; large = 0.14. The only factor was Group with two levels (Control and Treatment).

Part 1: Comparison of the control and treatment groups.

In this section the researcher analyzed the data to answer the first research question. The first research question is reiterated as follows:

1. Comparison of the control and treatment groups:

   How did the control and treatment groups compare in students' mathematics achievement based on mean scores:

   a. before the intervention,
   b. immediately after the intervention, i.e. in the short term;
   c. one year after the intervention, i.e. in the medium term;
   d. two years after the intervention, in the long term?

Before the intervention. In order to assess where the control and treatment groups stood before any intervention took place at the beginning of the school year, an analysis of variance (ANOVA) was conducted where the dependent variable was AIMS_2010_Math_Scale. Results depicted no statistically significant difference between the control and treatment groups before the intervention: $F(1, 589) = 1.963$, $p > 0.05$, $\eta_p^2 = 0.03$ and observed power was .288. The results are depicted in Table 7.

The control and treatment groups' mathematics achievement scores were compared before the intervention in order to establish a baseline. The fact that there was no significant difference between the two groups indicates that both groups started the intervention at the same level.

Table 7

Comparison of the Control and Treatment Groups in Students' Mathematics Achievement, Based on Their Mean Scaled Scores Before the Intervention.

Control_Treatment	N	Mean	SD	dF	F	Sig	Partial Eta	Observed Power

							Squared	
Control	295	382.49	48.131	1	1.963	.162	.003	.288
Treatment	296	377.03	46.606	589				

Immediately after the intervention. In order to assess the differences between the control and treatment groups immediately after the intervention, an analysis of variance with a covariate (ANCOVA) was conducted where the dependent variable was AIMS_2011_Math_Scale and the covariate was AIMS_2010_Math_Scale. The treatment group outperformed the control group and the results were statistically significant: F (1, 587) = 16.210, $p < 0.05$, $\eta_p^2 = 0.027$ and observed power was .980. The results are depicted in Table 8.a and 8.b.

Immediately after the intervention, students' 2011 mathematics achievement scores were compared using their 2010 mathematics achievement scores as a covariate. The treatment group did better as compared to the control group and the results were statistically significant. In other words, short term effects were in favor of the treatment group.

Table 8.a

Comparison of the Control and Treatment Groups in Students' Mathematics Achievement, Based on Their Mean Scaled Scores Immediately After the Intervention. .

Control_Treatment	N	Mean	SD	dF	F	Sig	Partial Eta Squared	Observed Power
Control	295	398.81	50.115	1	16.210	.000	.027	.980
Treatment	295	403.54	50.009	587				

Table 8.b

Adjusted Means and Standard Errors for the ANCOVA Depicted in Table 8.a

Control_Treatment	Mean	Std. Error
Control	396.504[a]	1.640
Treatment	405.848[a]	1.640

a. Covariates seen in the are assessed at AIMS_2010_Math_Scale = 379.85.

One year after the intervention. In order to assess the differences between the control and treatment groups one year after the intervention, an analysis of variance with a covariate (ANCOVA) was conducted where the dependent variable was AIMS_2012_Math_Scale and the covariate was AIMS_2010_Math_Scale. The treatment group marginally outperformed the control group; however the results were not statistically significant: F (1, 483) = 3.183, $p > 0.05$, $\eta_p^2 = 0.007$ and observed power was .429. The results are depicted in Table 9.a and 9.b.

One year after the intervention, students' 2012 mathematics achievement scores were compared using their 2010 mathematics achievement scores as a covariate. While no statistically significant differences between the control and treatment groups. In other words, the medium term effects were comparable with the treatment group performing marginally better than the control group.

Table 9.a

Comparison of the Control and Treatment Groups in Students' Mathematics Achievement, Based on Their Mean Scaled Scores One Year After the Intervention.

Control_Treatment	N	Mean	SD	dF	F	Sig	Partial Eta Squared	Observed Power
Control	249	412.80	46.919	1	3.183	.075	.007	.429
Treatment	237	413.83	51.042	483				

Table 9.b

Adjusted Means and Standard Errors for the ANCOVA Depicted in Table 9.a

Control_Treatment	Mean	Std. Error
Control	410.919[a]	1.909
Treatment	415.799[a]	1.957

a. Covariates presenting in the model are assessed at AIMS_2010_Math_Scale = 381.59.

