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Effectiveness of iLearn as a Formative Assessment Tool in Title I Middle Grade Mathematics

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This is to certify that the doctoral study by

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Abstract

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Ed.S., Nova Southeastern University, 2011

MA, Central Michigan University, 2009

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

Because students in two Georgia middle schools, Grades 6 through 8, performed poorly in standardized mathematics testing during the 2016-17 school term, the district sought improvements by using the computer-assisted formative assessment tool iLearn. The purpose of this quantitative project study was to determine whether the use of iLearn predicted increased mathematics achievement and to support professional development sessions for teachers to improve their pedagogy. With the theoretical framework of mastery learning theory, the study addressed the effectiveness of iLearn as a formative assessment tool, hypothesizing a positive relationship between iLearn and end-of-grade (EOG) assessment scores; a moderating effect of students' gender, ethnicity, and socioeconomic status (SES); and a score difference between students who did and did not use iLearn. Based on a causal-comparative and correlational analysis using archived data from 1,582 students, results indicated that the use of iLearn significantly predicted EOG scores, explaining nearly a quarter of their variance. Ethnicity and SES significantly moderated the relationship between iLearn and EOG scores; however, their moderating effect was too small to count. Finally, iLearn participants had significantly higher EOG scores than nonparticipants, displaying a small to medium effect size. Results showed that iLearn may be used in educational practice as a formative assessment tool regardless of students' gender, ethnicity, and SES. The project included a professional development plan for teachers who use iLearn in the classroom. This study may be used to increase achievement of middle school students in mathematics.

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Section 1: The Problem

The Local Problem

Two middle schools in Georgia did not meet state proficiency rates in standardized mathematics testing for 2 years, which undermined students' academic success rates and the district and school's academic yearly progress growth. This was a problem not only in the district and the state, but also throughout the United States (Westwood, 2013). The local school district and the two middle schools proposed a School Improvement Plan using the iLearn Mathematics Diagnostic program as a potential solution in predicting test performance and providing an early warning system to meet state proficiency rates.

There are mathematics diagnostic software packages similar to iLearn that are used at national and regional levels. Research supported programs such as Amazon's TenMarks, Curriculum and Associates' iReady, and Renaissance Star Math (Ferguson, 2014; Rickles, Williams, Meakin, Hoon Lee, & Walter, 2017; Tornquist, 2015). These programs impacted student learning and increased assessment scores in mathematics (Ferguson, 2014; Rickles, Williams, Meakin, Hoon Lee, & Walter, 2017; Tornquist, 2015). However, initial findings supporting iLearn (Collins, 2014) were insufficient for generalization in determining the effectiveness of iLearn in Grades 6-8. Students who used the TenMarks program at least once a week showed a significant increase in their end-of-grade (EOG) assessments than their peers who did not (Ferguson, 2014). The more time students used TenMarks, the greater chance they had of improving their overall math scores on their EOG assessments (Rickles et al., 2017). According to

Curriculum Associates (Collins, 2014), iReady has been proven to be an effective system for accelerating students' academic progress; students displayed growth in mathematics, thereby reducing the achievement gap in mathematics. Students who participated in iReady experienced a 38% higher gain in their mathematics achievement than students who did not (Collins, 2014).

Renaissance Star Math (Tornquist, 2015) is an adaptive formative assessment program that can monitor student progress and calculate growth. When students used this program on a quarterly or monthly basis, teachers were able to make adjustments to their instruction and monitor students' progress. Star Math assessments can predict state test proficiency rates, and educators were provided the necessary information on how well each student performed with respect to their grade level expectations (Tornquist, 2015). Successes from these programs suggested that iLearn may be beneficial to students' success in mathematics. These adaptive programs supported iLearn as a formative assessment in mathematics, which was addressed in the current study.

Studies conducted globally also indicated that middle school students showed low achievement rates in EOG mathematics assessment. In Italy, results of a longitudinal study indicated that, regardless of gender, students struggled in middle school mathematics (Contini, Di Tommaso, & Mendolia, 2017). This study addressed how well males and females performed in mathematics and how they differed according to various factors. Some of those factors were tied to students' parental genetics to exposure. Although there were many factors addressed in this study, the main finding was that all students struggled in mathematics.

There is a strong correlation between students' academic achievement and their family's socioeconomic status in most countries (Gustafsson, Nilsen, & Hansen, 2018), which may have had an impact on their EOG assessments. Educational reforms in countries like France and Norway were created in the 1960s and 1970s to determine effective ways to reduce achievement gaps among students in mathematics (van de Werfhorst, 2017). If students do not have the means to an equitable education, they will not be successful in mastering conceptual knowledge in school. Students not only have to have moral support from their teachers or parents, but they must also have equitable access to resources to support their education (van de Werfhorst, 2017). Achievement in middle school mathematics is not only a local issue but a global issue as well.

Rationale

Due to low state standardized assessment scores in two local middle schools, an instructional tool was implemented to promote students' growth and success in mathematics courses (School Improvement Plan, 2016). Table 1 displays data that show 72% of students scored at the beginning or developing learning level on their Mathematics Georgia Milestone Assessment. This problem of low standardized assessment scores in mathematics prompted many teachers and administrators to seek assistance at their schools. Table 1 shows the breakdown of EOG scores for the two local middle schools during the 2014-15 and 2015-16 school years. The data indicated that the schools were performing below achievement targets set by the state, which is seen in the second column.

Table 1

2014-16 Georgia Milestone Assessment Mathematics Scores

Year	GADOE Targets	School A Beginning %	School B Beginning %	School A Developing %	School B Developing %	School A Proficient and Distinguished %	School B Proficient and Distinguished %
2014-15	63.8	30	44	44	38.6	26	17.4
2015-16	63.8	30	37	44	43	26	20

Note. Georgia Department of Education, 2016.

Administrators and teachers at the middle schools analyzed archival data and concurred that the core content area of mathematics has been a problem and would like help in assisting students. According to an assistant principal of one of the middle schools, “our students have performed poorly for the last two years on their mathematics End of Grade Assessments and we’ve got to find some sort of solution that will meet them half way” (personal communication, April 27, 2015). This assistant principal also stated “our students have been acceptable to changes of the sort in the past but we’ve never had any centralized study to determine if the programs were effective” (personal communication, April 27, 2016). Given that this problem has been relevant for the last 2 years, I decided to delve deeper into the problem to determine the effectiveness of iLearn in an attempt to reduce the mathematics achievement gap for students in Grades 6 through 8. As an instructional tool, iLearn may help students grow academically, support their foundational mathematics skills, and increase their state standardized mathematics assessment scores. Because the effects of iLearn had not been assessed locally, the purpose of the current study was to assess iLearn as a formative assessment tool in middle school Grades 6 through 8 to increase mathematics achievement.

Definition of Terms

Computer-assisted intervention (CAI) tool: An instructional computer program that presents the learner a task that provides a means for the learner to respond to the task and provides feedback to the given response (Räsänen, Salminen, Wilson, Aunio, & Dehaene, 2009).

Early warning system (EWS): An intervention program used to indicate at-risk students' behaviors such as high absenteeism, chronic academic failure rates, or any other detrimental factor that may affect student success in school (Walsh, 2016).

End-of-grade (EOG) test: A summative test that is given annually to determine how well a student has been able to apply learned skills on the Georgia Milestones Assessment (Georgia Department of Education, 2016).

Formative assessment: An assessment done during the learning process that focuses on improving the learning process (Shute & Kim, 2014).

Georgia Milestone Assessment System (GMAS): An annual assessment for students in Georgia to determine how well they mastered concepts in reading, math, science, and social studies for students in Grades 3-12 (Georgia Department of Education, 2016).

Georgia performance standards: High-quality academic standards that were produced by the state of Georgia around 2010. These learning goals outline what a student should know and be able to do at the end of each grade (Georgia Department of Education, 2020.

iKnow: An assessment system within iLearn that provides benchmarks, diagnostic assessments, universal screener, and progress monitoring. Test results ensure validity and reliability of iLearn (Collins, 2014).

iLearn: A CAI program that provides a unique instructional approach that is student centered and also provides game-based learning opportunities (Collins, 2014).

School improvement plan: A plan provided for schools to improve learning that supports teachers and students to be proficient in core academic areas of reading and mathematics (Douglas County Schools, 2014).

Socioeconomic status (SES): The measure of an individual’s combined economic and social status that is often related to the health of the individual. The three common measures of socioeconomic status are education, income, and occupation (Baker, 2014).

Standardized assessments: Any large-scale test that requires students to answer the same test questions from a standard test question bank. Student test scores are then compared at the local, state, regional, or national level. These tests often come at the end of a student’s course that addresses educational needs of students (Rowntree, 2015).

Title I school: A school that has been mandated by national and state educational agencies due to high free and reduced lunch rates and a lower socioeconomic population. More educational funding is provided to support consistently failing schools (Dunlap, 2011).

Significance of the Study

I supported Walden's positive social change mission in recognizing the need for assistance in the field of mathematics at two local middle schools. The research addressed the effectiveness of iLearn as a formative assessment tool. Findings may provide a connection between a formative assessment mathematics program and effective instructional strategies in middle school mathematics classrooms. This study may have a direct and positive influence on classroom teaching locally and nationally. From a local perspective, administrators, teachers, and district assessment directors may have evidence to support future use of formative assessment programs such as iLearn. This study may influence other middle schools or school districts to use the program if results show an increase in EOG mathematics scores with the use of iLearn or other formative assessment programs.

Although formative assessments have been studied (DeWitte, Haelermans, & Rogge, 2015; Haelermans & Ghysels, 2015; T. H. Wang, 2014), further research was needed on iLearn as a formative assessment tool. Additionally, Faber, Luyten, and Visscher (2017) indicated that a digital formative assessment tool such as iLearn can have a positive impact on middle school mathematics. With the assistance of an online learning tool, students' scores increased (Haelermans & Ghysels, 2015). If the iLearn mathematics diagnostic program proves to be effective, other local middle schools may implement the program to increase mathematics achievement. The results of the current study may be beneficial for middle school students, teachers, and administrators.

Outcomes may provide administrators and teachers with empirical evidence of the effectiveness of iLearn as a formative assessment tool in middle-grade mathematics.

Research Questions and Hypotheses

The purpose of this study was to assess the use of iLearn as a means to increase mathematics achievement in Grades 6 through 8. Because this should was done independently of students' gender, ethnicity, and SES, I did not anticipate significant moderating effects of these variables on the relationship between iLearn scores and mathematics scores at the EOG test. The study was guided by three research questions and hypotheses:

RQ1: To what extent do the iLearn scores predict sixth- through eighth-grade students' mathematics score at the end-of-grade test?

H_o1: The iLearn scores do not predict sixth- through eighth-grade students' mathematics score at the end-of-grade test.

H_a1: The iLearn scores predict sixth- through eighth-grade students' mathematics score at the end-of-grade test.

RQ2: To what extent do gender, ethnicity, and socioeconomic status moderate the relationship between iLearn and mathematics scores at the end-of-grade test for sixth- through eighth-grade students?

H_o2: Gender, ethnicity, and socioeconomic status do not moderate the relationship between iLearn and mathematics scores at the end-of-grade test for sixth- through eighth-grade students.

H_a2: Gender, ethnicity, and socioeconomic status moderate the relationship between iLearn and mathematics scores at the end-of-course test for sixth- through eighth-grade students.

RQ3: What is the difference in Grade 6 through 8 students' math achievement between students using and students not using iLearn?

H_o3: There is no significant difference in Grade 6 through 8 students' math achievement between students using and students not using iLearn.

H_a3: There is a significant difference in Grade 6 through 8 students' math achievement between students using and students not using iLearn.

For a deeper understanding of the effects of iLearn, a review of the related literature is presented in the following section.

Review of the Literature

Theoretical Foundation

The theoretical foundation of the study was mastery learning theory (Morrison, 1926; Washburne, 1922). Mastery learning theory proposes that students can master materials presented in a lesson. Students are to be taught material, teachers test their students, teachers adapt their procedure, and teachers teach and test again until students are able to master concepts (Bloom, 1968). This process was adopted by Bloom (1968), who created the learning for mastery model. This model supported the theory of mastery learning in which student learning is checked frequently and immediate feedback is given (Block & Burns, 1976; Bloom, 1968; Guskey & Gates, 1986). Mastery learning theory is based on the concept that all children can learn when they are provided with conditions that are appropriate for their learning (Guskey & Gates, 1986). Mastery learning theory is a framework that promotes authentic student engagement in which students master specific concepts before moving on to another concept (Khaja, 2019). Although mastery learning may be time consuming, students benefit from an in-depth learning approach that they will use throughout their lifetime (Khaja, 2019). Students are allowed unlimited opportunities to demonstrate mastery of content that is taught (Wambugu & Changeiywo, 2008). Mastery learning theory and the learning for mastery model support formative assessment.

Black and Wiliam (2009) defined formative assessment as student achievement that is evoked, interpreted, and used by teachers, students, and their peers to make informative decisions. These decisions will determine the next steps in instruction teachers are to follow to improve students' academic performance. A formative assessment includes feedback and self-monitoring in which student responses can be used to improve student achievement without the use of tedious and ineffective trial-and-error learning (Sadler, 1989). A formative assessment is an effective strategy to enhance student learning (Shute & Kim, 2014). Formative assessments also help to improve pedagogical practices of teachers to provide specific instructional support for all students (Dunn & Mulvenon, 2009). The main components of formative assessment are self-assessment by pupils, interactive teaching, and classwork that raises standards of achievement (Black & Wiliam, 2005). Formative assessment involves gathering data for improving student learning, as well as modifying teaching and learning activities for students (Dixson & Worrell, 2016). Formative assessments can be used to prepare students for summative assessments that involve problem-solving learning experiences (Kelley, Fowlin, Tawfik, & Anderson, 2019). These findings supported the use of iLearn benchmark scores as a formative assessment tool to improve students' mathematics achievement in two local middle schools.

Formative assessment (Beatty & Gerace, 2009; Lee, Feldman, & Beatty, 2011), self-directed learning (Conradie, 2014; Knowles, 1975, 1984; Zimmerman, 2002), adaptive teaching (He, 2014; Parsons & Vaughn, 2014), early warning system (Aguilar, Lonn, & Teasley, 2014; Krumm, Waddington, Teasley, & Lonn, 2014) and self-assessment (Boud, 2013; Logan, 2015) are important elements of the learning process. The foundation of the current study was mastery learning theory in which an additional concept of formative assessment supported assessment of the learning process and feedback from teachers to students. Formative assessment supports self-directed learning, primarily self-assessment from the student's perspective, and initiates adaptive teaching from the teacher's perspective.

Mastery learning theory and formative assessments play a role in increasing student learning (Baleni, 2015) to ensure that the intended learning has taken place. This form of student learning prompts continual feedback from teachers to advance each student's learning. According to Shute and Kim (2014), formative assessments are associated with meaningful feedback to guide and support student learning. Teacher feedback, student feedback, and feedback from the iLearn program are necessary to promote self-efficacy and motivation among students (Shute & Kim, 2014). Formative assessments are closely related to teaching outcomes and refined student learning, which is instructionally appropriate to learning (Knowles, 1984). Wiliam (2011) confirmed that formative assessments provide evidence of what students have learned and next steps to consider. Quizzes, homework, and classwork are a few examples of formative assessments that support student learning (Wiliam, 2011). When formative assessments are in place and effective, students are able to self-direct their learning.

Mastery learning theory supported the research questions in the current study. Mastery learning theory was used to understand the relationship between iLearn and EOG scores for a population of students who used or did not use iLearn. Moderators such as gender, ethnicity, and socioeconomic status may influence the relationship between iLearn and EOG scores. Because iLearn possesses some mastery learning components, teachers who utilize the program will be able to increase students' achievement in middle school mathematics.

Formative assessments support self-directed learning with teacher and student feedback to guide student learning. When teachers or CAI programs use evidence from formative assessments, they are able to adapt their instructional methods to best assist the students in their learning (Andrade, Bennett, & Cizek, 2019). Feedback is generated in the iLearn program, and teachers and students are able to give feedback that assists in re-teaching and re-learning mathematical concepts that were not mastered. Self-directed learning enables students to gauge their continuous learning (Hammond & Collins, 2013. Students are able to self-adjust their learning with little to no assistance from a teacher. Self-assessments align with students' performance when feedback is available (Hattie & Yates, 2014). Participants are able to assess and predict others' actions, but self-assessment is not always effective due to participants overestimating their actions in their favor (Hattie & Yates, 2014). Although feedback is needed, students are able to support self-directed learning and self-assessments with well-developed checklists and rubrics (Hammond & Collins, 2013). The ability to self-assess and self-direct may also serve as an early warning system (Allensworth & Easton, 2005; Bruce, Bridgeland, Fox, & Balfranz, 2011; Dynarski et al., 2008; Hammond & Collins, 2013). When students are able to self-assess by identifying their weaknesses and building upon them with minimal assistance from the teacher, students become self-directed learners.

Early warning systems use researched-based warning signs to identify students who are at risk of not succeeding in their classes at any level of education (Faria et al., 2017; Heppen, & Therriault,(2008); Macfadyen & Dawson, 2010; Walsh, 2016). Sudden or consistent drops in a student's academic performance can be considered a warning sign that a student may need additional help. When this occurs, teachers are able to use programs such as iLearn as a form of response to intervention. This is an early detection strategy or program that assists struggling students before they fall further behind (Gersten et al., 2009). Benchmarks that are created within intervention programs such as iLearn help to track student performance. This encourages teachers to adapt their instructional approach to support students to master mathematical concepts. Teachers' goal is to improve student learning through adaptive teaching strategies (He, 2014). When teachers are able to identify student weaknesses early on, they are able to adjust their teaching strategies leading to more interactive lessons and individualized teaching.

In conclusion, formative assessment supports mastery learning theory. Self-directed learning and self-assessment support formative assessments with a focus on the student’s ability to learn. This can initiate adaptive teaching for teachers (Parsons & Vaughn, 2014). Self-directed learning and adaptive teaching have a positive influence on student achievement (Conradie, 2014; Westwood, 2013).

Review of the Broader Problem

In this review of the literature, I summarize resources to support the study. During the research of the broader problems, I used the following key words to limit my search results: *math achievement*, *formative assessment*, *adaptive teaching*, *early-warning systems, self-directed learning*, *self-assessment*, *self-assessment with rubrics*, *self-assessment by software*, *Title I Schools*, and *middle school*. I conducted my literature research with the assistance of ERIC, ProQuest, EBSCO, and Education Research Complete. These databases were used to locate resources and set notifications that allowed me to research further as the programs identified specific journals or prior work that was relevant to my study. I also used books and other resources at my local school and library. Except for seminal works, the search was focused on the last 5 years. I review the literature and define formative assessment, adaptive teaching, self-directed learning, self-assessment, self-assessment with rubrics, Title I schools, and middle schools.

Formative Assessment

A number of researchers (Black & Wiliam, 1998; Bloom, 1968; Broadfoot et al., 1999; Kahl, 2005; Sadler, 1989; Scriven, 1967; Shute & Kim, 2014) have provided definitions of formative assessment. Scriven (1967) was the first to define formative assessment as a process that is an "on-going improvement of the curriculum" (p. 41). Bloom (1968) also defined formative assessments as brief, formal tests used by teachers to improve students' assessment rates. Sadler (1989) stated that formative assessments displayed the "quality of student responses (performances, pieces, or works)" and could be "used to shape and improve the student's competence" (p. 120). Sadler (1989) confirmed that effective uses of formative assessments were not only the responsibility of the teacher, but the learner as well. Formative assessment is now considered as a form of eliciting student achievement. Students need formative assessments to meet major milestones and identify gaps in their education (Kulasegaram & Rangachari, 2018). Assessments are analyzed and used by teachers to support student learning. Formative assessments also prompt learners and peers to make better decisions about the next step they will take in their instructional approach (Black & Wiliam, 2009). Formative assessments help to identify areas in which more explanation or practice is needed (Broadfoot et al., 1999). This action is intended to guide students to understand their mistakes in their work.