Two years after the intervention. In order to assess the differences between the control and treatment groups two years after the intervention, an analysis of variance with a covariate (ANCOVA) was conducted where the dependent variable was AIMS_2013_Math_Scale and the covariate was AIMS_2010_Math_Scale. The treatment group outperformed the control group and the results were statistically significant: F (1, 423) = 5.449, $p < 0.05$, $\eta_p^2 = 0.013$ and observed power was .644. The results are depicted in Table 10.a and 10.b.

Two years after the intervention, students' 2013 mathematics achievement scores were compared using their 2010 mathematics achievement scores as a covariate. The treatment group outperformed the control group. In other words, the long-term effects were in favor of the treatment group.

It should also be noted that whether statistically significant or not, the mean scores for the treatment group were always greater than those for the control group.

Table 10.a

Comparison of the Control and Treatment Groups in Students' Mathematics Achievement, Based on Their Mean Scaled Scores Two Years After the Intervention.

Control_Treatment	N	Mean	SD	dF	F	Sig	Partial Eta Squared	Observed Power
Control	222	425.68	45.967	1	5.449	.020	.013	.644
Treatment	204	428.95	43.529	423				

Table 10.b

Adjusted Means and Standard Errors for the ANCOVA Depicted in Table 10.a

Control_Treatment	Mean	Std. Error

Control	424.179[a]	1.898
Treatment	430.584[a]	1.980

a. Covariates presenting in the model are assessed at AIMS_2010_Math_Scale = 383.99.

Part 2: Factors that affected the difference(s) in students' mathematics achievement for the treatment group, if any.

In this section, the second research question which evaluates the factors in play for the treatment group. The factors that may have affected the mathematics achievement for the treatment group were presumed to be the time and frequency of usage, the number of professional development hours, the manner of usage and the fidelity of implementation. The second research question is reiterated as follows:

2. Factors in effect for the treatment group:
    a. How did the total time and frequency of usage correlate with the gains in mean score?
    b. How did gains in mean scores correlate with:
        i. total hours of professional development;
        ii. the manner of usage, i.e. whole class and/or small groups and/or individual instruction;
        iii. mastery of components in OLAB?
    c. How did the total hours of professional development, the manner of usage and mastery of components correlate with one another?

In order to assess the association between the immediate (short term), medium term and long term gains in the scores and the total time and total frequency of usage of the learning activities, Pearson Correlation values were calculated. It was determined that there existed a weak positive correlation between the total time of usage and the short term, medium term and long term gains and only the correlation with the short term gain was statistically significant. It was established that a weak positive correlation was seen between the total frequency of usage and the short term, medium term and long term gains where the correlation with the short and long terms were statistically significant. The results are depicted in Table 11.

The correlational analyses showed that there existed a weak positive correlation between the total time of usage and the short term, medium term and long term gains in students' scores and only the correlation with the short term gain was statistically significant. It was also determined that there was a weak positive correlation between the total frequency of usage and the short term, medium term and long term gains where the correlation with the short and long terms was statistically significant.

Table 11

Gains in Mean Scores Correlated With Total Time and Frequency of Usage.

		Gain_2010_2011	Gain_2010_2012	Gain_2010_2013
Total_Time	Pearson Correlation	.177**	0.096	0.119
	Sig. (2-tailed)	0.002	0.141	0.089
	N	295	237	204
Total_Freq	Pearson Correlation	.203**	0.121	.151*

	Sig. (2-tailed)	0.000	0.063	0.031
	N	295	237	204

**. Correlation is statistically significant at the 0.01 level (2-tailed).

*. Correlation is statistically significant at the 0.05 level (2-tailed).

In order to assess the association between the immediate (short term), medium term and long term gains in the scores and the PD Hours, Manner of Usage, and Fidelity of Implementation, Pearson Correlation values were calculated. It was determined that all correlation values indicated a weak and positive association and that all correlations were statistically significant. The results are depicted in Table 12.