Feedback is most powerful when students are the central focus (Filsecker & Kerres, 2012). Students benefit the most from feedback given during instruction as opposed to after instruction (McMillan, Venable, & Varier, 2013). Formative assessments are effective when they communicate to students that success is achievable and teachers are able to make instructional adjustments (McMillan, Venable, & Varier, 2013). Feedback is vital in the enhancement of a student's learning ability (Black & Wiliam, 2005). Teacher-to-student feedback is a form of adaptive teaching that affects a teacher's instruction as well as student achievement (Black & Wiliam, 2005; Evans, 2013).

Detailed, individualized rubrics and exemplars from teachers provide effective feedback for students (Lipnevich, McCallan, Miles, & Smith, 2013). Rubrics have been shown to communicate expectations to students based on their learning goals set by their teacher regarding what they were looking to achieve (Andrade & Du, 2005). This process guides students in revising their work and making improvements to enhance their performance (Lipnevich et al., 2013). When students are informed as to what they need to improve upon, then feedback effects students' self-regulation and self-monitoring (Lipnevich et al., 2013). Lipnevich et al. (2013) also confirmed that certain types of feedback such as encouragement, impersonal feedback, and untimely feedback do not improve a student's ability to learn; therefore, teachers have to be selective of the feedback they use.

The act of providing consistent feedback can be daunting for teachers to complete in a timely manner without proper resources to assist them. Beatty and Gerace (2009) determined that technology-enhanced formative assessments give teachers the opportunity to provide the appropriate scaffolding to help students find answers efficiently. This then leads to a more engaging classroom, which helps teachers identify students' strengths and weaknesses quicker.

Adaptive Teaching

Adaptive teaching is an adjustable form of teaching that allows teachers to implement unique forms of instruction to accommodate different learning styles at once

(Parsons & Vaughn, 2014). When teachers use formative assessments with feedback to students through rubrics or constructive criticism, they are able to adjust their teaching to address the needs of the students. Feedback is an important part of adaptive teaching because it provides clarification to mistakes identified during instruction (McMillan et al., 2013). Dewey (1910/1997) argued that the goal of education is to develop a teacher's mindset to adapt their teaching to improve their student's learning. Educators often encounter problems that need resolutions in a timely manner. To solve problems, the educator must collect data, consider all possible resolutions, and take action. Adaptive teaching along with inclusion became relevant in the 1990s as schools attempted to meet the learning needs of students in a wide range of abilities (Westwood, 2013). These abilities ranged from gifted to intellectually impaired individuals, and the aim of adaptive teaching was to include all learners within a mixed-ability classroom. Westwood (2013) stated that adaptive teaching seeks to reach all students regardless of their learning abilities.

Teachers must be able to extend student thinking by merging prior knowledge with new knowledge (Parsons & Vaughn, 2014). Teachers and students are the two most important users of adaptive teaching (He, 2014). Adaptive teaching encourages teachers to improve their instructional strategies as a way of displaying they are capable of understanding how students learn best. This allows teachers to identify learning risks among students and provide early interventions to guide students to academic success.

Adaptive teaching is aimed at achieving a common instructional goal with learners when their individual differences are taken into consideration (Ikwumelu, Oyibe,

& Oketa, 2015). This allows teachers to adapt their instruction to address various students at once (He, 2014). Educators are then able to group students based on abilities, analyze relationships of students' knowledge, track students' learning behaviors and evaluate students' learning performance. When educators have a greater understanding of students' learning styles, it has an impact on adaptive teaching and allows the teacher to identify and address those different learning styles in a timely manner. Adaptive teaching requires schools to value and evaluate teacher support that allows teachers to create long-term relationships with students (Darling-Hammond, 2016). Effective teachers adapt their teaching styles to best fit the needs of their student's therefore adaptive teaching "can provide for a range of opportunities for success" (Darling-Hammond, 2016, p. 85).

The ultimate goal of adaptive teaching is to achieve a common instructional goal amongst a variety of learners at once (Ikwumelu et al., 2015). Adaptive teaching occurs naturally, and it does not prevent learners from achieving success (Adeyami, 2017). This practice enhances student performance, promotes positive attitudes and supports conceptual knowledge that has been learned. Effective teachers use adaptive teaching to remediate and clarify misconceptions students may have had while learning concepts. Westwood (2013) affirmed that adaptive teaching is quite demanding, but it requires careful planning on behalf of the teacher to implement effectively. Adaptive teaching is another form of differentiation (Parsons, Dodman, & Cohen-Burrowbridge, 2013). This form of teaching allows teachers to observe students' progress, so they can make immediate changes or interventions. This approach is effective and innovative in the teaching and learning process (Adeyemi, 2017). Overall, the aim of adaptive teaching is to include all learners regardless of their learning ability.

Early Warning Systems

An effective form of adaptive teaching is the implementation of Early Warning Systems (EWS) in education. Adaptive teaching optimizes a teacher's approach to meet the needs of different students at once. EWS brings attention to student problems that affects their academic performance as an extension of adaptive teaching. These preventive measures are used in various capacities in an attempt to help at risk students achieve their educational goals. EWS is used as a portion of a working framework to use data in making decisions (Franzell, Nagel, & Northwest, 2015). These systems are set to assure that students remain in school to learn rather than dropping out (Heppen & Therriault, 2008). EWS identifies several factors such as students who are academically disengaged, exhibit high-risk rates, chronic failures, high absentee rates or behavioral issues. These issues may affect a child's opportunity to succeed in school (Walsh, 2016). The use of EWS allows for quick analysis of students to improve student achievement rates as well as student needs (Allensworth & Easton, 2007; Johnson & Semmelroth, 2010).

Although the use of EWS is still evolving, school administrators, counselors and teachers have a quicker response time to catch kids before they slip through the cracks (Walsh, 2016). Research is limited in stating how soon EWS should be implemented, how long interventions should be followed and the specific timeframe in which teachers are to correspond to EWS. Due to EWS evolving as technology improves, the evolvement of EWS has led to an increased use of internet and communication technologies for pedagogical goals and content delivery flexibility (Macfadyen & Dawson, 2009). Educators use technology and EWS to gain access to a plethora of tools that make learning student centered. Learning Management Systems and online assessment tools allow for students to become more engaged with their peers in an attempt to strengthen their skills and minimize their learning deficiencies.

When educators are able to focus on a small set of indicators, early warning systems can be implemented effectively and efficiently early on (Frazelle et al., 2015). The earlier problems are addressed, the less likely they are to occur again (Allensworth & Easton, 2005). Disengagement is just one factor that EWS addresses but this study will best use early interventions to address assessment performance. Student engagement is a possible object of immediate teacher action that is rather quick and positively impact student performance. EWS shall be used frequently in an attempt to address student's assessment performance.

Research is continually expanding on the use of EWS as a predictive tool. Studies provide valid support that EWS has a positive trend in identifying students who are prone to fail a course or not graduate in the future (Balfranz, 2007; Carl, Richardson, Cheng, Kim, & Meyer, 2013). Now that early warning systems are easier to use, teachers are able to use preventive measures earlier in a student's educational years. In the past, educators manually tracked data such as low attendance rates, behavior problems and failing grades. Now, technology supports Learning Management Systems (LMS) and several online programs to warn educators of these problems students may have in school.

The effects of EWS impacts student's lives beyond school. Academic disengagement has triggered behavioral issues as students become adults (Henry, Knight, & Thornberry, 2012). These issues impact the judicial system as well as the economy. This leads to the fact that early indicators are effective in attempting to correct problems before they become larger issue. Educators are aware of these external and possible intrinsic characteristics students exhibit, which may hinder them from progressing academically (Kahu, 2013). External factors such as family issues, inability to arrive to school on time, lack of diet play a vital role in student's daily performance. In order to combat problems of the sort, early warning systems are put in place. Early Warning Systems (EWS) in education identify strengths and weaknesses students' exhibit on formative assessments or computer assisted instructional programs. Aguilar, Lonn, and Teasley (2014) affirmed that EWS support decision making around students' academic performance in mathematics and other content areas. They also confirmed that EWS provides necessary information for teachers to facilitate timely interventions for students. The utilization of EWS has led to increased contact between the student and the teacher (Krumm, Waddington, Teasley, & Loon, 2014). This allowed students to communicate with teachers and teachers were able to provide timely feedback to assist the students in understanding misconceptions. They also mentioned that EWS provided data that led to an understanding as to "how, when and why students' academic performance may be declining (Krumm et al., 2014, p. 117)." This simple act promotes self-directed learning from a student's point of view and supports teacher's decision to use specific learning strategies while teaching.

Self-Directed Learning

Early warning systems in education detect problems that hinder student academic growth (Walsh, 2016). When students have a stronger sense of self, they are able to self-direct their learning. Self-directed learning is a process in which individuals take responsibility for identifying learning needs, developing and executing learning plans, fostering initiatives for their need to learn, and identifying resources to enhance their learning (Knowles, 1975). Learners and educators self-manage as well as share control of their learning (Aliponga et al., 2015). From the student's perspective, self-directed learning allows them to make positive choices about how they face real-world scenarios or everyday life (Wijayanit & Sukamto, 2017). Students have the opportunity to improve their knowledge, individual development and abilities to define their own learning goals. When this occurs, students are able to direct their own learning (Aliponga et al., 2015). The educator presents what is to be learned and the learner then controls how they learn creating a form of communication between the two. This shift from the educator to the learner, in which the learner controls the learning process (Conradie, 2014). This form of learning supported iLearn's approach in increasing mathematics achievement. The framework of learning is lifelong in that it strengthened foundational skills that are important for learning which would occur throughout each student's life (Merriam, 2001). Therefore, the framework began with the concept of adult education and progressed to that of middle school aged children that supported self-directed learning and self-assessment.

Self-directed learning is a shift of responsibility of learning from the educator to the student according to Conradie (2014). Students build on past learning experiences, which enhances their ability to guide their learning and deepen their understanding of a concept. “Self-directed learning thus nullifies the idea of a passive learner, but instead focuses on mutual dialogue between learner and educator, with the learner actively involved in knowledge construction” (Conradie, 2014, p. 255). This form of learning supports students as they set personal academic goals. Knowles (1975) also supported the idea of self-directed learners in that they are able to formulate goals and implement appropriate learning strategies to benefit their learning.

Knowles (1984) considered self-directed learning to comprise of (a) self-evaluation, (b) self-reflection, and (c) self-initiative. Prior to learning, learners must self-evaluate their purpose to learn. One may question as to “Why must I learn this? How will I benefit from this? Who will know that I have learned this? How can I display that I have learned and understood thoroughly what I am to be taught?” (Knowles, 1984). Individuals often consider these questions when learning new facts and conceptual ideas. Individuals also self-evaluate and reflect on multiple perspectives as to why they are learning and how can it benefit them in the future. Learners have to initiate what and how they are to learn. Considering these three characteristics, Knowles (1984) generated a conceptual framework that supports this study of evaluating the iLearn Mathematics Diagnostic Program and its effectiveness in increasing achievement in middle school mathematics.

Self-directed learning is a Higher Order Thinking Skill (HOTS) (Wijayanti & Sukamto, 2017). HOTS places emphasis on what the learner should know and how deeply they understand particular concepts. Higher order thinking takes place at a higher level of cognitive processing (Ramos, Dolipas, & Villamor, 2013). When teachers ask higher□order questions, students are encouraged to provide clear explanations, demonstrating depth of knowledge. This enables students to retain information in which they will apply to real-world problems and solve problems logically. This is a higher order thinking strategy that teachers utilize to help their students develop vital critical thinking skills (Ramos et al., 2013). Educators encourage HOTS to deepen students' knowledge as well as promote self-directed learning. This form of learning is valued as an important skill for self-development (Worapun, Nuangchelerm, & Marasri, 2017).

Self-directed learning allows students to be creative in their critical thinking (Ramos et al., 2013). Students are able to manage various ideals at once using intellectual strategies and thoughtfulness to achieve personal, educational goals. In order for self-directed learning to be effective, teachers have to be able to adjust their instruction and trust in their students to learn at their own pace (Worapun et al., 2017). Self-directed learning can be a multi-faceted concept, but it solely depends on what is accomplished by each student. When students are able to delve deeper into their understanding of a topic, self-directed learning comes into fruition and leads to lifelong learning skills. Self-directed learning strategies are cultivated when students are provided effective feedback that strengthens their understanding.

Self-Assessment

Self-assessment is vital in developing students' self-regulated learning, independence, and autonomy (Taras, 2015). The term self-assessment became relevant in the 1930's in which students were required to evaluate their own work to meet specific criteria and optionally for a grade. During the 1970's and 1980's, the idea of self-assessment led to student independence and autonomy. The emphasis was then placed on students being able to work and develop their own skills with the direct support from teachers but more so from their peers (Taras, 2015). This emphasis is still relevant in which students are able to self-assess their learning to further their understanding of what they have learned from their teacher and peers.

Self-assessment relates to self-directed learning in that students evaluate what they have learned and build upon those foundational skills to deepen their knowledge. The term self-assessment has evolved as one is learning over a period of time (Kulkarni et al., 2013). Learners assess their prior learning to what they are currently learning in this process. Teachers and students use this as a learning tool to expand their understanding of what they have learned. Self-assessment helps students reflect on gaps of misunderstanding leading to more success (Kulkarni et al, 2013). When students are able to assess their learning, they are able to achieve learning at a higher rate than those who do not self-assess.

Self-assessment is more than, students grading their personal progress (Boud, 2013). Self-assessment requires students to consider effective characteristics and strategies that they can apply to their work. These traits promote lifelong learning skills.

Self-assessment is also necessary for effective learning. Boud (2013) confirmed, "self-assessment provides the fundamental link with learning" (p. 15). Students are able to experience personal learning as well as observe work from the assessor's perspective (Kulkarni et al., 2013). When students are able to evaluate other's work, it leads to positive feedback. Self-assessment is valuable to students in that they are able to reflect on how they learn, grow academically and quickly identify misconceptions that they would oftentimes miss with a graded assessment without the proper feedback.

Students and teachers play a vital role in self-assessment. Not only must students learn from personal mistakes, but teachers must influence those learners. Support from teachers encourages students to pay attention to the how and why of their learning. In this study, not only is SDL important to what and how well a student learns, but self-assessment supports effective learning habits.

Self-Assessment With the Use of Rubrics

Past research supports the use of rubrics to support student learning, self-regulation, and self-assessment (Andrande & Du, 2005; Belanger, Zou, Mills, Holmes, & Oakleaf, 2015; Efklides, 2011; Goodrich, 1997; Jonsson & Svingby, 2007; Kulkarni et al., 2013; Panadero, Alonso-Tapia, & Huertas, 2012; Panadero & Romero, 2014; Reddy & Andrade, 2010; Schafer, Swanson, Bene, & Newberry, 2001). Rubrics were designed to analyze final products and to help students establish appropriate goals (Panadero et al., 2012). These researchers also affirmed that rubrics have also been used to help students self-assess their learning process and performance. Self-assessment depends on student goals which affect teacher's instructions (Efklides, 2011). Rubrics are used as self-assessment tools with a criteria list assessing important goals, grading scales and the description of the grading scale.

Rubrics are comprised of guiding questions that student work is graded upon (Kulkarni et al., 2013). Students can use rubrics to guide their work and teachers can use rubrics to provide feedback which leads to areas of improvement amongst the students' work. This supports self-regulation in which students must ask themselves why they missed the concept then find solutions to their questions. Rubrics are also divided into sections eliciting feedback per section according to Belanger et al. (2015). The use of a rubric is to communicate what students should learn, elicit direct feedback, promote self-assessment and provide meaningful scores. Students are able to understand their learning outcomes and teachers are able to reflect on their teaching practices to support student learning.

Effective rubrics are not just handed out but they are supported by structured interventions the involve feedback according to Jonsson and Svingby (2007). The proper use of rubrics enhances student mastery due to inclusive key concepts that are relevant to the task at hand (Panadero et al., 2012). Students become aware of their ability to learn when rubrics are followed by feedback. When rubrics are effectively implemented, which includes feedback and follow up, they can promote self-regulation leading to self-assessment (Goodrich, 1997). The increased use of rubrics supports self-regulation and students are able to self-assess their learning needs with greater score accuracy on assessments (Panadero & Romero, 2014). This greater sense of personal support improves student's perceptions of themselves when it comes to their ability to learn.

In order for students to feel that they are important in their learning process, they must be able to own their learning. According to Andrande and Du (2005), students' perceptions of themselves have improved with the use of rubrics. When students are able to self-assess with rubrics, they experience a decreased sense of anxiety and their self-security improves. The use of rubrics is beneficial to both teachers and students (Andrade & Du, 2005). They are the creators, users and facilitators of rubrics in an attempt to improve learning or teaching strategies. Teachers can create rubrics and students should be able to provide their input, as they are the end-users (Andrande & Du, 2005). When this occurs, clarified assessment criteria and assessment scores are fairly given therefore, the use of rubrics support student learning and self-assessment.

Self-Assessment by Software

Self-assessment is conducted at a faster pace with the assistance of software. This minimizes teacher's workloads, removes barriers between students and provides instant feedback (Ćukušić, Garača, & Jadrić, 2014). Students then become less dependent on teachers and become more responsible of their learning. Students develop self-confidence and play a more proactive role in their learning. This is important as this prepares students for work and life settings.

The participants of this study will use iLearn. This research-based software program is student centered and provides adaptive assessments and game-based learning opportunities. Students are able to self-assess and receive assistance from teachers as needed, as the program is solely online; however, teachers are encouraged to provide little to no assistance as the program is curated for self-discovery to promote student learning at a higher level. iLearn uses the Rasch Item Response Theory Model (Collins, 2014) which is a theoretical model that calculates a student's success rate at certain levels of learning. This theory promotes strong foundational skills and provides valid and reliable inferences that the iLearn Diagnostic program supports. Wesolowski, Wind, and Englehard (2016) made an inference that the Rasch Item Response Theory Model "converts raw scores to a log-odds scale using a logistic transformation" (p. 337). This transformation allows students to test their mathematical skills progressively throughout the iLearn program. This theory created a baseline understanding of independent and adaptive learning that the iLearn program has successfully implemented to over 2,000,000 students (Wesolowski et al., 2016).

The iLearn Diagnostic Mathematics Assessment program is valid and reliable and has the basis of an adaptive assessment and item response program (Collins, 2014). Students are prompted to take a diagnostic, prior to accessing content. Specific content is prescribed based on their mathematical strengths. As a prescriptive program for students, the contents of iLearn are presented and calculated in a unique way. iLearn content compromises of the following: basic facts, computation, concepts and application (Collins, 2014). Each students' performance focuses on fluency of mathematical skills that are provided within the program. In order to progress forward, students have to master at least 80% of the content presented. The iLearn program serves as an online administration system that tracks students' progress and provides real-time reports on their performance (Collins, 2014). Students are then shown how they have progressed before they move on to the next topic. If the content or standard is not mastered, students' revisit the same topic repeatedly. Collins (2014) asserted that this process ensures a systematic and progressive approach to content mastery.