It is important to acknowledge that correlations depicted in Table 12 were greater than those depicted in Table 11, signifying the stronger association between the immediate (short term), medium term and long term gains in the scores and the PD Hours, Manner of Usage and Fidelity of Implementation, as indicated by the Pearson Correlation values that were all positive, and statistically significant.

Table 12

Gains in Mean Scores Correlated With Professional Development Hours, Manner of Usage and Fidelity of Implementation.

	Gain_2010_2011	Gain_2010_2012	Gain_2010_2013

PD_Hours	Pearson Correlation	.310**	.181*	.156*
	Sig. (2-tailed)	0.000	0.011	0.041
	N	243	195	171
Manner_of_Usage	Pearson Correlation	.307**	0.140	.192*
	Sig. (2-tailed)	0.000	0.050	0.012
	N	243	195	171
Fidelity_of_Implementation	Pearson Correlation	.336**	.165*	.159*
	Sig. (2-tailed)	0.000	0.021	0.037
	N	243	195	171

**. Correlation is statistically significant at the 0.01 level (2-tailed)

*. Correlation is statistically significant at the 0.05 level (2-tailed).

In order to assess the association among the PD Hours, Manner of Usage, and Fidelity of Implementation between one another, Pearson Correlation values were calculated. There was a strong correlation between all pairs. The results are depicted in Table 13. These strong, positive and statistically significant correlations signify that PD Hours and Manner of Usage, PD Hours and Fidelity of Implementation, and Manner of Usage, and Fidelity of Implementation are strongly related with one another.

Table 13

Professional Development Hours, Manner of Usage and Fidelity of Implementation Correlated With One Another.

		Manner_of_Usage	Fidelity_of_Implementation
PD_Hours	Pearson Correlation	.953**	.955**
	Sig. (2-tailed)	0.000	0.000
	N	244	244
Manner_of_Usage	Pearson Correlation		.947**
	Sig. (2-tailed)		0.000
	N		244

**. Correlation is statistically significant at the 0.01 level (2-tailed).

Part 3: Comparison of treatment group teachers with one another.

The third research questionbeing is being addressed in this part, namely, the short, medium and long term gains are broken down by teacher and school along with the factors in play.

1. Comparison of the treatment group teachers with one another:
    a. How did the treatment group teachers compare in students' mathematics achievement based on gains in mean scores:
        i. immediately after the intervention, i.e. in the short term;
        ii. one year after the intervention, i.e. in the medium term;
        iii. two years after the intervention, in the long term?
    b. How did the intervention affect the differences in students' mathematics achievement in the short, medium and long term for the treatment group teachers with each other in terms of:
        i. usage statistics, i.e. the total time and frequency of usage;
        ii. total hours of professional development;
        iii. fidelity of implementation, i.e. the manner of usage?
    c. How did the school culture effect the performance of treatment group teachers if any?

Table 14 depicts the immediate, medium, long term, average gains along with the PD Hours, Manner of Usage and Fidelity of Implementation for each teacher and school. The table concurs with the results shown in Tables 11, 12 and 13.

Table 14

Comparison of Treatment Group Teachers With One Another.

School ID	Teacher ID	Gain 2010_2011	Gain 2010_2012	Gain 2010_2013	Average Gain	Total Time	Total Freq	PD Hours	Manner of_Usage	Fidelity_of Implementation
5	7	5.26	26.71	30.39	23.04	20.75	1			
5	16	18.38	30.72	28.40	24.38	20.94	1			
3	26	8.81	24.67	36.13	24.92	22.12	1	5	1	19
4	25	19.22	26.82	60.81	35.47	345.52	11	5	1	28
4	2	22.36	24.88	50.38	30.79	155.74	3	5	1	36
5	28	24.44	33.91	20.00	19.00	20.23	1	5	1	41
5	9	26.06	47.86	35.46	33.87	962.80	19	10	1	49
5	23	26.43	44.30	61.25	52.81	179.17	3	10	2	58
3	19	28.16	42.44	55.08	44.31	3779.49	49	10	2	62
2	1	32.05	31.32	56.35	40.85	253.02	5	10	2	65
3	6	36.92	35.04	52.29	41.76	3346.91	38	10	2	69
2	20	38.75	40.62	59.73	47.21	229.40	5	15	3	81
2	17	40.21	47.86	56.25	49.81	379.75	17	15	3	84
2	5	43.67	42.25	60.46	50.38	732.76	18	15	3	88
2	14	44.25	41.73	53.15	43.69	1817.85	21	15	3	90