Title I Schools

Title I is recognized as the federal government's most important program as a way to support schools and school districts who are in need of financial assistance to provide an equal education for all students (Gordon, 2004). Education is one aspect of life that every child in America is afforded regardless of their Socioeconomic Status according to the Elementary and Secondary Education Act (1965) hence Title I was created (McClure, 2008). One third of the U.S. Department of Education's elementary and secondary education financial budget is dedicated to Title I schools and school districts (Gordon, 2004). The ESEA provides an equal opportunity for all students to receive an equal education. Unfortunately, all schools are not able to afford their students with equal opportunities due to a lack of resources stemming from finances, technology and safety to name a few. In 2015, President Barack Obama reauthorized the Every Student Succeeds Act (ESSA) which replaced the No Child Left Behind Act (NCLB) from President George Bush in 2001. ESSA authorized state-ran schools to be granted additional federal funding to combat the needs of struggling schools and school districts. When schools are in need, students are not provided a quality education if they are unsure of where their next meal may come from, if they struggle to understand and comprehend English, or if they have a difficulty learning. Although Title I was created in 1965 under the Elementary and Secondary School Act, schools and school districts continue to reap the benefits it has to offer to support students' education.

In order for a school to be considered Title I, they have to meet specific requirements to receive additional Federal funding. Schools or school districts have to have at least a 40% poverty rate, considered persistently low achieving based on state assessment data over a period of time, and must exhibit a financial need to improve achievement for students who struggle academically. Specific funds had to be allocated to support students' education to (Isernhagen, 2012; McMurrer, & McIntosh, 2012). Schools then had to create a school improvement plan to speak on how funds were delegated within the school. Each state receives funding from Title I and those funds are distributed to school districts that are in need. Once those funds are allocated at a local level, schools have to report how those funds were allocated and have to adhere to strict stipulations set from the federal government. This funding allows school districts to purchase equitable means of technology, additional teachers and free food to support the well-being of students who are poverty stricken.

Middle Schools

In the American culture, children's ages determine their academic stance or grade level as well as their intellectual well-being. Our school systems are broken down into grade levels to support specific leaning needs children need at specific times of their lives (Lounsberry, 2010). Students as young as 6 years of age are considered Kindergarteners while students as old as 18 are graduating from high school. Students in between the ages of 10 and 15 are deemed middle school aged students as their age is in the middle and their thoughts and mental capabilities have a wide range extending those of a child and somewhat of an adult. Dating back as far as 1947, middle schools or junior high schools were conceptualized to mold and provide a healthy well-being for students in between the ages of 10 and 15 (National Middle School Association, 1982; National Middle School Association, 2003). In 1982, *This We Believe* was position paper published in support of the National Middle School Association and their stance on what middle school education was and should be to support the education of adolescents. From this paper, schools were to provide an in-depth understanding of content in Reading, Mathematics, Social Studies and Science to support the mental capability of these adolescents (Erb, 2005). This was done to create lifelong learners who would in turn remain optimistic about their future.

The concept of middle school education evolved yet it still supported the well-being of adolescents' mental capacity over time. As an extension of elementary and secondary schools, middle schools provide advisory programs, sports teams and exploratory learning opportunities to enrich the learning of adolescents. Research shows that this time in a child's life is very critical as they grow physically and mentally rather quickly; therefore they require consistent experiential learning to develop intellectually (Erb, 2005; Lounsbery, 2010; National Middle School Association, 2003). Middle school years are critical in a child's life as it is a time to explore who they are with the support of influential teachers and effective instructional strategies that promote a stronger sense of self-directed learning that they will need during their secondary and post-secondary education.

Implications

The findings of the study shall contribute to the current gap in practice and research on the effectiveness of iLearn as a formative assessment tool in middle school mathematics as a way to support an increase in mathematics achievement displayed in end-of-grade assessments. At the local level, results of the study could encourage the use of iLearn to predict end-of-grade assessment scores in middle school mathematics. Anticipated findings may imply that students who used iLearn would have higher achievement growth than those who did not. Students' scores may predict an increase of math scores on end-of-grade tests. Anticipated findings may also imply that gender, ethnicity and socioeconomic status moderate the relationship between iLearn benchmark scores and mathematics scores on the end-of-grade assessments. Findings may also imply that participant views may or may not determine the effectiveness of utilizing iLearn with an intent of increasing mathematics achievement at two middle schools.

Data will be collected and analyzed through iLearn and GADOE leading to project deliverables from the study. As possible project deliverables, the outcome of the study could be considered as a report on the effectiveness of iLearn as a formative assessment to support an increase in achievement in middle school mathematics. Potential future users of iLearn may be able to utilize findings from the study to implement iLearn into curriculum plans and create a training curriculum and materials for teachers and or future users. School district policy makers may also recommend schools to use iLearn as the outcomes may support its use in increasing achievement in middle school mathematics.

Summary

In Section 1, I have provided an overview of the effectiveness of iLearn, the local problem, and a review of the literature that supports the theoretical framework pertinent to this study. The purpose of the literature review is to support the need for future research on the impact of CAI tools, such as iLearn. The purpose of the study is to assess the use of iLearn as a means to increase mathematics achievement at two middle schools. Few studies have been conducted focusing on the effectiveness of iLearn. As an approach to reduce the gap, two middle schools used iLearn to help students strengthen their foundational skills in mathematics.

Supportive research questions mentioned attempted to address the increase in mathematics achievement at two local middle schools. ILearn benchmark scores may show a strong correlation as a predictor to end-of-grade scores on state standardized mathematics assessments. Gender, ethnicity and socioeconomic status may also support iLearn benchmark scores and end-of-grade assessment scores. This study may exhibit a difference in achievement amongst students who used iLearn and those who did not.

In Section 2, I provide a description of the quantitative design and approach, setting and sample of the study, data collection strategies, data analysis and limitations considered for the study.

Section 2: Methodology

Research Design and Approach

The purpose of this study was to determine the effectiveness of iLearn as a formative assessment tool in terms of prediction accuracy and change in student achievement in middle school mathematics. I used a quantitative post-hoc approach that consisted of a combination of correlational and causal-comparative designs. Archival data were obtained from iLearn and EOG tests at the local schools. These data allowed me to examine the possible predictive relationship between iLearn use and increased EOG scores. I also used archival data to determine whether gender, ethnicity, or SES would moderate the relationship between the test scores. I conducted tests to determine possible differences in achievement between students who used and students who did not use iLearn.

Setting and Sample

The population consisted of approximately 1,600 middle school students from two middle schools. The participants came from two Title I middle schools. Title I schools receive additional federal funding to support academic performance for students with high rates of free and reduced lunch (>78%), poverty (>75%), and low SES (>75%). There was no significant difference ($p > .05$) in terms of demographics, mathematics achievement, or iLearn scores between the two schools. Ethnicity and SES were equally distributed. Table 2 shows the demographic frequencies and percentages of the two local middle schools. Although School B had more students, the gender and ethnic makeup were similar in both schools.

Table 2

Demographic Frequencies and Percentages of School A and School B

School A		*N*	%
Gender	Male	329	53%
	Female	295	47%
Ethnicity	African American	453	75%
	Hispanic	103	17%
	White	36	6%
	Multiracial	12	2%
	Total	604	100%
School B		*N*	%
Gender	Male	496	51%
	Female	482	49%
Ethnicity	African American	753	77%
	Hispanic	98	10%
	White	68	7%
	Multiracial	59	6%
	Total	978	100%

Note. School Improvement Plan, 2016.

Table 2 displays the number of students at each school who were disaggregated into subgroups. Table 3 provides disaggregated data of ethnic groups and the numbers of students who received free and reduced lunch during the 2016-17 school year. Table 3 also shows that there was a large number of African American students who received free or reduced lunch. Other ethnic groups had lower rates of free and reduced lunch, but this may have been due to both schools having a higher percentage of African American students. Tables 2 and 3 provide demographic frequencies and percentages for both schools in the study. The number of students and the percentage of the population are provided. School A and School B were similar. School B had a higher number of students, but their percentages were similar with respect to gender and ethnicity.

Table 3

Distribution of Ethnicity and SES

		African American	White	Hispanic	Other
Socioeconomic status	Free or reduced lunch	1188	4	22	45
	No free or reduced lunch	3	101	180	37

Note. School Improvement Plan, 2016.

The statistical power analysis program G*Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009), indicated 89 participants as the minimum sample size for a linear regression (one predictor, effect size f^2 = .15, alpha error probability .05, power .95), 153 participants for a multiple linear regression (seven predictors, effect size f^2 = .15, alpha error probability .05, power .95), and 210 participants as the minimum sample size for analysis of variance (fixed effects, main effects and interactions, two groups compared, no covariates, effect size f = .25, alpha error probability .05, power .95, degrees of freedom df = 1). The resulting minimum sample size was 210.

As noted in the two schools' School Improvement Plan (2016), close to 1,600 students exhibited academic gaps in mathematics. Based on their previous EOG and mathematics course scores, these students were invited to participate in using iLearn to help them succeed in their future mathematics courses and standardized assessments. The sample for this study consisted of 1,582 students who had responded to the invitation and volunteered to participate in using iLearn to improve their scores on the EOG mathematics assessment test. This sample size was substantially larger than the minimum sample size indicated by the power analysis.

Instrumentation and Materials

The variables in this study were the iLearn score (independent variable [IV]), the mathematics achievement score at the EOG test (dependent variable [DV]), and the demographic variables of gender, ethnicity, and SES (moderating variables). iLearn tests are considered to be valid and reliable because they were created through a rigorous process. The purpose of iLearn diagnostic tests is for students to show mastery of math content that meets the state of Georgia's standards (Collins, 2014; Georgia Department of Education, 2016). Any state that participates in iLearn is mandated by law to test students with that particular state's mathematics standards to gauge the overall quality of that state's educational system and their approach to implementing successful instructional strategies. The next step is to create specific test items to determine how deeply students understand specific topics in mathematics (Collins, 2014). iLearn tests are then created and written by state-certified educators who then test each question. Students are then given the test, which creates baseline data. These baseline data establish standards to be addressed on future tests. When scale scores are produced and distributed to each student, iLearn tests become a valid and reliable source of student mastery in mathematics.

For iLearn to be reliable, test scores have to show consistency over time. Cronbach's alpha reliability coefficient is a measure of internal consistency among responses to a set of items. When students produce similar scores in multiple attempts, completed tests in iLearn are considered to be reliable. Students take tests within the iLearn program numerous times, which indicates test-retest reliability. Each student completes a multitiered lesson that consists of interactive games, benchmarks, and minilessons to ensure they are proficient in a particular topic. Once the lesson is complete, students take an assessment to predict the next phase of their learning. The iLearn test is considered reliable, with a Cronbach's alpha coefficient of .90 (Collins, 2014).

Evidence that the iLearn tests and test scores were valid was based on relations to other variables (Creswell & Creswell, 2009). This validity evidence is applicable to any test in which test scores provide evidence of the relationship to variables external to the test. Becuase iLearn is an adaptive program, student test scores support their strengths and weaknesses to provide next steps based on a criterion-based cumulative data.

Table 4

2016-17 GMAS EOG Mathematics Scale Score Ranges by Grade

Grade	Beginning (B)	Developing (D)	Proficient (P)	Distinguished (DI)
Grade 6	285 to 474	475 to 524	525 to 579	580 to 700
Grade 7	265 to 474	475 to 524	525 to 579	580 to 740
Grade 8	275 to 474	475 to 524	525 to 578	579 to 755

Note. Georgia Department of Education, 2016.

Table 4 informed teachers, students, parents, and district stakeholders of how well students performed on their EOG mathematics assessment. The goal was to have more students scoring Proficient and Distinguished than Beginning and Developing. The iLearn scores were computed with iKnow, a program published in 2014 as an adaptive diagnostic tool that identifies students' strengths and focuses on areas of need (Collins, 2014) upon the completion of a mathematical diagnostic test. Students completed diagnostic tests given prior to level placement. As students progressed, they continued to take diagnostic benchmarks to ensure they were placed in their proper learning level. According to iLearn, the iKnow Assessment System established validity and reliability through a systematic approach. This allowed iLearn to streamline similar test scores making the program valid and reliable (Collins, 2014).

Table 4 breaks down scaled score ranges by grade for the 2016-17 testing period. The score ranges were similar with the exception of the proficient score range for Grade 8 as well as the Beginning Level entry scores. The state provides numerical scale score ranges as well as the levels listed so teachers, students, parents, and stakeholders have a better understanding of scores.

The mathematics achievement was measured using the 2016-17 EOG mathematics scale score ranges. The scale scores were calculated using standardized mathematics assessment scores prior to the implementation of iLearn and the 2016-17 EOG. I was provided a summary of scale scores per grade level to determine the outcomes of the mathematics end-of-grade test from the school district's assessment coordinator. I was unable to attain personal student scores from the school district because it would have violated students' personal rights according to the Family Educational Rights and Privacy Act that protects the privacy of students' educational records (see Daggett, 2008). Table 4 provides a breakdown for each achievement level as the scale score ranges by grade. Additional archival data based on gender, ethnicity, SES, and iLearn use were retrieved from the school archives. Raw data that were stored with the school administrators and district assessment coordinator were obtained and used for the study.

Data Collection and Analysis

The data from these measurements were accessed through iLearn and the Georgia Department of Education. Data were retrieved after approval from the school district and the Walden Institutional Review Board (05-09-19-0372558). Data from the Georgia Department of Education were time sensitive and were made public for school districts to obtain. At the beginning of the data analysis, I calculated generic descriptive statistics (mean values and standard deviations for the continuous frequencies for the discrete variables).

To answer RQ1, I tested the relationship between iLearn scores and EOG scores by regression analysis for approximately 1,600 students in Grades 6 through 8 at the two local middle schools. iLearn scores was the predictor variable, and EOG scores was the criterion variable. After running the regression analysis, I provided the regression coefficient β▪ , its statistical significance *p* (significance level: $p < .05$), and the amount of variance explained by the regression model R^2.

To answer RQ2, I ran separate regression analyses for different subgroups (i.e., boys vs. girls, African American vs. White vs. Hispanic vs. others, and students with vs. without free or reduced lunch). To test the statistical significance of the moderating effects of gender, ethnicity, and SES, I used analysis of covariance with gender, ethnicity, and SES as categorical IVs, iLearn scores as covariate, and EOG scores as DV. Significant direct and interaction effects of the potential moderators indicated the statistical significance of the moderating effects. In addition, the effect sizes (partial η^2) indicated the practical significance of the moderators.

To answer RQ3, I used one-way analysis of variance to test the difference in mathematics achievement between students using and students not using iLearn. After running the analysis, I provided the descriptive statistics (*M* and *SD*) for the two subgroups, the degrees of freedom (*df*), the *F* value, and the error probability (*p*). If $p < .05$, the effect of using iLearn was regarded as statistically significant and the null hypothesis was rejected. All statistical calculations were completed using the software package IBM SPSS Statistics Version 25.

Assumption, Limitations, Scope and Delimitations

This study was based on several assumptions. One was that all students who participated in iLearn at school had internet access through laptops and computers. I also assumed that archival data were accurate, and that EOG and iLearn administrative procedures would remain consistent throughout the study.

For the study, there were many strengths but there were also limitations. One limitation was the result validity that was limited by implementation time of the computer assisted instructional program iLearn. iLearn informs participants that they must work at least 45 minutes a day to impact their mathematics achievement rate (Collins, 2014). However, this did not occur because there may have been problems with scheduling or natural incidents such as safety drills, student absences, or school functions that impeded students' time in iLearn. Although students had the capability to work away from school, many students did not have the means to do so. While at school, it is the norm for students to access their computers with ease but the ease of access to computers or laptops was a limitation. Teachers had to schedule times for students to work with laptops or even work in computer labs. This was inconsistent as teachers had to create a weekly working schedule to ensure all students had equitable access to work in iLearn and other computer programs. There were specific areas of the school where wireless-fidelity (wi-fi) access was limited or not working at all and this attributed to limit student access to iLearn.

During the time of the study, a new state standardized assessment, Georgia Milestones Assessment, was implemented which was also a limitation of the study. The state and school districts had limited access to how questions would be asked and this may have an impact on how successful the new assessment would be for schools and their school districts. Effective instructional strategies would have to be supported at a higher rate to ensure students would not only do well in their content classes but on the state standardized assessment as well. This would lead to more professional developmental sessions for the teachers to strengthen their instructional strategies as well as effectively use iLearn to reduce the achievement gap in mathematics. The schools' parental involvement served as possible limitations of the study as well. As a Title I school, we were required by our district to host meetings quarterly to inform parents and the community of various events going on within the school. Despite having various informative meetings that were open to parents and stakeholders, there was little to no participation from parents. Unfortunately, low parental involvement was a limitation which solely put the responsibility on teachers to ensure students were provided effective instruction.

Another limitation that was considered was that the two urban schools were quite diverse and may or may not reflect the progress of the general population of American middle school aged students. Student progress, or lack there-of, may have impacted the outcome of the study with respect to student performance on iLearn and GMAS testing. Although student progress may have been made, it may have impacted how well students performed on their new, End-of-Grade Mathematics Assessment which was given during the 2016-17 school year.

The scope of the study focused on students who did or did not use iLearn to support an increase in mathematics achievement in grades 6 through 8. The scope of the study was delimited to 2016-2017, 6^{th} through 8^{th} grade students at both schools with a total population of close to 1,600 students. The study was delimited to these students who completed the iLearn and EOG test during the 2016-17 school year.

Protection of Participants' Rights

The Federal Government Department of Health and Human Services (2016) regulation 45CFR § 7246.10 ensured that research participants were treated fairly and ethical. As the researcher, I upheld participant personal rights and respected their privacy throughout the study. I obtained the Walden IRB approval (05-09-19-0372558) as well as the school district's superintendent approval for this study. I adhered to all ethical standards set forth as a Walden doctoral student and no names were retrieved, data was not individualized before I received them. The study was performed with established boundaries set by Walden University. As the researcher and facilitator of the program, I took every necessary precaution to protect the participants of the study.

I obtained data which was stored on a private, password protected, personal computer and an encrypted, school district owned hard drive. This data will be stored for up to five years. The data shall be deleted after five years of being housed with the school administrators and District Assessment Coordinators. I honored the confidentiality of the archival data.

Data Analysis Results

For the study, I analyzed archival data stemming from iLearn and EOG scores during the 2016-17 school year. These data were obtained from the District Assessment Coordinator and Principals of the two local middle schools. Data that were obtained was stored on a private, password protected, personal computer and an encrypted, school district owned hard drive. These archival data were analyzed using the software package IBM SPSS Statistics version 25.

Table 5

Descriptive Statistics for the Criterion and Predictor Variables

Variable	*Min*	*Max*	*M*	*SD*
iLearn	0	3	.38	.723
EOG	0	3	1.82	.635

Note. N = 1,559.

Generic Results

The descriptive statistics showed that students scored on average .38 points (*SD* = .723) at iLearn, and 1.82 points (*SD* = .635) on their EOG. Table 5 displays the minimum and maximum values, mean, and standard deviation. There were a total of 1,559 students who took the EOG and iLearn during the 2016-17 school year. Although the mean scores were different, the SD was within a very similar range for the two schools.

End-of-Grade Test Scores Prediction (RQ1)

To answer RQ1, whether the iLearn scores (IV) predicted GMAS scores (DV), I used regression analysis, resulting in $\beta = -.461$, $p = .000$ and $R^2 = .213$. This showed that the iLearn scores significantly and negatively predict GMAS scores in Grades 6 through 8 at the research site, explaining over 20% of the variance in the DV. This result supported the alternative hypothesis (H_{1A}).

Moderating Effects of Gender, Ethnicity, and SES (RQ2)

To answer RQ2 as to what extent does gender, ethnicity and socioeconomic status moderate the relationship between iLearn scores and end-of grade scores for 6th through 8th grade students, I first conducted separate regression analyses for gender, ethnicity and socioeconomic status subgroups. With respect to *gender*, I found that iLearn scores predicted the EOG scores more accurately for girls (β = -.657, p = .000 and R^2 = .432) than for boys (β = -.511, p = .000 and R^2 = .261), meaning that the regression coefficient was greater and the amount of explained variance higher. With respect to *ethnicity*, the prediction was more accurate for African American students (β = -.613, p = .000 and R^2 = .376) than for Hispanic students (the regression was non-significant with β = -.051, p = .475 and R^2 = .003). Due to the small number of White and Multi-Racial students, data could not be analyzed therefore this particular subgroup was not a moderating factor. With respect to *socio-economic status*, for students with free or reduced lunch the prediction was more accurate (β = -.619, p = .000 and R^2 = .383) than for students with no free or reduced lunch (β = -.258, p = .000 and R^2 = .066). An overview of the regression results for separate participants' subgroups is provided in Table 6.

Table 6

Regression Results for Separate Participant Subgroups

	β	p	R^2
Gender			
• Boys	-.511	.000	.261
• Girls	-.657	.000	.320
Ethnicity			
• African American	-.613	.000	.376
• White*			
• Hispanic	-.051	.000	.003
• Multiracial*			
SES			
• Free or reduced lunch	-.407	.000	.383
• No free or reduced lunch	-.398	.000	.066

Note. * The regression could not be calculated because of insufficient subsamples.

Table 6 provides regression analysis results for gender, ethnicity and SES. Each subgroup supplies the correlation coefficient (*β*), the significance (*p*), and the regression model (R^2). The best way to read the correlation coefficient (*β*) is to consider the absolute value (positive) of the number. The closer the number is to 1 the stronger the correlation. These differences in the prediction accuracy strongly suggest a moderating effect of gender, ethnicity and SES on the relationship between iLearn and GMAS scores.

To calculate the statistical significance of this moderating effect, I conducted an analysis of covariance (ANCOVA) with gender, ethnicity and SES as categorical IVs, GMAS scores as DV, and iLearn scores a covariate. The main effects of the IVs and covariate were significant for ethnicity ($df = 3$, $F = 3.125$, $p = .025$, partial $\eta^2 = .006$), SES ($df = 1$, $F = 4.606$, $p = .032$, partial $\eta^2 = .003$) and the iLearn scores ($df = 1$, $F = 552.867$, $p = .000$, partial $\eta^2 = .261$), and non-significant for gender ($df = 1$, $F = .008$, $p = .927$, partial $\eta^2 = .000$). The interaction effects of the ANCOVA were non-significant for gender x ethnicity ($df = 3$, $F = 1.782$, $p = .149$, partial $\eta^2 =.003$), gender x SES ($df = 1$, $F = .469$, $p = .494$, partial $\eta^2 = .000$) and gender x ethnicity x SES ($df = 2$, $F = .225$, $p = .799$, partial $\eta^2 = .000$) but significant for ethnicity x SES ($df = 3$, $F = 3.367$, $p = .018$, partial $\eta^2 = .006$). It follows that, while ethnicity and SES have significant direct effects on the EOG scorers, they are significant moderators of the relationship between iLearn and EOG scores only in combination with each other. This means that EOG scores are better predicted by the iLearn scores for African American students with free or reduced lunch than for other ethnicities without free or reduced lunch. However, due to very small effect sizes (partial $\eta^2 < .01$ for all three effects), this moderating effect can be disregarded in the educational practice.

Differences in End-of-Grade Test Scores (RQ3)

I used analysis of variance (one-way ANOVA) to determine the difference in mathematics achievement in GMAS between students using vs. not using iLearn. The test result was significant with $df = 1$, $F(1,1) = 35.382$, $p = .000$, partial $\eta^2 = .022$, meaning that iLearn participants had higher GMAS scores ($n_1 = 1559$, $M = 1.824$, $SD = .635$) than non-participants ($n_2 = 21$, $M = 1.000$, $SD = .000$) with a small to medium effect size.

Summary and Discussion of Findings

The purpose of this study was to determine the effectiveness of iLearn as a formative assessment in terms of prediction accuracy in middle school mathematics. According to the statistical analysis results, iLearn proved to be an accurate predictor of mathematical achievement on EOG, explaining over 20% of the variance in the mathematics achievement. For particular subgroups, the prediction was even more accurate; over 30% for girls, and nearly 40% for African American students, and for students with free or reduced lunch. However, the moderating effects of gender, ethnicity and SES on the prediction accuracy were either statistically non-significant or very small, so that they could be disregarded. Therefore, it appeared that iLearn can be successfully used as a formative assessment tool in school practice. Moreover, there was no statistical evidence for an application of this assessment tool that would be biased with respect to gender, ethnicity or SES.

A somewhat surprising result worth discussing was the negative correlation between the two scores. I understand this in the sense of the formative assessment as described in the theoretical section (Beatty & Gerace, 2009; Black & Wiliam, 1998; Black & Wiliam, 2005; Black & Wiliam, 2009; Bloom, 1968; Broadfoot et al., 1999; Kahl, 2005; Knowles, 1984; Lee et al., 2011; Sadler, 1989; Scriven, 1967; Shute & Kim, 2014; Wiliam, 2011). A low iLearn score may work as a negative feedback for the students, revealing to teachers and parents that some students are at risk of failing the year. In consequence, teachers may focus their instructional support on these at-risk students (Allensworth & Eaton, 2005; Allensworth & Eaton, 2007; Darling-Hammond, 2016; Evans, 2013; Frazelle & Nagel, 2015; He, 2014; Ikwumelu et al., 2015; Kahu, 2013; Krumm et al., 2014; Lipnevich et al., 2013; McMillan et al., 2013; Parsons et al., 2013; Parsons & Vaughn, 2014; Westwood, 2013). Students need additional skills other than achievement test in order to succeed (Allensworth & Eaton, 2005). This delves from a stronger instructional approach from teachers to parents assisting their children in attaining a quality education. Test scores are important measures of student success but they need support from teachers and parents to raise their level of success. At-risk students are in need of constant and consistent feedback (Evans, 2013). Feedback provides at-risk students with a form of support that they can build upon to strengthen their academic skills. Intentional or unintentional feedback plays an important part in molding their learning futures. Early warning systems inform teachers of problems students may have when it comes to implementing computer assisted instructional tools

(Frazelle & Nagel, 2015). When teachers are aware of student deficits, they are able to work directly to minimize the problem.

Students have to invest in themselves to direct their learning (Aliponga et al., 2015; Conradie, 2014; Knowles, 1975; Ramos et al., 2013; Wijayanti & Sukamto, 2017; Worapun et al., 2017). There's a positive correlation between self-direct learning and academic performance (Conradie, 2014). When students are forced to support their self-directed learning, they have a higher academic performance than they would have with a teacher providing direct instruction. The role of the teacher is motivate students to become stronger self-regulated and self-directed learners (Knowles, 1975). Teachers have to be role models of self-directed learning so students would be able to solve social problems that occur in and outside of school (Worapun et al., 2017) Student's gender also play a role in how well they direct their learning (Ramos et al., 2013). Depending on the subject area and age, each gender displays unique traits in being strong self-directed learners.

Students' parents may also support them more in their effort in learning (Boud, 2013; Kulkarni et al., 2013; Taras, 2015). As children mature, they become more independent in their learning but their foundational learning skills stem from their daily lessons at home (Boud, 2013) When students are able to formulize their learning based on past experiences and their parent's ability to teach them life skills, they become self-sufficient learners and transition well academically. Students have a greater sense of self-assessment to strive for success (Kulkarni et al, 2013). Students become confident in their ability to learn on their own and it helps them to reflect on gaps in their understanding. This leads to resourceful teaching and makes learning easier for students.

Parents can even put their child under pressure to learn more (Andrande & Du, 2005; Belanger et al., 2015; Collins, 2014; Ćukušić et al., 2014; Efklides, 2011; Goodrich, 1997; Jonsson & Svingby, 2007; Kulkarni et al., 2013; Panadero et al., 2012; Panadero & Romero, 2014; Reddy & Andrade, 2010; Schafer et al., 2001; Wesolowski et al., 2016). Oftentimes, teachers provide students with rubrics to guide their understanding of a particular subject. Parents can use this rubric to assist their children in reaching the highest amount of points possible by providing them with their own exemplar or force the child to research the best ways to complete their work with the rubric in mind. This also leads to feedback as many students benefit from effective feedback (Andrade & Du, 2005). Parents can provide feedback as well as teachers to guide students to success. The use of rubrics or guided work raises the expectations for students to learn (Efklides, 2011). Effective feedback from parents and teachers promotes self-regulated learning students are able to grow from (Panadero & Romero, 2014). Although there may be some pressure with the use of rubrics, students have positive perceptions of the work they are to complete.

The fact that the iLearn participation was voluntary suggests that students, their parents, and their teachers were motivated to assess the academic achievement and to their best to increase it whenever necessary. Eventually, the increased effort will result in increased academic achievement.

Altogether, the study results were very encouraging for the two local middle schools. Learning and achievement related early-warning systems used as formative assessment tools (Aguilar et al., 2014;; Carl et al., 2013; Franzell et al., 2015; Heppen & Therriault, 2008; Johnson & Semmlroth, 2010; Kahu, 2013; Krum et al., 2014; Walsh, 2016) indeed seem to increase academic performance. Initially, there was pushback from students as the new early-warning system and formative assessment tool, iLearn, provided a unique form of feedback to students that they were not accustomed to. Despite this pushback, students were successful with the early warning system, iLearn that served as a formative assessment tool (Aguilar et al., 2014). Early warning systems like iLearn provide valid data to support student learning and can be tailored to address each student's individual needs (Heppen & Therriault, 2008). As a formative assessment tool, iLearn may possibly predict student success (Johnson & Semmlroth, 2010) in their mathematics course or even their end-of-grade standardized assessment in mathematics. In consequence, early warning systems may be increasingly used in middle schools, which implies that teachers should become familiar with them, learn how to use them and discover which results they can expect under which circumstances. Therefore, the project proposed in the next section is a professional development concept for teachers who may use iLearn in the classroom.

Section 3: The Project

This study was conducted to be used for professional development purposes. Outcomes from the study will be used as a deliverable to conduct effective professional developmental sessions and to promote the effectiveness of iLearn as a formative assessment tool in middle school Grades 6-8 mathematics. Outcomes from this study may not only guide future professional development trainings but may also improve two local middle schools' achievement rates in mathematics using the CAI tool iLearn, as well as advance teacher proficiency in teaching math. Teachers, who are the target audience, will be provided professional development based on the study. If teachers implement what is offered during the sessions in their daily instructional practices, professional development will support iLearn. If not, then the professional development sessions will be revisited in the future. The goal of this study was to examine the effectiveness of iLearn in closing the achievement gap for mathematics students in Grades 6 through 8.

Future professional development sessions may help teachers improve instruction to support student learning. Teachers may have a better understanding of the mastery learning theory model proposed by Bloom (1968) in that concepts are taught and taught again until a level of mastery has been achieved by the students. Once students are able to achieve an in-depth understanding of a concept, they are able to use that understanding to support or apply to other concepts for their knowledge. Teachers may be able to use formative assessments and early warning systems more effectively to strengthen their instructional practices as they use CAI tools like iLearn to meet the needs of their students. Students may then be able to self-direct and self-assess their learning using a rubric or software such as iLearn to support mastery learning.

Rationale

The purpose of this project study was to develop professional development sessions for teachers that will enable them to better understand iLearn and how to use it effectively. Teachers may have a better understanding of the mastery learning model, formative assessments, and early warning systems to address student academic needs. Students may then be able to self-assess and self-direct their learning to master mathematical concepts. Teachers, administrators, and district stakeholders may have a better understanding of what to do or not to do to use iLearn effectively for their students. Although this was the first year of implementation at the local level, this study may support iLearn implementation based on other users nationwide.

During the professional development, teachers will be provided at least 3 full days of training to learn how to use iLearn. Each day will consist of intensive training so teachers will have a better understanding of iLearn and ways to implement its instructional practices in their daily mathematics lessons. Teachers will need their laptops, current curriculum standards, and access to iLearn during the professional development sessions. These 3-day sessions will be implemented quarterly to ensure teachers have a clear understanding of how iLearn works and ways to improve their instructional practices. On the third day of each quarterly session, teachers will complete in-depth surveys so the facilitator will be able to address teacher concerns and new ways to support their instructional practices and use of iLearn. The math teachers will be required to attend the professional development sessions, and their participation will be evaluated on their annual evaluations. Once EOG tests have been completed, teachers will analyze data to determine if professional development was beneficial in strengthening their instructional practices and supporting the mastery learning model for their students. This will also allow teachers and administrators to determine how they will have future professional development sessions.

Table 7 displays a breakdown of the 3-day professional development for teachers to attend throughout the course of the school year. This is a sample of the of 3-day sessions. Each day allows teachers to work with one another to improve their instructional practices and to clarify misconceptions about using iLearn.

Table 7

Sample of 3-day Professional Development sessions

Day 1	Day 2	Day 3
8am-9:15am	8am-9:00am	8am-9:00am
Breakfast	Breakfast	Breakfast
Introduction	Review of Norms	Review of Norms
Norms	Analyze Best Practices	
Analyze Pre-Data		
Discuss possible impact on instruction		
9:15-9:30am	9:00-10:30am	9:00-11:00am
Break		

	Use iLearn to see practices used in program	Work with students in iLearn
9:30-11:00am	10:30-11:00am	11:00am-12pm
Analyze student data individually/teams Discuss ways to reduce deficit	Recap of 1.5 days	Lunch
11:00am-12:00pm	11:00am-12:00pm	12:00-1:00pm
Lunch	Lunch	Review students work in iLearn Determine best practices to use in class
12:00pm-1:00pm	12:00pm-1:00pm	1:00-2:15pm
Discuss ways to reduce deficit	Analyze teacher work by learning activities of teacher's instructional methods	Model Best Practices
1-2:15pm	1:00-2:15pm	2:15pm
Model best teaching practices by developing higher order thinking questions, feedback,	Analyze team work Summarize today's work	Summarize PD Adjorn

question stems, mnemonics and visuals		
2:15 pm Adjourn	2:15 pm Adjourn	

This study will also support future professional development sessions for teachers to analyze EOG mathematics scores. Findings from this study may support a local need for future research on the impact of CAI tools such as iLearn. When formative assessments such as iLearn are effective, they communicate to students that success is a goal and teachers are able to make instructional adjustments. Because mathematics scores indicated a large gap in achievement in prior years, all students will be required to participate in iLearn as a means to assist in closing the achievement gap for the initial study. These same students will participate in the annual standardized EOG assessment in mathematics to determine whether there was a positive correlation between iLearn and EOG mathematics scores. Results of this study may guide future professional development and provide administrators and teachers with empirical evidence on the effectiveness of iLearn as a formative assessment tool in middle-grade mathematics. Teachers may be able to determine specific professional needs to be met in the future with the results of the study.

Garet, Porter, Desimone, Birman, and Yoon (2001) reported there were three components of professional development that have been successful in the past. Garet et al. suggested there had to be a unique form of activities to keep teachers interested and to implement effective instructional strategies for their students. Professional development attempts are best used over time, meaning a few sessions may not support teachers' learning opportunities. The sessions will have to be provided often for teachers to feel supported and to implement what was taught to them.

Rationale

For this study, I chose professional development to promote teacher implementation of effective mathematics instructional strategies. According to Aldosemani (2019), professional development sessions will advance the pedagogy of teachers and their knowledge. Professional development sessions have to be provided over a period of time because one day of professional development is ineffective in strengthening teachers' instructional practices (Aldosemani, 2019). Professional development is an important investment for teachers as a way to improve their instructional strategies to increase students' learning. Because technology is a major factor in education, it is important for teachers to know how to integrate technology successfully, and professional development will make this transition easy for teachers (Aldosemani, 2019). Not only will teachers benefit from professional development sessions as a way to support student learning, but professional development will also promote students' self-directed learning skills.

For professional development sessions to be successful, they must occur over a period of time (Coenders & Verhoef, 2019). Professional development cannot be done in one setting. Teachers have to be actively involved with a focus on the students' weaknesses. There also has to be coherence between what is being taught by teachers and learned by the students for professional development sessions to be effective. As teachers become more aware of the problems students face while using iLearn, they will have a better approach to teach effective learning strategies to lead students to success in mathematics. There is a great need for professional development because iLearn is being used for the first time at the two local middle schools. This professional development about use of iLearn and methods to improve mathematics instruction may support teachers in reducing the mathematics achievement gap for students in Grades 6 through 8. In the following section, a review of the literature provides themes associated with the study.

Review of the Literature

The literature review was conducted to locate peer-reviewed, scholarly articles published within 5 years of the study's expected completion date. Although some of the studies were published outside of the 5-year period, those studies were connected to recent studies. Databases used to complete the literature review were ERIC, ProQuest, EBSCO, and Education Research Complete. The search terms used were *blended learning, educational technology*, *computer adaptive tests*, *middle school math instruction*, and *effective professional development*. Each search term serves as a topic heading in the literature review.

Blended Learning

Blended learning is a newer form of learning that occurs when there is a mixture of the traditional classroom setting, with teacher-led instruction, and digital technology on a daily basis (Delgado, Wardlow, McKnight, & O'Malley, 2015). Due to the daily changes teachers face with technology, Delgado et al. (2015) addressed the paradigm shift in implementing technology into schools. Technology has influenced people's daily lives in how they obtain information. Educational technology has evolved, and Delgado et al. (2015) were able to provide research that supported the advantages and disadvantages of technology in schools to support a rapidly changing shift of student learning. With the implementation of technology, blended learning has become a common classroom setting to support instructional strategies. This form of learning strengthens students' understanding of educational concepts that should be mastered prior to progressing to the next grade or graduating from high school. Blended learning is a way to connect students with other students outside of their geographical domain (Stein & Graham, 2020). Stein and Graham (2020) focused on developing a relevant and effective way to blend online and face-to-face learning for teachers. Stein and Graham (2020) wanted to create a streamlined approach for teachers and staff development trainers to have a better understanding of blended learning. Stein and Graham (2020) found that blended learning increases students' access to technology, improves their learning, and decreases cost to stakeholders. Students benefit from blended learning because they have individualized learning opportunities and more time on tasks to master their learning. Stein and Graham (2020) also discovered that blended courses effectively mix synchronous and asynchronous activities. Synchronous activities such as video conferences or instant messaging are done in real time. Asynchronous activities such as email or discussion forums allow students to communicate on their own time. Mixing these two sets of tools makes for an effective blended learning setting. Administrators and teachers will also benefit from Stein and Graham's (2020) study because it will ease the burden of creating resources on their own.

Technology is a vital part of people's daily lives and is present in a blended learning classroom. With the changing demands teachers face to implement new and innovative ways to provide effective instructional strategies, blended learning allows teachers to use traditional measures with the help of technology to support student learning (Anders, 2018). Teachers utilize CAI tools and provide traditional instructional methods as a means to meet students' academic needs. Blended learning is a rather unique attempt to promote learning, and there have been recent and past studies conducted that had mixed results for a blended learning classroom in terms of success (Bernard et al., 2004; Davis, 2006; Hokanson & Hooper, 2004; Ma'arop & Embi, 2016; Simonson, 1996; Stockwell, Stockwell, Cennamo, & Jiang, 2015; Wang, Han, & Yang, 2015). These studies informed the professional development.