Comparison of the treatment group teachers with one another indicated that short term, medium term and long term gains in the scores of students have a tendency of being more positively related with the Fidelity of Implementation, Manner of Usage and PD Hours rather than the Time and Frequency of Usage. The strong, positive association between the Fidelity of Implementation, Manner of Usage and PD Hours signifies that professional development is an essential component while adopting an online learning environment. The OLAB used in this study presented a variety of tools as well as modes of usage; but in order to be able to use the OLAB effectively, the teacher must assume the role of the facilitator seriously which implies learning to use the OLAB in the best possible way.

In this study, the teachers had the freedom of whether or not to use the OLE, as well as whether or not to seek professional development, which was made available to all of them. Table 14 illustrates that the greatest gain in scores go hand in hand with those teachers who implemented the OLAB with the highest fidelity and not surprisingly those teachers came from the same schools which indicates that school culture is indeed a very important factor. When an OLAB is adopted at a school district and is made optional to use, it is up to the school administration to encourage the teachers to 1) learn to use OLAB in a competent manner, 2) to actually use OLAB, and, 3) to use OLAB so as to create long and lasting effects.

Chapter 5

DISCUSSION

Study Overview

Within the scope of this study the researcher has identified several desirable characteristics of OLE's. These characteristics are subject to increase with research and will be adopted by the new generation OLE's with the ever evolving technology. The OLE (OLAB) which was the subject of this study was relatively new, and thus it possessed many of the features that the researcher identified. However, the extent to which an OLE can be effective is not only related to what it has to present but also how these are exploited by the facilitators, i.e. the educators and teachers. OLAB was an OLE' for mathematics and science education of middle and high school students, offering a rich library of learning activities with many online resources.

Most of the research that studied the effects of online learning investigated the immediate or short term changes in achievement; few had examined medium and long-term retention of mathematical knowledge as an outcome of online learning, which was one of the contributions intended in this study.

On the other hand, a program or an approach that has previously been effective in one setting can be ineffective in another if implemented in a way that is far-off from the way it was designed originally. In this respect, researchers have shifted their focus on *fidelity of implementation* which is often the missing link between a promising program and positive impacts on students. Fidelity of implementation was a very important aspect of this study.

Turning the lights off and playing a learning activity is simply not enough to make sure that students have learned the concept. Students should practice through the interactive exercises, do the assessments and the independent practices. Facilitators should not only assign the learning activities but also monitor the progress of students, review the topics that students struggle with until they are sure students have learned the material.

Findings

This study probed a number of questions. The researcher investigated the immediate, medium and long-term effects of the OLAB. The researcher found that the treatment group performed better than the control group in the short, medium and long terms and that the results were statistically significant in the short and long terms. The researcher investigated the extent to which short, medium and long-term gains are related to time, frequency and manner of usage as well as the fidelity of implementation. The researcher found that fidelity of implementation is indeed one of the most significant aspects of online learning and that it is directly related to professional development efforts which is in a way associated with school culture. To create long and lasting effects on students' knowledge, it is imperative that any OLE' be used to its fullest capacity. Research has determined and will continue to determine the necessities which have been and will continue to be integrated to the new and existing OLE's; however, if these integrations are not utilized, the time, money and effort placed in creating and adopting the OLE's will be in vain.

Limitations to the Study

OLAB was adopted by the school district toward the end of the 1st quarter in the 2010-2011 school year; therefore the intervention started with the beginning of the 2nd quarter and continued until the 2011 AIMS test that took place in April 2011. Effectively, OLAB was used for only two quarters and this indicates valuable intervention time lost in the decision making process was a major limitation. Another limitation to this study was the fact that control and treatment groups were created based on whether or not a teacher decided to use the OLAB. With the control and treatment groups thus formed, the study became quasi-experimental.