A meta-analysis study that spanned from 1985 to 2002 was conducted to compare the various forms of blended learning in education (Bernard et al., 2004). They considered blended learning as the combination of computers and teachers to carry out the content of a course in a non-traditional setting. They compared traditional teaching and blended learning to see which one was more beneficial for students. After studying close to 15,000 participants, the researchers discovered that there was a mix of results supporting traditional teaching and blended learning. During their study, there were two groups that were the focus to determine which learning setting was best (Bernard et al., 2004). There were those students who only learned in a blended learning setting and the other half were students who participated in the traditional learning setting. Findings from their study show that students who participated in a blended learning setting outperformed the traditional instructional group by 50%. There was also evidence in which those students in the traditional setting outperformed blended learning by 48% or more due to their attitudes toward learning.

This study also discusses the difference between synchronous and asynchronous learning (Bernard et al., 2004) and how it had an effect on the outcome of the study. Synchronous learning occurs when learning takes place in real time such as video chats or instant messaging. Students learn at their own pace and work together with their classmates to achieve their learning goals. Although learning occurs in a non-traditional setting, learning is in sync. On the other hand, asynchronous learning occurs in the traditional setting when students have a personal relationship with their instructor or peers. Overall, synchronous learning favored traditional learning while asynchronous learning favored students in the blended learning setting.

Davis (2006) developed a study that focused on the role of technology in the classroom and how blended learning can be effective for teachers. He determined that the role of technology can be positive for teachers who understand the pedagogy behind it. Once teachers understand the role blended learning plays in their instruction, then their students are successful in linking what they've learned in class and online together. This deepens students' understanding of their content that they would in the past only get from their teacher.

Stockwell, Stockwell, Cennamo, & Jiang (2015) conducted a study on the effects of blended learning. They understood that there was a paradigm shift in how blended learning was being used in schools and wanted to delve deeper in determining the effectiveness of blended learning. In their study, they considered blended learning to be an emerging instructional pedagogy. This meant that the resources that could be provided in a blended learning setting could supplement or replace the traditional lecture or textbook approach to learning. As a result, they determined that blended teaching and learning which consisted of video assignments and pre-lectures to pique the interest of students, was an effective strategy compared with traditional approaches. Although video assignments did not improve student assessment scores, they did increase attendance and student satisfaction of the course.

Researchers Wang, Han, & Yang (2015) developed a study on the impact blended learning had on education. At the time of the study, blended learning was considered an up and coming educational trend to support student learning in a non-traditional setting. Their study focused on how blended learning had an impact on the learner and the teacher. Students' learning performance and satisfaction rates improved with blended learning. They were afforded a flexible approach to learning that past students have not have. Although students were held accountable for learning in their classrooms, the implementation of blended learning raised their level of accountability to a higher standard than in the past. Teacher's role in the blended learning setting transformed as they were traditionally the initiator of knowledge to a facilitator and promoter of learning. Therefore, students and teachers benefit from blended learning.

Blended learning requires careful preparation. According to Simonson (1996), blended learning classrooms are up and coming but learning practitioners should not heavily promote this new form of learning as the answer to education's problems. Educators should strive to make learning experiences equivalent with the use of consistent and effective instructional practices with and without technology. So many factors have to be accounted for blended learning to be effective but there's nothing consistent to truly say it is effective (Bernard et al., 2004). There are many forms of technology to use and consider for helping to improve education but how and why technology is used is when the change occurs Hokanson and Hooper (2004) stated. With all good teaching, teachers have to revise and stick to a plan to ensure students succeed and this goes along with the use of technology to support their education. Teachers should not minimize their instructional strategies to utilize technology therefore both should be used equally to support one another (Davis, 2006).

African-American and other minority students in K-12 online learning have displayed significantly lower standardized test scores in mathematics overall than White students with respect to blended learning (Dziuban et al., 2018). Students who lack in computer and internet skills suffer from blended learning (Kintu, Zhu, & Kagambe, 2017). These same students have external and familial factors that hinder their blended learning. Despite negative factors of blended learning, there were also other studies that supported blended learning and its positive impact on education.

Some studies supported the use of blended learning. For example, Wang et al. (2015) stated that this unique learning setting is complex, adaptive, and co-evolving but it has proven to be effective. It was stated that if the teacher is heavily involved in the blended learning setting as a facilitator and promoter of learning then blended learning will be effective. Despite blended learning being complex, students and teachers are able to adapt to the environment with the proper learning support and professional development. Blended learning provides a flexible approach to learning and increases student's accessibility to work with sources they would not typically have in a traditional classroom (Boelens, Voet, & De Wever, 2018). Not only does blended learning allow students to learn at their own pace but it caters to each students' individual needs to achieve real instruction. Researchers Ma'arop and Embi (2016) found that in order for blended learning to be successful, there are several factors that must be in place. The authors suggested the following: (a) consistent and continuous training for teachers to utilize blended learning effectively, (b) teachers have to be willing to consistently adapt and change daily based on student needs. Given that technology makes up a portion of the blended learning setting, there has to be a support system and back-up plan in the case of a technical error. Blended learning is a cumulative mixture of online learning, organized face-to-face and real-world practices to broaden students' knowledge (Kristanto, Mustaji, & Mariono 2017). Therefore, there is past and current research that supports the concept of blended learning that can be effective. A suitable model is needed for each school to follow based on their needs.

Educational Technology

Educational technology has been around for over 40 years as a way to connect students to education outside of the classroom with the assistance of computers and computer programs (Delgado et al., 2015). It is often referred to as computer assisted instruction, games, or computer soft/hardware. All of these terms are relevant as educational technology has increased and evolved over the years. Studies provide supportive evidence that educational technology is effective as well as ineffective (Angeli et al., 2017). A few research-based strategies that have proven effective state that the computer to student ratio plays a large factor with effective educational technology. The lower the ratio of student to computer, the more effective instructional technology is. Preferably, 1:1 ratio is ideal to see a positive effect of instructional technology (Delgado et al., 2015). Schools and school districts must invest time and money into educational technology for it to be successful (Rashid & Asghar, 2016). The use of educational technology has a direct and positive effect on students and their ability to self-regulate and self-direct their learning. Educational technology facilitates learning rather than controlling it (Ipek, & Ziatdinov, 2017). The use of educational technology has had a positive impact on the intellectual development of students as well as their career preparation. It also promoted reading and writing skills to strengthen students' information-processing skills.

On the other end, educational technology has been proven ineffective. Educational technology does not guarantee closure to an academic achievement gap. If school districts are not willing to dedicate time and resources to implement educational technology effectively, then they must redirect their resources elsewhere (Rashid & Asghar, 2016). Educational technology cannot be used to eliminate teachers but to enhance a student's education. If teachers do not support educational technology, then it is ineffective. Educational technology and teaching have to come together to increase student achievement. Sana, Weston, and Cepeda (2013) stated that technology in classrooms has had a negative effect on students' performance on comprehension tests. They wanted to study the effects of blended learning as they noticed that students who multi-tasked their learning with technology were unable to perform as well as those individuals who did not multi-task. These researchers derived this conclusion as their study had evidence that students were unable to multi-task while learning online or with technology therefore technology in those cases was ineffective in the classroom.

Students have to be provided instruction that is rigorous and deepens their understanding of conceptual knowledge. Other factors that were considered an ineffective use of educational technology is when the concepts students are to master are too ambiguous or extremely difficult (Spencer, 2017). This deters students from learning and has a negative impact on student success. Educators may pose a threat to student learning as well. If educators do not understand or do not want to utilize computer assisted instructional programs to support student learning, students are unable to master their learning and are negatively impacted (Alenezi, 2019). This impact has proven to be ineffective in implementing and supporting the use of educational technology. Overall, there are mixed perceptions and data that support the use of educational technology in classrooms.

Computer Adaptive Tests

As technology has improved and changed since the 1970's, Computer Adaptive Tests (CAT) have evolved as they adapt instruction based on student answers (Clemens et al., 2015; Larson & Madsen, 2013; Martin & Lazendic, 2018; Rezaie & Golshan, 2015). In 1985, the first CAT was created by Larson and Madsen (2013) at Brigham Young University, in the United States of America. CAT automatically adjust how questions were presented based on the student's estimated instructional level or accuracy on previous items (Clemens et al, 2015). CAT provide customized items that are designed to fit each student's aptitude and cognitive status (Huey-Min, Bor-Chen, & Su-Chen, 2017). If a student answers a question correctly, the test then provides a more complex question. If a student answers a question incorrectly, the test generates a question that lacks the rigor to ensure they get the next question correct. Over the course of the test, specific questions are generated that are aligned with their academic performance at the time. This CAT process generates data that teachers can use to provide a streamlined approach to closing achievement gaps in deficit areas.

As technology progresses and computer assisted tests are used to determine student's academic strengths and weaknesses, there are many advantages of CAT. The rationale behind CAT is to provide adaptive tests that are not too vague or too easy for each student who takes the tests (Aybek & Demirtasli, 2017). Questions are provided based on each student' responses. These tests have been used to help improve student success in all content areas in school. Students become familiar with the standardization of test administration conditions and are able to adjust quickly when taking computer adaptive tests (Rezaie & Golshan, 2015). These tests are also cost efficient as way to implement more programs into the school setting (Clemens et al., 2015). CAT also minimize the use of paper and data can be stored easily within the program. This is a unique form of differentiation as each test is specific to each student's needs. Feedback is quickly provided to students, which leads to a higher form of self-regulation and self-directed learning (Martin & Lazendic, 2018). CAT identify student error patterns and address mistakes quickly.

Although there are quite a few advantages, there are also disadvantages to computer adaptive tests and technology. Cost for computer adaptive tests are initially high and under-sourced schools or school districts may be unable to purchase them (Clemens et al., 2015). Additionally, instances have occurred when results were not met due to the lack of computers for students to use. A concern is that some students simply lack the self-regulatory skills to benefit from computer assisted technology and they are often unsuccessful. Another disadvantage of CAT is that students are unable to review answers or change them to better understand their misconceptions (Dascula et al., 2017). This limits students' opportunities to correct mistakes, so they won't make them in the future. Some CAT may not be able to provide a plethora of learning styles or questions which hinders students from learning (Chrysafiadi, Troussas, & Virvou, 2018). Other factors such as testing anxiety, the lack of human interaction and reading skills have an impact on students being unable to truly benefit from computer adaptive tests. Research also supports the idea that each program has a different cutoff score and this may vary depending on the program (Rezaie & Golshan, 2015). If a test is created to identify multiple traits at once, then a computer adaptive test may not always be sufficient in providing data that supports students' needs. Overall, computer adaptive tests are beneficial to reducing student achievement gaps in school however schools and school districts must be made aware of the various factors that may support or impede student progress while using the program.

Middle School Mathematics Instruction

Mathematics instruction at the middle school level is quite different than that of elementary and high school. Elementary mathematics instruction provides base knowledge for students to strengthen in middle school. The rigor increases as students' base knowledge increases. Mathematics instruction at the middle school level has an increased level of rigor and a streamlined focus in algebraic concepts in which some may consider to be an extension of skills learned in elementary schools (Montague & Jitendra, 2018). Students in middle school are expected to be self-directed and independent learners who are able to comprehend what they are learning and can connect to what they have previously learned (Brahier, 2020). Students at the middle school level have a great sense of accountability on them that they did not have in elementary school. They have to complete accurate homework, ask questions, understand how to take assessments and be able to work cooperatively with peers to gain a deeper understanding of concepts. Middle school teachers have a higher content knowledge of mathematics than those teachers at the elementary level.

Middle school mathematics instruction provides students with a deep consolidated understanding of mathematical concepts that allows them to further expand the depth of their understanding of secondary mathematics (Younger, 2018). At the middle school level, students' higher order thinking level as this is a critical time where they convey what is acceptable as evidence in mathematics (Piccolo et al., 2008). Middle school mathematics instruction allows teachers to further elicit student responses, stimulate their productive thinking, and extend the lines of conceptual thought.

Effective Professional Development

Professional development (PD) allows educators an opportunity to grow and improve their instructional strategies. Effective professional development should be structured to challenge and change teacher knowledge and instructional practices to improve in student learning outcomes (Darling-Hammond, Hyler, & Gardner, 2017). Effective professional development occurs over time and is not a one-time event. Longer periods of training have been proven to be effective and necessary for teachers to expand their beliefs and professional knowledge (Kalinowski, Gronostaj, & Vock, 2019). This also allows teachers to create well-established classroom routines. Successful professional development is closely related to the individual teacher's practice which includes timely feedback. The more professional development teachers attend and can successfully implement into their daily instructional practices, the better they will become in addressing various student learning styles at once. This gives teachers a stronger sense of differentiating their lessons. Effective PD then leads into professional communities which allows teachers to work with other teachers to enhance their instructional practices.

Working in teams can also lead into effective professional development (Gast, Schildkamp, & van der Veen, 2017). Participating in a collaborative team creates commitment and reduces resistance to organizational change as each individual brings their expertise to the table (Gast, Schildkamp, & van der Veen, 2017). Successful and effective professional development activities have an impact on teachers' knowledge and skills, as well as their attitudes.

Effective professional development needs to focus on students and what they need to know and be able to do. Practices from professional development have to be embedded into teachers' daily instructions and teachers have to be intentional in how they implement what they've learned in professional development (Wilkinson et al., 2016). As teachers participate in professional development, they are able to combine phases of input, then implement new knowledge in the classroom, and periods of reflection on the new practices. The implementation of effective professional development and collaborative teams leads to a change in teaching practices, new teaching knowledge, and changes teachers' attitudes.

Project Description

This study is for professional development for teachers and administrators is an attempt to demonstrate how to help improve mathematics progress as well as reduce the achievement gap in middle school mathematics. The first step I will take is to compile information needed to conduct professional development and present it to the (a) principals of the two schools, (b) District Assessment Coordinator and (c) the teachers of the two schools. Then, I would seek for approval to conduct the professional development sessions. During this meeting, these individuals will be provided with details of the study, its purpose and need for professional development sessions. Details would include a daily dedication of at least 45 minutes of iLearn and benchmark assessments given once students reach specific milestones within the program. Once the professional development sessions are approved, I will schedule the sessions to be held during the school year during scheduled teacher workdays. Once the professional development sessions are completed, I would meet with the teachers monthly throughout the year to see how well the teaching strategies worked. I will then continue to provide support to those teachers who need additional help.

Resources needed for the project are access to laptops with access to the internet, Promethean/Smart board, digital timer, and access to websites that allow for synchronous work such as Padlet or Google Forms, post-it notes, handouts and large easel pads. Teachers need to come to the professional development sessions with an open mindset. They must be willing to make changes to their instructional practices to support student achievement. The administrators will serve as an existing support to help ensure teachers are using strategies discovered during the professional development sessions. They will be able to observe teachers and provide effective feedback to ensure they are utilizing effective instructional practices attained during professional development. Administrators will also be able to observe student engagement as well. Another existing support is a space for professional development sessions. This space is an unoccupied classroom or computer lab that will be used for professional development. During pre-planning, which occurs during the summer months, days have been allocated to host professional development sessions. Administrators will adhere to these days to host professional development sessions. The schools also have a space allocated for computers, EOG and iLearn test materials.

Potential barriers to the project could include teachers' unwillingness to use iLearn and the implementation of professional development sessions to increase teacher's awareness of iLearn. Evidence from this study determining the effectiveness of iLearn and the future professional development sessions for teachers will be potential solutions to this barrier. ILearn or other computer assisted instructional tools can be used to reduce the achievement gap in middle school mathematics as well as support the need for continuous professional development sessions for teachers. This study will also explain how the use of the iLearn mathematics program could predict future EOG scores for all students who use the program.

The proposal for implementation of this project will include a recommendation that the two middle schools' testing coordinators and administrators implement iLearn in the future. This will help teachers to determine if iLearn will have a strong prediction correlation to the upcoming EOG. Table 8 provides the details of the proposed timeline for the PD.

Table 8

Proposed Timeline of 3-Session Professional Development

Date	Task	Persons Involved	Deliverable
July/August	Pre-Planning Meetings	Administration/Teachers/District Assessment Coordinator	Announcement of iLearn
August/September	Determine participants and analyze archival data	Researcher/Teachers/Administration	Professional Development
September	Begin iLearn	Student participants	iLearn usage and assessment data
October	1st PD	Researcher/Teachers/Administration	Usage and Assessment Data from iLearn/EOG data/Effective instructional methods and resources from teachers
December	2nd PD	Researcher/Teachers/Administration/District Assessment Coordinator	Effective instructional methods and resources from teachers and District Assessment Coordinator
January	Mid-Year check on iLearn	Researcher/Teachers/Administration	Slide show highlighting 1st half of iLearn and PD
February	3rd PD	Researcher/Teachers/Administration/District Assessment Coordinator	Usage and Assessment Data from iLearn/Effective instructional methods and resources
March	Begin to gather data to present to District	Researcher/Teachers/Administration/District Assessment Coordinator	Compilation of assessment data from iLearn and deliverables from past PD
April-June	Assess the effectiveness of iLearn and PD	Researcher/Teachers/Administration/District Assessment Coordinator	Compilation of deliverables from iLearn/PD/EOG data for District

Table 8 provides a breakdown of the implementation of ilearn, PD and deliverables throughout the school year. This timeline is what I plan to do in PD for teachers supporting iLearn and ways to increase achievement in mathematics. Administrators, Teachers and the District Assessment Coordinator will adhere to this proposed timetable to ensure iLean and PD sessions have taken place to support student learning. They will also be able to determine if implementing iLearn and professional development sessions for teachers were beneficial to reducing the mathematics achievement gap for students in grades 6 through 8. Teachers who attend the PD will evaluate the sessions with the evaluation tool they'll be provided at the end of each session. The tool will include a series of questions gauging their involvement in the sessions as well as suggestions to make the sessions beneficial for their learning. Responses from the teachers will be included in the project report to determine the effectiveness of the pd sessions.

Roles and responsibilities of the project would rely on the District Assessment Coordinator, school administrators and teachers to ensure iLearn was used effectively. Administrators have to have an open line of communication with teachers and the District Assessment Coordinator to ensure they receive effective PD during the school year to support student learning. There has to be a continued approach to ensure teachers are using iLearn daily and that teachers are trained to use the program as prescribed in the program details. Those details include a daily dedication of at least 45 minutes of iLearn and benchmark assessments given once students reach specific milestones within the program. Administrators must also provide a timeline for teachers to follow to attend professional development sessions as seen in Table 8. They also have to provide a timeline for teachers to implement iLearn into their daily instructional schedules. Teachers have to be sure to follow the program details with respect to time and usage and support it in their daily instructional practices. Students have no formal role but may need additional instructional and testing support if found to be at risk of failing prior to EOG Milestones assessments. I included more information on the evaluation plan of the project in the next section.

Project Evaluation Plan

Formative Evaluation

What is Formative Evaluation? Formative evaluation is used to promote student or teacher learning by providing feedback after instruction (Moya & Tobar, 2017). Teachers will be allowed to give their feedback on the progress they are making in the PD. I will allow them to reflect on what worked and what needed to be improved upon for future PD. Formative assessments allows teachers to reflect on effective instructional practices. Once this occurs, students will be able to adapt their learning style to the improved techniques teachers acquired in their PD sessions. At the conclusion of each PD session, I will use tickets out of the door to summarize PD on electronic platforms such as Padlet or Kahoot. I can also summarize the sessions on index cards or post it notes to review before the conclusion of the sessions. Written feedback will be discussed and analyzed to support student learning.

All formative evaluations will be included in PD presentations, facilitator notes or handouts. Teachers will provide written feedback and I will ask open ended questions during PD to gauge teacher's understanding of iLearn and effective instructional practices. Asking open ended questions will help me better understand what teachers are grasping or not grasping. It also gives me insight as how future PD sessions should be structured. At the conclusion of each session, I will be able to review teacher input to make adjustments for the next day's PD. This will allow me to gather formal and perception data that I will use to reteach or redirect their learning to achieve their learning goals.

Summative Evaluation

For this study, I will also use summative evaluation to determine how well PD sessions helped teachers support student learning with iLearn. On the first and last day of each 3-day PD, teachers will be given an assessment to track their growth. Questions are based on their ability to work with other teachers, communication and knowledge and pedagogy of the mathematics content. This approach will occur each 3-day session as the questions will vary based on the outcomes teachers desire. Teachers may find the summative evaluation beneficial as the evaluation will measure the depth of their understanding of effective instructional practices and the iLearn program. The seven questions I will ask on the summative evaluation are as follows:

1. Explain why you feel that professional development is needed?
2. What skills are needed to link classroom and iLearn instruction?
3. What are some ways we can improve the use of iLearn?
4. What are some effective strategies that you've gained or plan to gain from this professional development?

5. What are some barriers you foresee and how do you plan to overcome them?
6. What was the most useful aspect you discovered during this PD?
7. What are some recommendations you have to improve this PD?

This summative evaluation will be used to determine the effectiveness of the 3-day PD sessions. The answers teachers provide will help guide future PD sessions to strengthen their instructional strategies.

Overall Evaluation Goals

The overall goal of the outcomes-based study is to determine the effectiveness of the 3-day PD sessions as well as deepen teacher's mathematical pedagogy to support iLearn. Those teachers who participate in the PD sessions will have a better understanding of how to blend conceptual knowledge their students learn with iLearn and in their classes. The formative evaluations allow teachers to provide written feedback and answer open ended questions that lead to crucial conversations that build their confidence in supporting their students. When the teachers complete the PD, I will collect their responses as a summative evaluation to determine if the sessions were useful and could impact their instructional practices in the future.

Key Stakeholder Groups

When the outline of the 3-day PD sessions was created, I wanted to be sure that all stakeholders were included as a way to ensure each party played a role in the implementation of iLearn into the two middle schools successfully. Those stakeholders were teachers, administrators of the two middle schools and the District Assessment Coordinator. The teachers would be able to provide direct input as they are the individuals who work with students daily to see their struggles in action. The two principals understand the need for the implementation of iLearn and how it could have an impact on reducing the achievement gap that has been present for the last two years. They have a broader perspective to relay the importance to the teachers. The principals have the ability to get their teachers involved to support iLearn. The District Assessment Coordinator is able to provide a larger perspective on the importance of blended learning that the principals may not be able to offer. The District Assessment Coordinator is also able to bring outside resources that will impact PD and effective instructional strategies. All three parties play a critical role ensuring students are able to increase their mathematical knowledge from effective instructional strategies from their teachers and iLearn.

Project Implications

Social Change Implications

Teachers are the eyes and ears of a school. They are the driving force and are the change agents of all schools. Leadership plays a role in the school's culture but without teachers, no change will occur. They have a power to be agents of social change as they have an impact on student's daily lives. Their interactions, words of affirmation and nurturing persona mold students into model citizens. Although many teachers serve as change agents, many of them do not understand the power they have in encouraging their students to deepen their conceptual knowledge that they can use for the rest of their lives. This study and PD have the potential to support an increase of achievement in middle school mathematics, thus contributing to positive social change for Georgia middle school teachers and students. Through my research, I have learned that teachers' roles expand beyond their classrooms to promote school improvement, individually and as a collective group. Teacher's input from the PD sessions will give insight as to what they want to improve upon to further their instructional practices and to support various learning styles each student possesses.

The importance of the project to local stakeholders is that they will have data to support future use of iLearn for professional development to assist students with mathematical deficiencies in Grades 6^{th} through 8^{th}. This project could be used to understand the importance of PD in an attempt to strengthen teacher's instructional practices with the assistance of a CAI tool like iLearn. The district where I am employed could benefit from the study because there are six principals, one superintendent, one assistant superintendent and a district assessment coordinator who can use this project to support future PD. There are a total of six middle schools in the district that could benefit from the findings of this study that could lead to future professional development at the district level.

Importance of the Project in the Larger Context

On a larger scale, this project could have a major impact on teachers and schools nationwide. Professional development through collaboration is a key factor to student achievement (Girvan, Conneely, & Tangney, 2016) and this study supports the need for professional development to promote student learning. This study could also be used as a template for other schools and school districts to follow to implement a CAI tool like iLearn to reduce an achievement gap in mathematics. Effective PD refines teacher's pedagogies to teach mathematics and other subjects (Darling-Hammond, Hyler, & Gardner, 2017). The field of education has changed tremendously over the last 30 years; therefore teachers have to be aware of current educational trends and effective teaching strategies to reach a new generation of learners. Currently, there have not been any local studies supporting effective PD and implementing a CAI tool like iLearn therefore this study will have a local impact as well. In Section 4, I discuss the reflections and conclusions of the project study.

Section 4: Reflections and Conclusions

In this section, I share reflections and conclusions of my project study. This section includes strengths and limitations of my study and recommendations for alternative approaches, scholarship, project development, leadership, and change. I also reflect on the importance of the work and the implications, applications, and direction for future research. I conclude this section with what I learned from this study.

Project Strengths and Limitations

For this study, there were several strengths that supported my findings. Archival data from iLearn and the Georgia Department of Education were used to address my research questions to determine whether iLearn was an effective assessment tool for middle school students in Grades 6 through 8. This data included iLearn use because it had an impact on the outcome of the study. I was able to determine whether iLearn was an effective program that would increase student achievement with standardized mathematics assessments. The 2016-17 Mathematics EOG has been proven to be a valid and reliable assessment for students in Georgia. These data supported my study in determining whether iLearn was an effective assessment tool.

Although there were many strengths associated with the study, there were also limitations that had an impact on the outcome of the study. These limitations included insufficient time to examine iLearn's potential to raise the achievement rate for students in Grades 6 through 8. Also, there was an inconsistent number of participants at each school, which had a negative impact on the outcome of the study. School A had a significantly lower number of participants than School B. Another possible limitation that impacted the outcome of the study was inconsistent Wi-Fi connectivity for some laptops. This hindered usage time and may have discouraged student participation. Lack of consistent professional development for teachers was another limitation because the sessions did not occur as often as initially planned. For iLearn to have an effect on student achievement, teachers have to be aware of changes that may have occurred with the program. This tied into consistent teacher support and feedback to encourage student participation with iLearn.

Recommendations for Alternative Approaches

I would recommend that teachers adhere to usage guidelines from iLearn. The program requires students to use iLearn at least 45 minutes a day to impact their mathematics achievement rate (Collins, 2014). School administrators or teachers should schedule times to use laptops to conduct tests in a timely manner. This will allow teachers to track the use of iLearn, which will promote stronger learning habits from students. Teachers and administrators can also encourage the use of iLearn using data from other school districts to show its effectiveness as a prediction tool for passing scores on the GMAS EOG.

I also recommend that professional development sessions be provided to the teachers to ensure they are up to date with any changes that students may encounter while using iLearn. If students are confident and knowledgeable about their decisions while using iLearn, it will have a lasting impact on their confidence in completing standardized mathematics assessments in the future.

Scholarship, Project Development, and Leadership and Change

This has been a unique experience because I was able to reflect on my growth as a researcher and willingness to complete my study over time. The doctoral process has been a challenging and daunting task, but it has encouraged me to continue to have faith and appreciate achieving small milestones that lead to larger milestones. This experience has given me a new appreciation for educational research that I have grown to understand as a teacher leader. The project study required me to view educational processes through the lens of a scholar and practitioner for social change.

The use of technology has evolved, forcing many educators to adapt to using technology as a means of supporting instruction. When I began this journey, I wanted to know more about technology and its possible impact on education. I considered the misconceptions that educators face with implementing technology into their classrooms. I then formalized an idea to determine whether use of the CAI tool iLearn would predict increased mathematics standardized test scores for two schools in my district. This idea led to the research questions that were answered in my study.

From the idea of determining whether iLearn is an effective formative assessment tool to promote students' learning, I now have a deeper understanding of the impact instructional tools like iLearn can have on students in supporting their academic growth. This study was a testament to never giving up on effective educational practices that are being strengthened as educators evolve into forward thinkers. As a teacher leader and researcher, I am pleased to see that my research will have a local impact on my school district and may impact other school districts nationwide.

Reflection on the Importance of the Work

Overall, this study was important in education and instructional technology. Although the use of technology has evolved in education, there is still work to be done to understand the impact on 21st century learners. Technology is changing, and educators have to be willing to adapt to the changes that occur daily. CAI tools such as iLearn have had an impact on education over time, but there is always a tweak that is made to make each program better than the day before. Now that standardized assessments have been moved to online platforms, students, teachers, and school district administrators must address educational concerns and allow programs to impact education as much as possible.

Implications, Applications, and Directions for Future Research

This project may have an impact on social change because it may provide data to support local and national stakeholders' decisions to purchase programs like iLearn to reduce achievement gaps in mathematics for middle school students in Grades 6 through 8. From a local perspective, district stakeholders may have a better understanding of iLearn and its impact in schools. Stakeholders may have a better reason to purchase the program with local data to support students' education. This project may show teachers how to maximize learning and ensure that students are guided to use iLearn with a consistent amount of time to support their math skill development. The project may show teachers how to maximize learning with a streamlined approach to using iLearn and effective instructional strategies. Students may then have a stronger sense of applying their math skills to raise their achievement rates in their math classes and standardized tests.

As technology improves, programs such as iLearn adapt to address more students' needs at a faster rate. Although technology plays a role in teaching students successful math skills, teachers have to continue to adapt their instructional approaches to support the program in its attempt to reduce the mathematics achievement gap in middle schools. Although students from the two schools were of a lower SES, iLearn can serve as a program that assists any student with their math skills regardless of their SES.

Conclusion

Findings showed that iLearn had some impact on achievement rates for middle school students in Grades 6 through 8 during the 2016-17 school year. Despite some inconsistencies among the schools ensuring students use iLearn at least 45 minutes a day with consistent professional development sessions, this study showed that iLearn is an effective formative assessment tool. Findings showed that the use of iLearn had some impact on student success rate on their 2016-17 EOG mathematics. African American, Hispanic, and female students benefitted the most from iLearn as their scores showed a positive trend.

This study provided a quantitative examination to determine whether iLearn had an effect on student achievement. For future studies, I would recommend a qualitative approach to explore why these students improved their performance. I would also encourage researchers to determine whether negative feedback from iLearn had any impact on student achievement.

iLearn scores did not completely predict Grade 6 through 8 students' mathematics score at the EOG test. Gender, ethnicity, and SES did not moderate the relationship between iLearn scores and mathematics scores at the EOG test for Grade 6 through 8 students. Overall, this study may have an impact on the use of CAI tools such as iLearn and instructional practices at the local level. CAI tools such as iLearn may be used to minimize achievement gaps in mathematics for students in Grades 6 through 8. The purpose of the iLearn program is to increase mathematics achievement amongst students in Grades 6 through 8. However, the current study findings indicated that iLearn was not a strong predictor of Grade 6 through 8 EOG math scores.

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Appendix A: Professional Development

"Developing Effective Professional Development to Support iLearn in Two Local Title I Middle Schools"

Chris Atkinson

Goal

The goal of this causal-comparative study was to provide a means of professional development for teachers to better assist students with iLearn. The PD would be at least 3 days during the school year to help increase academic achievement for students in grades 6 through 8. The pd would help teachers, administrators and the District Assessment Coordinator to determine the effectiveness of iLearn as a formative assessment tool in terms of prediction accuracy and change in student achievement in middle school mathematics. The implementation of professional development would not only strengthen teacher's instructional practices but it would improve student's mathematical abilities to reason and solve problems. The trainer will use teacher reflections, collaboration and structured conversations to promote academic success amongst their students.

Learning Outcomes

During the pd sessions, teachers will learn a variety of skills that will assist them in providing effective instructional strategies to support students while participating in iLearn. Teachers will be able to self-assess their learning and utilize effective instructional strategies to support student learning. Teachers will have a better understanding of how iLearn works and how they can implement instructional practices into their daily instruction. At the end of the PD, each teacher will develop a plan to implement the effective instructional practices they've learned during the sessions.

Target Audience

This study was conducted to support two local middle schools in Georgia who did not meet state proficiency rates in standardized mathematics testing for a few years. Students within these two local middle schools serve as the target audience as the principals of the two schools, teachers and the District Assessment Coordinator are also a part of the study. At the time, the computer assisted instructional tool, iLearn, was purchased by the local school district to help reduce the achievement gap in mathematics for students in grades 6^{th} through 8^{th}. Prior studies (Collins, 2014) support iLearn's attempt to minimize achievement gaps nationwide but no study had been done locally to support this.

Components and Timeline

The 3-day PD will focus on the modules that are presented in iLearn. The following topics will be presented during the PD:

Day 1: Grade 6-Modules 1 & 2, Solving Problems with Multiplication and Division and Measurement

Day 2: Grade 6-Modules 3 & 4, Multiplication, Area and Fractions

Day 3: Grade 6-Modules 6 & 7, Fractions and Multiplication

The computer assisted instructional tool, iLearn, was purchased by the local school district to help minimize the achievement gap in mathematics. This program would assist students in grades 6^{th} through 8^{th} and would utilize data from the 2016-17 Georgia

Milestones Assessment. Overall, the PD would assist teachers in promoting effective learning strategies for students in grades 6 through 8 at two local Title I middle schools.

Activities provided during the PD are organized with trainer notes followed by slideshows that are presented at each session. The slide shows contain training links, vital information about iLearn modules and details the trainer will use to run the sessions. Participants will receive hard copies of the slide shows as well as the electronic version. Teachers will have formative and informative assessments built within the PD to gauge for understanding. The following charts outline the days of PD:

Day 1: Grade 6-Modules 1 & 2, Solving Problems with Multiplication and Division and Measurement

Time	Topic	Method
8:00am-9:15am	Welcome Remaining Dates Ice Breaker Overview of Modules	Presentation of PD Agenda Handout of presentation with notes about various models Discussion on the importance of iLearn and how it connects to daily mathematical practices.
9:15-9:30	Break	Restroom/Break Room;

9:30-11:00am	Understanding the Math You Teach; Model Lesson	Teachers work in pairs to discover best teaching methods for Modules 1 &2
11:00am-11:05am	Quick Summative check	Summative questions
11:05am-12:05pm	Lunch	Lunch on your own
12:05pm-1:05pm	Rubric Overview Assessment and Rubric Data	Rubrics create by iLearn and Teachers as well as current data from iLearn
1:05pm-2:05pm	Module Coherence	Review of Modules 1 & 2/Review Best practices
2:05pm-2:15pm	Questions and Answers Summative Check	Padlet-Online for Teachers to provide what they've learned during Day 1;
2:15pm	Adjourn	Dismissal

Day 2: Grade 6-Modules 3 & 4, Multiplication, Area and Fractions

Time	Topic	Method;
8:00am-9:00am	Welcome Remaining Dates Ice Breaker	Presentation of PD Handout of modules and other notes needed for PD Discussion of remaining dates and ice breaker

9:15am-10:30am	Overview of Modules 4 & 5	Presentation Handout Discussion
10:30-10:45am	Break	Restrooms/Break Room
10:45am-11:00am	Quick Summative check	Summative questions
11:00am-12:00pm	Lunch	Lunch on your own
12:00pm-1:00pm	Review Modules 4 &5 Model Lessons	Presentation Teachers use provided materials to determine best practices for Modules 4&5;
1:00pm-2:10pm	Module Connections Difference between iLearn and GMAS	Review Best practices Determine connections between Modules 1-4 Compare/Contrast between iLearn and GMAS with Easel Pad
2:10pm-2:15pm	Questions and Answers Summative Check Evaluation	Padlet-Online for Teachers to provide what they've learned during Day 2

		Evaluation form provided and completed by teachers prior to dismissal
2:15pm	Adjourn	Dismissal

Day 3: Grade 6-Modules 6 & 7, Fractions and Multiplication

Time	Topic	Method
8:00am-9:00am	Welcome Remaining Dates Norms Module Reflections	Presentation of PD Agenda Handout of Upcoming Modules and remaining dates Discussion about upcoming Modules
9:00am-10:45am	Modules 6 & 7 Introduction Group Task	Module 6 & 7 Handouts Teachers will get in small groups of 3 to prepare a brief presentation as an overview of Modules 6 & 7
10:45am-11:00am	Summative Assessment	Teachers will provide a quick summary of what has been discussed thus far using Google Forms

11:00am-12:00pm	Working Lunch Discover and work with Constructed Responses	Constructed responses will be discussed using samples from iLearn and GMAS study guides Teachers will determine best ways to introduce as well as implement constructed responses into daily lessons.
12:00pm-1:00pm	Continue to work with constructed responses	Teachers will continue to construct responses to samples of questions from iLearn and GMAS study guides
1:00pm-2:10pm	Review of all Modules 1-7 Preview GMAS Testing Schedule	Teachers will get into groups and provide best practices and a summary of information gathered from all PD. They will share out what has been learned on easels and through Google Forms. They will also

		review a handout outlining the upcoming testing schedule.
2:10pm-2:15pm	Evaluations	Teachers will complete evaluation for PD
2:15pm	Adjourn	Dismissal

Trainer Notes for Day 1

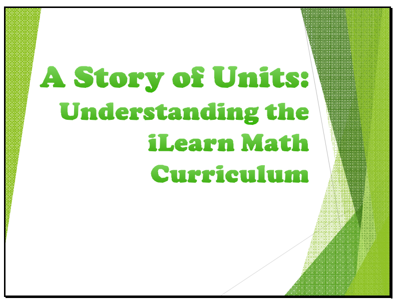
The trainer will implement the following tasks at the beginning of session 1:

- Participants will be welcomed to the first day of PD in which we will provide norms to follow during pd. There will be an IceBreaker video that will inform the teachers on how important they are. We will briefly discuss why the video was relevant.
- We will then look into Modules 1 & 2 and what we can learn going into the PD.
- Once we discuss what Modules 1 & 2 contain, we will then construct model lessons that they could use in the near future while working with their students in iLearn.
    - Teachers will split into groups of 2 or 3 and provide effective, research based instructional strategies that were given to them to implement Modules 1 & 2 into daily practices. They have the option of providing the lesson online through Google or they can create the lesson on paper/poster before modeling to others

- Once we go over effective instructional strategies, we will then do a quick summary check to summarize what has been learned so far. This will be done using Padlet, post it notes or Google Forms dependent upon the time. Post it notes can be used for quick checks whereas Padlet and Google Forms can be used at the end of PD.