Still another limitation is the number of participating students decreasing every year due to the high dropout rates at the district. To be more specific, part of the sixth-grade students that participated in the study left the district at grades 7 and 8 which resulted in not being able to study their achievement results. An additional limitation was that the teachers who chose to use OLAB were not mandated to participate in the periodic professional development sessions resulting in significant differences between the teachers in terms of their knowledge of OLAB and how to implement it with fidelity. Finally, the fact that this study was being conducted three years after the intervention had already concluded, brings its own limitations: 1) Classroom observations were not made; 2) The actual number of professional development hours were not concurrently recorded for each teacher; 3) The survey on teachers' OLAB experience was conducted three years later, rather than immediately after the intervention; 4) Some of the participating teachers left the district, so locating and persuading them to complete the survey posed a significant challenge; 5) Because of the participating teachers who left the district, the classroom dynamics changed with the teacher changing; therefore the differences between the control and treatment groups may also be due to the changing dynamics as a contributing factor.

Recommendations

Studies designed to assess the effectiveness of an OLE should ideally not be quasi-experimental. Therefore, the following recommendations are suggested.

- The control and treatment groups should consist of sufficient number of randomly selected individuals; sample size in each group should be equal; sample size should neither be too small, nor be too large.
- Control and treatment groups have to share qualities and are not likely to change, especially if the study is planned to be longitudinal.
- The intervention should be planned ahead of time, toward the end of the previous school year the latest.
- The facilitators should be made to attend professional development sessions regularly and be held accountable for the sessions they missed.
- The facilitators should be periodically audited in the learning environment (i.e. the classroom) and encouraged to apply most, if not all of the different aspects offered by the OLE.
- Time and frequency of usage should be carefully recorded.
- Facilitators should periodically be surveyed on their experience of utilizing the OLE.
- The comments made by the facilitators should be conveyed to the developers of the OLE for the upcoming versions of it.

- Control and treatment groups should be compared at least twice, once before the study and once after the study. Both comparisons should be made using an assessment instrument that is similar.

Conclusion

For this study, the main focus was on the short, medium and long-term effects of an OLAB curriculum on middle school students' performance in terms of their mathematics scaled scores in statewide high stakes tests. The OLE in question, being a new generation learning system, possessed most of the desirable characteristics of an ideal OLE, also identified in this study. The factors that were presumed to play into the effectiveness of the OLE were time and frequency of usage, hours of professional development, the manner of usage and fidelity of implementation. The research found that in the short and long terms, the treatment group statistically significantly outperformed the control group; in the medium term, the treatment group marginally performed better than the control group without statistical significance. The time and frequency of usage were found to have a weak positive correlations with the immediate, short and long-term gains. On the other hand hours of professional development, the manner of usage and fidelity of implementation were found to have stronger and statistically significant correlations with the immediate, short and long-term gains. Furthermore, a breakdown of the treatment group teachers individually and in terms of the schools they worked at brought to light the importance of a hidden factor, the school culture. The highest performing teachers attended more professional development hours, utilized the OLE with greater fidelity and a much superior manner and their students attained the greatest short, medium and long-term gains; interestingly enough, all of these teachers worked at the same schools. The study also showed that hours of professional development, the manner of usage and fidelity of implementation are at least as important as time and frequency of usage and all of these factors are interrelated with one another and related to school culture. These results are in agreement with Zhang (2005), Zhang et al. (2006) and Zhao et al. (2005).

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APPENDIX A

BIG IDEAS IN MIDDLE SCHOOL MATHEMATICS

BIG IDEAS IN MIDDLE SCHOOL MATHEMATICS

Grade 6

Focal Points

In Grade 6, focus should be on four critical areas:

1. connecting ratio and rate to whole number multiplication and division and using concepts of ratio and rate to solve problems;
2. completing understanding of division of fractions and extending the notion of number to the system of rational numbers, which includes negative numbers;
3. writing, interpreting, and utilizing expressions and equations; and
4. developing understanding of statistical thinking.