Slideshow for Day 1

Slide 1



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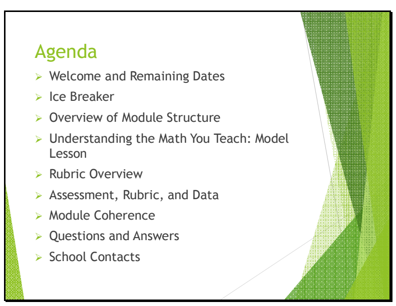

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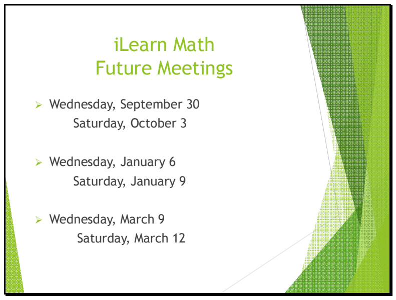

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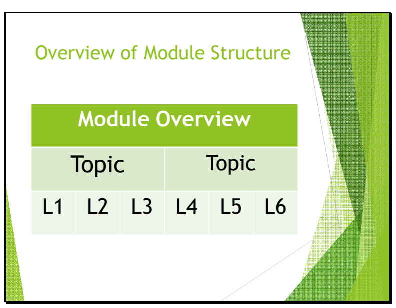

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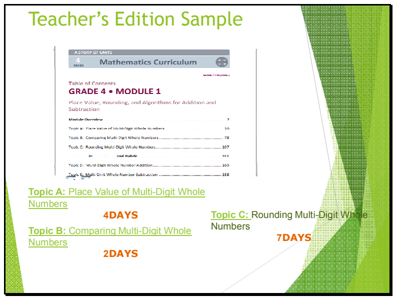

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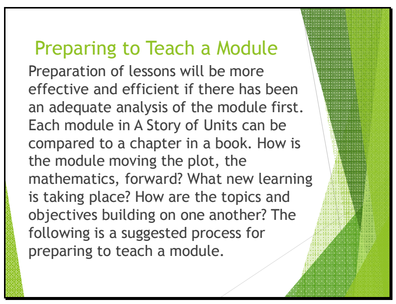

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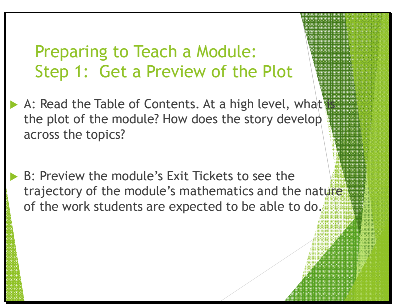

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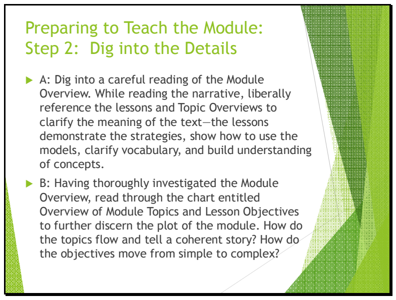

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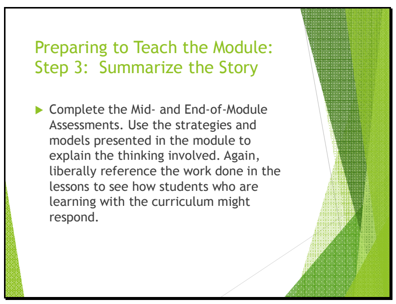

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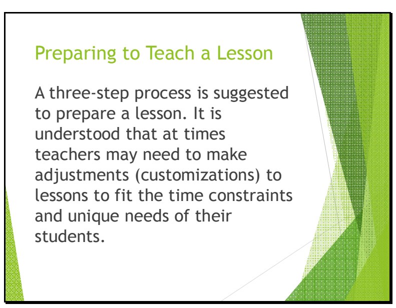


Slide 12

Preparing to Teach a Lesson
Step 1: Discern the Plot

- A: Briefly review the Table of Contents for the module, recalling the overall story of the module and analyzing the role of this lesson in the module.
- B: Read the Topic Overview of the lesson, and then review the Problem Set and Exit Ticket of each lesson of the topic.
- C: Review the assessment following the topic, keeping in mind that assessments can be found midway through the module and at the end of the module.

Slide 13

Preparing to Teach a Lesson
Step 2: Find the Ladder

- A: Complete the lesson's Problem Set.
- B: Analyze and write notes on the new complexities of each problem as well as the sequences and progressions throughout problems (e.g., pictorial to abstract, smaller to larger numbers, single- to multi-step problems). The new complexities are the rungs of the ladder.
- C: Anticipate where students might struggle, and write a note about the potential cause of the struggle.
- D: Answer the Student Debrief questions, always anticipating how students will respond.

Slide 14

Preparing to Teach a Lesson
Step 3: Hone the Lesson

- At times, the lesson and Problem Set are appropriate for all students and the day's schedule. At others, they may need customizing. If the decision is to customize based on either the needs of students or scheduling constraints, a suggestion is to decide upon and designate "Must Do" and "Could Do" problems.

Slide 15

Preparing to Teach a Lesson
Step 3: Hone the Lesson

- A: Select “Must Do” problems from the Problem Set that meet the objective and provide a coherent experience for students; reference the ladder. The expectation is that the majority of the class will complete the “Must Do” problems within the allocated time. While choosing the “Must Do” problems, keep in mind the need for a balance of calculations, various word problem types, and work at both the pictorial and abstract levels.
- B: “Must Do” problems might also include remedial work as necessary for the whole class, a small group, or individual students.

Slide 16

Depending on anticipated difficulties, those problems might take different forms as shown in the chart below.

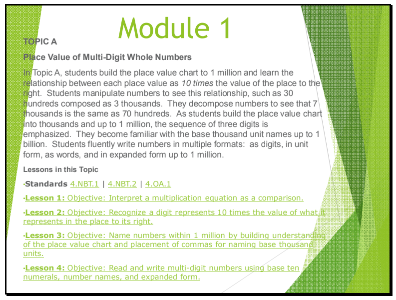
Anticipated Difficulty	“Must Do” Remedial Problem Suggestion
The first problem of the Problem Set is too challenging.	Write a short sequence of problems on the board that provides a ladder to Problem 1. Direct the class or small group to complete those first problems to empower them to begin the Problem Set. Consider labeling these problems “Zero Problems” since they are done prior to Problem 1.
There is too big of a jump in complexity between two problems.	Provide a problem or set of problems that creates a bridge between the two problems. Label them with the number of the problem they follow. For example, if the challenging jump is between Problems 2 and 3, consider labeling these problems “Extra 2s.”
Students lack fluency or foundational skills necessary for the lesson.	Before beginning the Problem Set, do a quick, engaging fluency exercise, such as a Rapid White Board Exchange, “Thrilling Drill,” or Sprint. Before beginning any fluency activity for the first time, assess that students are poised for success with the easiest problem in the set.
More work is needed at the concrete or pictorial level.	Provide manipulatives or the opportunity to draw solution strategies. Especially in Kindergarten, at times the Problem Set or pencil and paper aspect might be completely excluded, allowing students to simply work with materials.
More work is needed at the abstract level.	Hone the Problem Set to reduce the amount of drawing as appropriate for certain students or the whole class.

Slide 17

Preparing to Teach a Lesson
Step 3: Hone the Lesson

- C: “Could Do” problems are for students who work with greater fluency and understanding and can, therefore, complete more work within a given time frame. Adjust the Exit Ticket and Homework to reflect the “Must Do” problems or to address scheduling constraints.
- D: At times, a particularly tricky problem might be designated as a “Challenge!” problem. This can be motivating, especially for advanced students. Consider creating the opportunity for students to share their “Challenge!” solutions with the class at a weekly session or on video.
- E: Consider how to best use the vignettes of the Concept Development section of the lesson. Read through the vignettes, and highlight selected parts to be included in the delivery of instruction so that students can be independently successful on the assigned task.
- F: Pay close attention to the questions chosen for the Student Debrief. Regularly ask students, “What was the lesson’s learning goal today?” Hone the goal with them.

Slide 18



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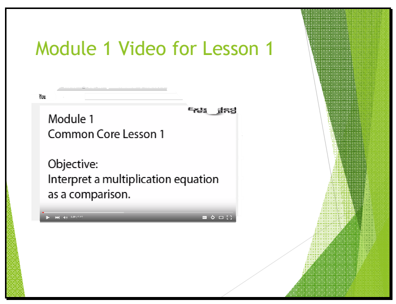

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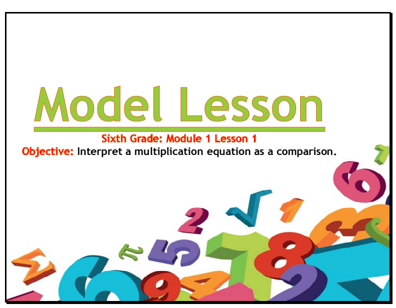

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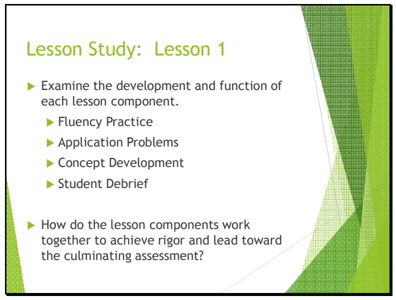

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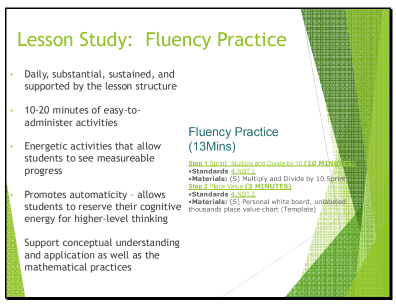

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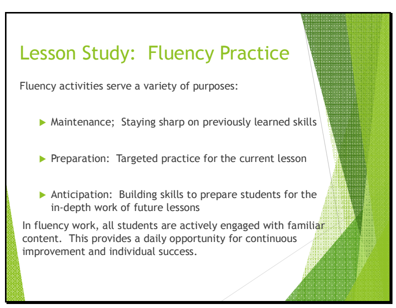

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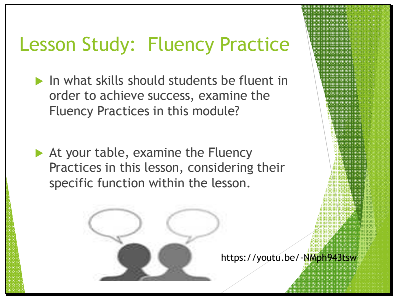

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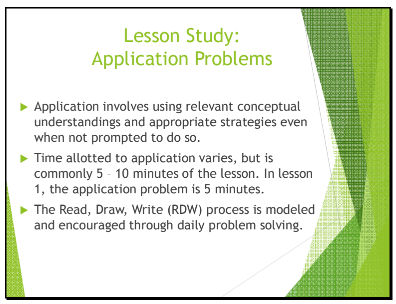

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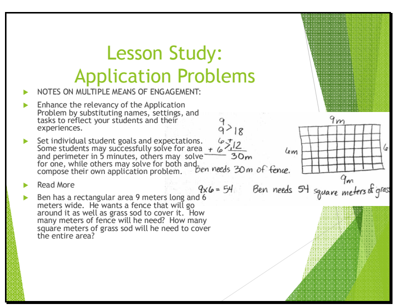


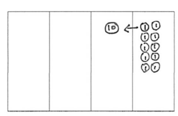
Slide 27

Lesson Study: Concept Development

- Constitutes the major portion of instruction and generally comprises at least 20 minutes of the total lesson time. In this lesson it is 30 minutes due to introducing a new concept.
- Builds toward new learning through intentional sequencing within the lesson and across the module.
- Often utilizes the deliberate progression from concrete to pictorial to abstract, which compliments and supports an increasingly complex understanding of concepts.
- Accompanied by thoughtfully sequenced problem sets and reproducible student sheets.

Slide 28

Lesson Study: Concept Development 25 minutes

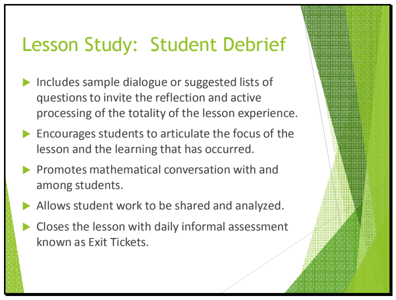


Slide 29

Problem Set-10 minutes

- Students should do their personal best to complete the Problem Set within the allotted 10 minutes. Some problems do not specify a method for solving. This is an intentional reduction of scaffolding that invokes MP.5, Use Appropriate Tools Strategically. Students should solve these problems using the RDW approach used for Application Problems.

Slide 30



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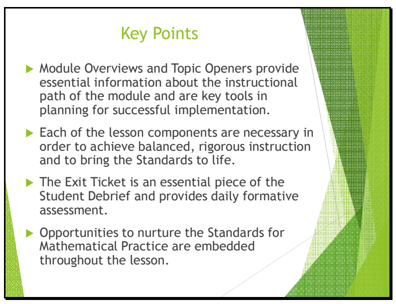

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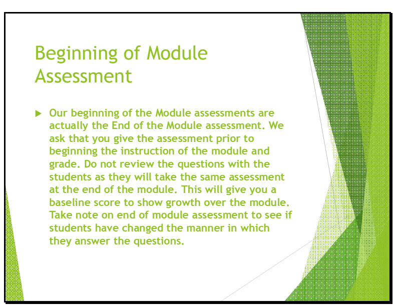

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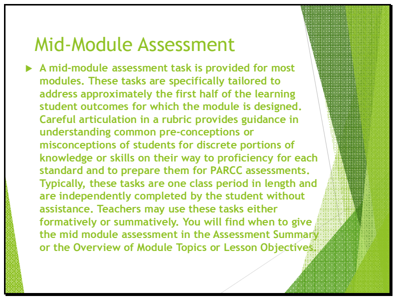

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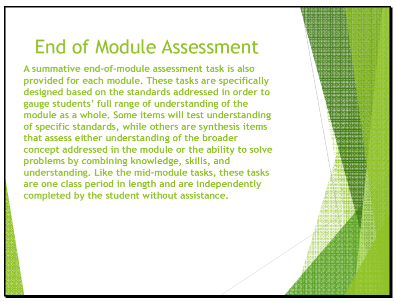

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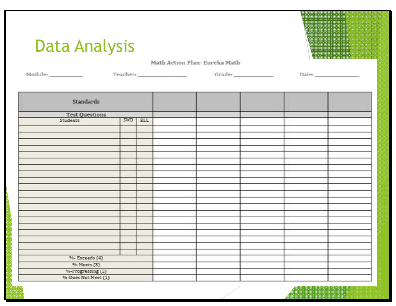

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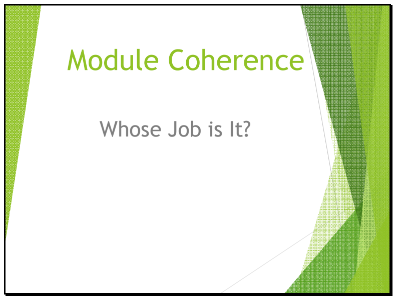

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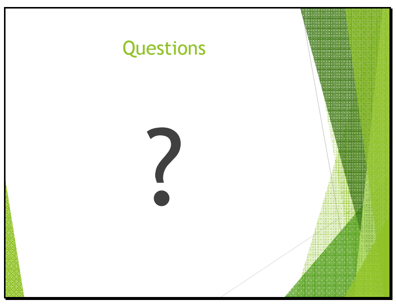


Slide 38

Trainer Notes for Day 2

The trainer will implement the following tasks at the beginning of session 2:

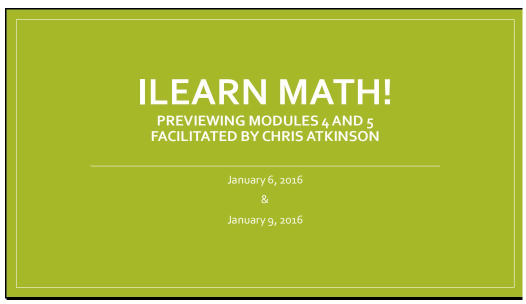
- Participants will be welcomed back to PD and norms will be briefly discussed and adhered to. There will be an IceBreaker activity that will lighten the mood. The IceBreaker will be a "braindump" in which teachers will write down and compare notes from the previous PD. This will allow them to begin a discussion on what they learned prior to today's session. I will pass out paperwork displaying the slideshows and other resources needed for the day.
- We will then look into Modules 4 & 5 and what we can learn going into the PD. We will go into detail about the various lessons in Modules 4 & 5 and ways to improve student's academic success.
- Once we discuss what Modules 4 & 5 contain, we will then construct model lessons that they could use in the near future while working with their students in iLearn.
    - Teachers will split into groups of 2 and provide effective, research based instructional strategies that were provided to them to implement Modules 4 & 5 into daily practices. They have the option of providing the lesson online through Google or they can create the lesson on paper/poster before modeling to others. I will collect the strategies used to support future PD sessions.

Once we go over Modules 4 & 5, we will then do a quick summary check to summarize what has been learned so far. They will answer summative questions to check for understanding on a handout that will be given out prior to lunch.

- We will then make connections between Modules 1 through 4 and possible GMAS questions. Teachers will use the large easel pad to chart the connections between the two.
- Once we complete the connections, participants will ask questions and perform another summative check to check for understanding. They will also complete an evaluation form that will be handed out to them to evaluate the pd.

Slideshow for Day 2

Slide 1



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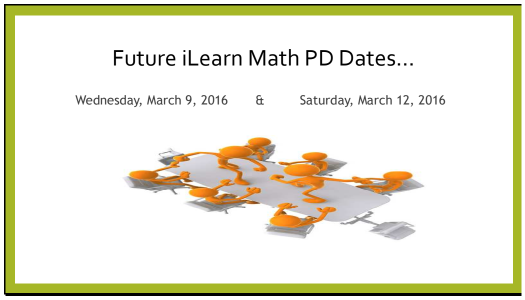

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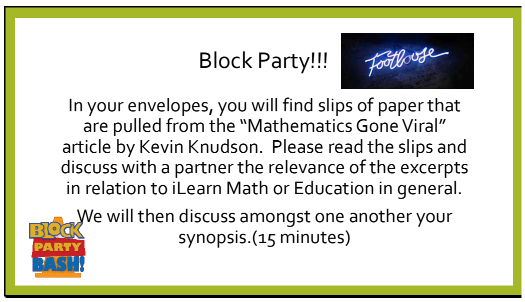

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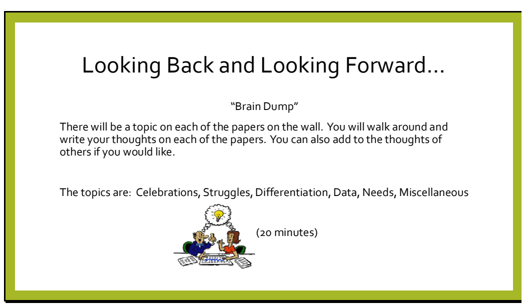
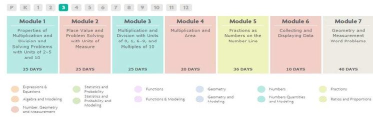


Slide 5

Looking Ahead at Module 4 and Module 5



- Grade 6 Module 4 Overview (pg.v in Livebinder)

http://www.livebinders.com/media/get/MTE0MDMoMzM=

- Grade 6 Modules 5 Overview (pgs.v-vi in Livebinder)

http://www.livebinders.com/media/get/MTE0MDMoNDE=

Slide 6

Looking Ahead at Module 4 and Module 5

- Grade 6 Modules 4 and 5 Omissions and/or Consolidations

Grade 6 Module 4

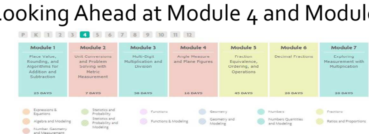
1. Consolidate L2 and L3. Omit the Application Problem in L3 and the use of square centimeter tiles.
2. Omit L9
3. Omit 15 & 16

Grade 6 Module 5

1. Omit L3
2. Omit L4
3. Consolidate L10 and L11: Both lessons are comparing unit fractions pictorially.
4. Omit L13
5. Omit L19
6. Omit L20
7. Omit L25 Embed the concept into other lessons regularly

Slide 7

Looking Ahead at Module 4 and Module 5



- Grade 6 Module 4 Overview (pgs.vi-vii in Livebinder)

http://www.livebinders.com/media/get/MTE0MDM1ODM=

- Grade 6 Modules 5 Overview (pgs. ix-xi in Livebinder)

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Slide 8

Looking Ahead at Module 4 and Module 5

- Grade 4 Modules 4 and 5 Omissions and/or Consolidations

Grade 6 Module 4

1. Those from outside New York State, may want to teach Module 4 after Module 61 and truncate the lessons using "Planning a Shorter Lesson." (see the Appendix) This would change the order of the Modules to the following: Module 1, 2, 3, 5, 6, 4 and 7.
2. Those from New York State might apply the following suggestions and truncate Module 4's lessons using "Planning a Shorter Lesson" protocol (see the Appendix)

Grade 6 Module 4 continued

3. Topic A might be taught simultaneously with Module 3 during an art class. Topics B and C might be taught directly following Module 3, prior to Module 5 since they offer excellent scaffolding for the fraction work of Module 5. Topic D might be taught simultaneously with Module 5, 6, or 7 during an art class, when students are served well with hands-on, rigorous experiences.