Topical Area	**Instructional Objectives**
Ratios and Proportional Relationships	• Understand ratio concepts and use ratio reasoning to solve problems.
The Number System	• Apply and extend prior understandings of multiplication and division to divide fractions by fractions. • Compute fluently with multi-digit numbers and find common factors and multiples. • Apply and extend previous understandings of numbers to the system of rational numbers.
Expressions and Equations	• Apply and extend prior understandings of arithmetic to algebraic expressions. • Reason about and solve one-variable equations and inequalities. • Represent and analyze quantitative relationships between dependent and independent variables.

Geometry	• Solve real-world and mathematical problems involving area, surface area, and volume.
Statistics and Probability	• Develop understanding of statistical variability. • Summarize and describe distributions.

Grade 7

Focal Points

In Grade 7, focus is on four critical areas:

1. developing understanding of and applying proportional relationships;
2. developing understanding of operations with rational numbers and working with expressions and linear equations;
3. solving problems that involve scale drawings and informal geometric constructions, and working with two- and three-dimensional shapes to solve problems involving area, surface area, and volume; and
4. drawing inferences about populations based on samples.

Topical Area	**Instructional Objectives**
Ratios and Proportional Relationships	• Analyze proportional relationships and utilize them to work out real-world and mathematical problems.
The Number System	• Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.
Expressions and Equations	• Use properties of operations to generate equivalent expressions. • Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

Geometry	• Draw, construct and describe geometrical figures and describe the relationships between them. • Solve mathematical and real-life problems that involve angle measure, area, surface area, and volume.
Statistics and Probability	• Use random sampling to draw inferences about a population. • Draw informal comparative inferences about two populations. • Investigate chance processes and develop, utilize, and assess probability models.

Grade 8

Focal Points

In Grade 8, focus is on three critical areas:

1. formulating and reasoning about expressions and equations, including modeling an association in bivariate data with a linear equation, and solving linear equations and systems of linear equations;
2. grasping the concept of a function, and utilizing functions to describe quantitative relationships;
3. analyzing two- and three-dimensional space and figures using distance, angle, similarity, and congruence, and understanding and applying the Pythagorean Theorem.

Topical Area	**Instructional Objectives**
The Number System	• Know that there exist numbers which are not rational, and approximate them using rational numbers.
Expressions and Equations	• Work with radicals and integer exponents.

	• Understand the connections between proportional relationships, lines, and linear equations. • Decipher, analyze and solve linear equations, and pairs of simultaneous linear equations.
Functions	• Define, evaluate, and compare functions. • Use functions to model relationships between quantities.
Geometry	• Understand congruence and similarity using physical models, transparencies, or geometry software. • Understand and apply the Pythagorean Theorem. • Solve mathematical and real-world problems that involve volume of cylinders, cones and spheres.
Statistics and Probability	• Investigate patterns of association in bivariate data.

APPENDIX B

TEACHERS' OLAB CURRICULUM EXPERIENCE SURVEY

TEACHERS' OLAB CURRICULUM EXPERIENCE SURVEY

1. Number of Online Learning Activity Based Curriculum professional development hours attended: Please indicate the total professional development hours you participated; i.e. please circle one of the following:

   0 5 10 15

2. How did you use Online Learning Activity Based Curriculum? (select all that apply)
   a. Whole class setting (one computer operated by the teacher) (1 point)
   b. Small groups of students (when multiple computers are available and a groups of students use each computer) (1 point)
   c. Individual instruction (tone computer per student) (1 point)

3. Frequency of using each component within Online Learning Activity Based Curriculum: Please indicate how often you made use of the following Online Learning Activity Based Curriculum instructional resources?

	Never (0 pts)	Rarely - One to three times a semester (1 pts)	Sometimes - One to three times a quarter (2 pts)	Often - One to three times a month (3 pts)	Very Often - At least once a week (4 pts)
My Class					
Lesson Plans					
Performance Objectives					
Search Feature					
Learning Activity					
Animation Objects					
Interactive 3D Models					

Teacher Guide					
Directional Info					
Assessment					
Question and Answer					
Activity Sheet (Student Version)					
Activity Sheet (Teacher Version)					
Independent Practice (Student Version)					
Independent Practice (Teacher Version)					
Glossary					