4. Topics B and C are foundational to Grade 7's missing angle problems. In Asia, missing angle problems are used to introduced variables. When using a protractor the value of the variable, , is verifiable and its meaning has a distinct value, eradicating the misconception that its value is "variable" when the equation is true.

Slide 9

Looking Ahead at Module 4 and Module 5

- Grade 6 Modules 4 and 5 Omissions and/or Consolidations

Grade 6 Module 5

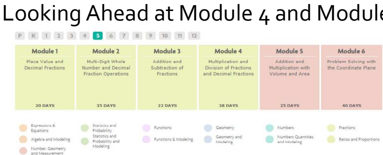
1. Consolidate L1, L2, and L3.

2. Omit L4. Embed the contrast of the decomposition of a fraction using the tape vs. the area model in the coming Lesson 5. "We could do it this way, too!" The area model's cross hatches are used to transition to multiplying to generate equivalent fractions, to add related fractions in G4 L20/L21, to add decimals in G4 M6, to add/subtract all fractions in G5 M3, and multiply a fraction by a fraction in G5 M4.

3. Omit L29. Embed estimation within many problems throughout the Module and curriculum. 4. Omit L40. Embed line plot problems in social studies or science. Be aware that there is a line-plot question on the End-of-Module Assessment.

Slide 10

Looking Ahead at Module 4 and Module 5



- Grade 6 Module 4 Overview (pgs. ix-xi in Livebinder)

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- Grade 6 Modules 5 Overview (pgs.viii-ix in Livebinder)

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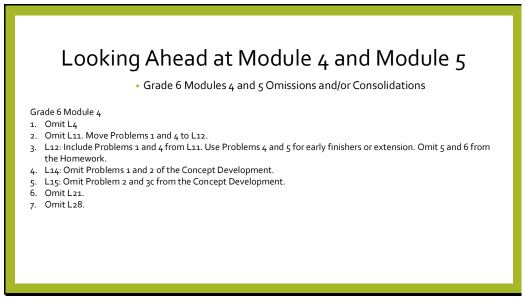

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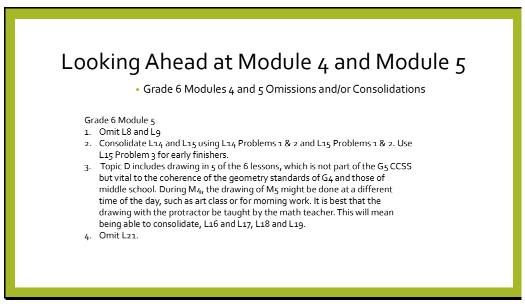

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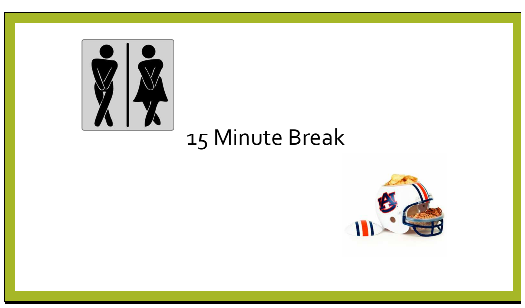


Slide 14

Assessments

- Ms. Anitra Paige of North Douglas Elementary to speak…
  - Change in format of assessment
- Other teachers are welcome to give their perspective on assessments and rubrics
  - Possible future changes/additions to iLearn Math for 2015-16 (30 minutes)

Slide 15

Looking Ahead at Module 4 and Module 5

- Vocabulary Mini Lessons/Summaries

Given the terminology for Modules 4 and 5, your table will create a mini lesson/Summary of at least 10 vocabulary terms that will be in the iLearn Lessons.

Your table will have 30 mins to make a strong 5-7 minute presentation of your findings.

Present your lessons with a touch of iLearn…

Slide 16

iLearn Math Reflections!!

- **Dr. Maurice Wilson**

Slide 17

Connections anyone?*

- Have you noticed any connections from the 1st Semester to now?
- Please post your connections on the Padlet app provided at http://tinyurl.com/iLearnJan (20 Minutes)

Slide 18

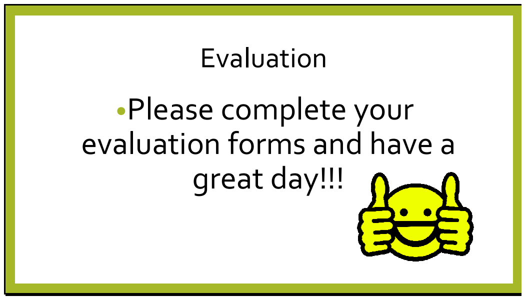
10 Minute Break

Slide 19

iLearn vs. GMAS

- Divide into groups of your school.
- Compare the rigor of the Georgia Milestones Assessments to the rigor required by iLearn
- Report out findings

Slide 20



Trainer Notes for Day 3

The trainer will implement the following tasks at the beginning of session 3:

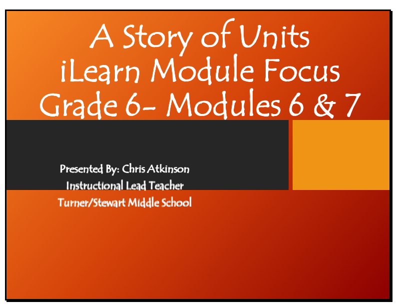
- Participants will be welcomed back to PD and norms will be discussed to adhere to. We will review the module connections that we discussed during the last PD. I will also hand out slideshows and other handouts to begin our session.
- Once we've completed the previous module connections, we will then look into the final Modules 6 & 7. We will go into detail about the various lessons in Modules 4 & 5 and ways to improve student's academic success.
- Once we discuss what Modules 4 & 5 contain, we will then construct model lessons that they could use in the near future while working with their students in iLearn.
    - Teachers will split into groups of 2 and provide effective, research based instructional strategies to implement Modules 4 & 5 into daily practices. They have the option of providing the lesson online through Google or they can create the lesson on paper/poster before modeling to others.

Once we go over Modules 4 & 5, we will then do a quick summary check to summarize what has been learned so far. They will answer summative questions to check for understanding on a handout that will be given out prior to lunch.

- We will then make connections between Modules 1 through 4 and possible GMAS questions. Teachers will use the large easel pad to chart the connections between the two.
- Once we complete the connections, participants will ask questions and perform another summative check to check for understanding. They will also complete an evaluation form that will be handed out to them to evaluate the pd.

Slideshow for Day 3

Slide 1



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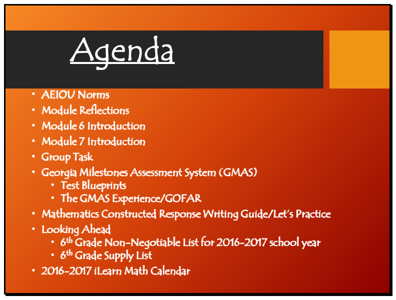

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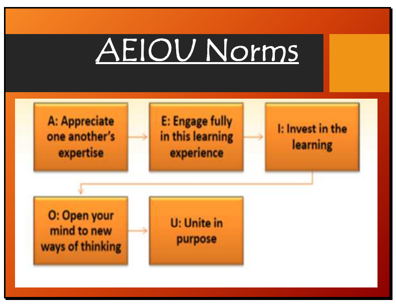

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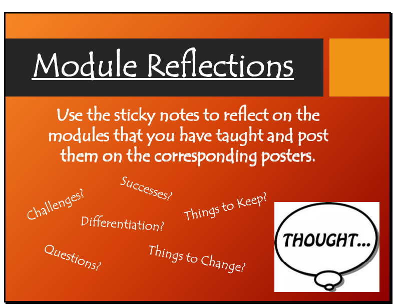

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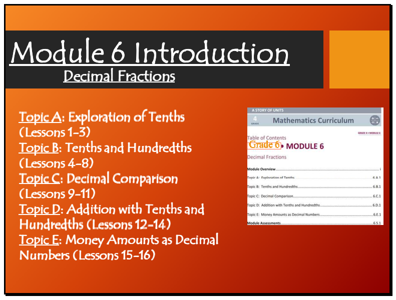

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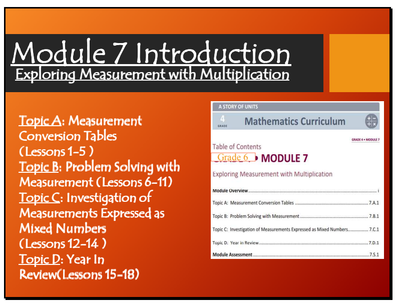

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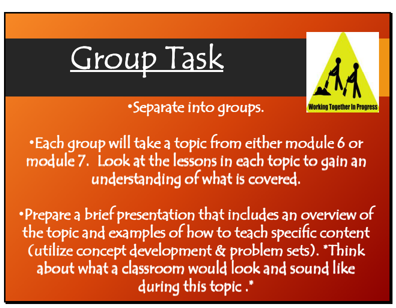

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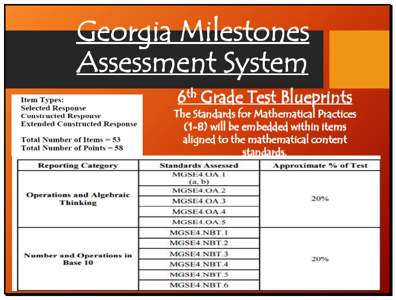

Reporting Category	Standards Assessed	Approximate % of Test
Operations and Algebraic Thinking	MGSE4.OA.1 (a, b)	20%
	MGSE4.OA.2	
	MGSE4.OA.3	
	MGSE4.OA.4	
	MGSE4.OA.5	
Number and Operations in Base 10	MGSE4.NBT.1	20%
	MGSE4.NBT.2	
	MGSE4.NBT.3	
	MGSE4.NBT.4	
	MGSE4.NBT.5	
	MGSE4.NBT.6	

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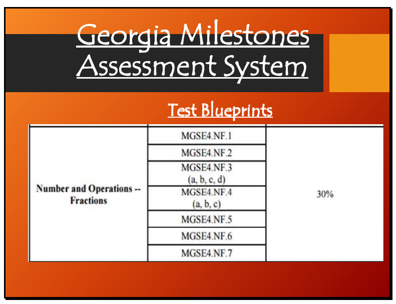

Number and Operations -- Fractions	MGSE4.NF.1	30%
	MGSE4.NF.2	
	MGSE4.NF.3 (a, b, c, d)	
	MGSE4.NF.4 (a, b, c)	
	MGSE4.NF.5	
	MGSE4.NF.6	
	MGSE4.NF.7	

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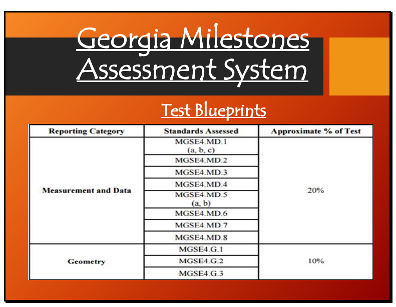

Reporting Category	Standards Assessed	Approximate % of Test
Measurement and Data	MGSE4.MD.1 (a, b, c)	20%
	MGSE4.MD.2	
	MGSE4.MD.3	
	MGSE4.MD.4	
	MGSE4.MD.5 (a, b)	
	MGSE4.MD.6	
	MGSE4.MD.7	
	MGSE4.MD.8	
Geometry	MGSE4.G.1	10%
	MGSE4.G.2	
	MGSE4.G.3	

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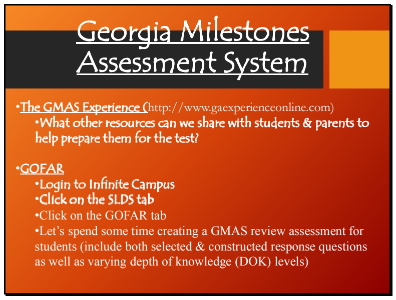

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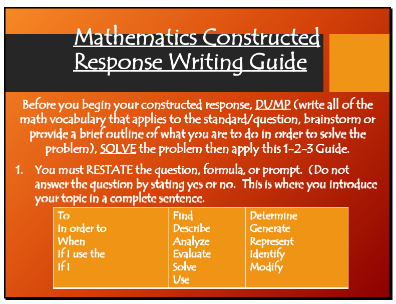

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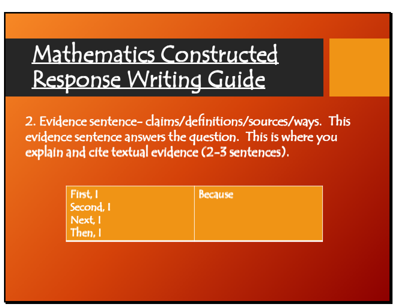

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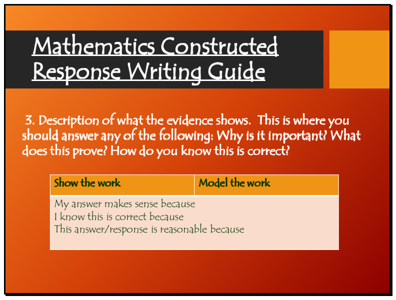

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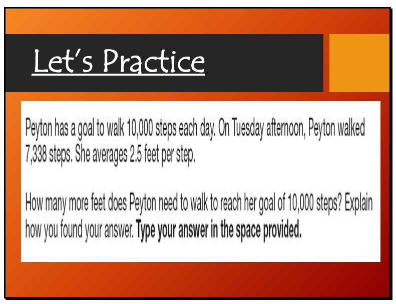

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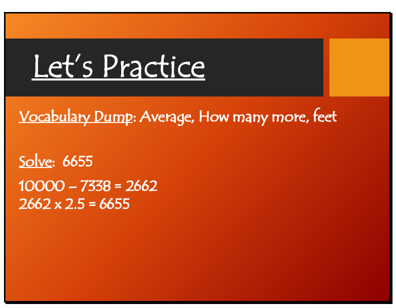

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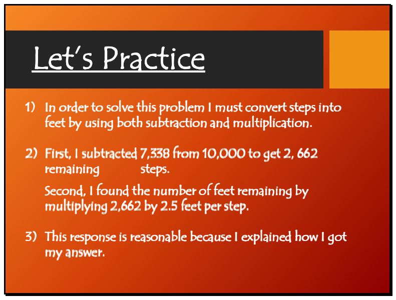

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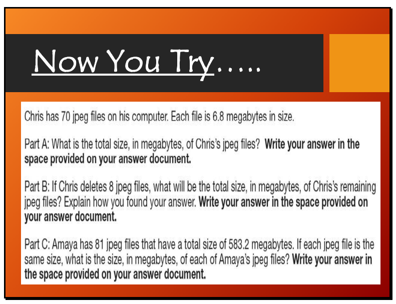

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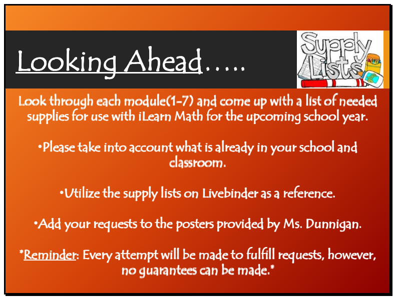

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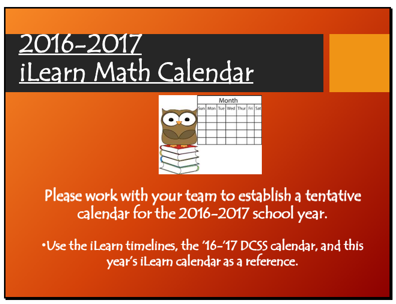

The Problem

Mathematics is a critical field in education that many students seem to lose interest in as they grow older. There seems to be a stigma as to why students struggle with mathematical concepts as early as 7 years old. Various factors play a role in this mindset such as anxiety, socioeconomic status or equity (Gustafsson, Nilsen, & Hansen, 2018). Prior achievement significantly predicts future attitude towards mathematics but prior achievement does not significantly predict future achievement (Recber, Isiksal, & Koç, 2018). This is evident in two local middle schools as students have exhibited a deficit in their mathematical concepts with standardized tests from 2014-2016. The Georgia Milestones End-of-Grade Assessments were introduced to Georgia school systems during the 2014-2015 school year to combat the traditional Criterion Reference Competency Test (CRCT) (GADOE, 2020). At the time, CRCT's were implemented into Georgia school systems in 2000 and ended in 2014. According to the GADOE website, CRCT was designed to measure student's knowledge in English/Language Arts, Mathematics, Science and Social Studies ranging from 3rd to 12th grades. Student's individual strengths and weaknesses to gauge the quality of education in the state of Georgia.

This study was conducted to support two local middle schools in Georgia who did not meet state proficiency rates in standardized mathematics testing for a few years. At the time, the computer assisted instructional tool, iLearn, was purchased by the local school district to help reduce the achievement gap in mathematics for students in grades 6th through 8th. Prior studies (Collins, 2014) support iLearn's attempt to minimize achievement gaps nationwide but no study had been done locally to support this.

Mastery Learning Model

The mastery learning model is the theoretical foundation of this paper. Mastery learning is a belief that all students can learn when they are provided the proper amount of time and appropriate resources to learn (Ozden, 2008). Experiences outside of the classroom provided by students' families, surroundings, religion and society also support the mastery learning model. Although these various experiences mold a student's learning, the ultimate mastery learning model occurs in a classroom. When standards are clearly defined and implemented in the classroom, students' ability to learn and master specific conceptual ideas rise despite their background. Bloom (1968) believed that the mastery learning theory and model stemmed from cognitive behaviors and emotional welfare of a child. This would then lead to motivate the child to improve their leaning. This form of learning can also improve instructional effectiveness for teachers. Mastery learning does not focus on content, but on the process of mastering it. While in school, teachers first provide instruction to students on specific concepts, administer formal and informal assessments, then provided in-depth feedback for students to improve upon (Guskey, 2007). This cycle continues as student's progress and mastery improves.

As students participated in iLearn, they were mastering mathematical concepts. They were provided multiple attempts and feedback to ensure they mastered the concept. This allowed students to eventually close academic achievement gaps that were present prior to the implementation of iLearn into their daily curriculum. The use of iLearn not only provided students with vital feedback but it enriched their learning experience as the program's avatars provided unique and innovative ways to keep the students' mind engaged on the task at hand. Teachers also provided in-depth feedback to assist students in mastering mathematical concepts. Teaching for mastery not only improves a child's short and long term social being but it encourages students to evoke higher order thinking strategies that can be used for a lifetime (Block & Burns, 1976). A conceptual model of mastery learning by John Carroll (1963) supports the fact that the more time students spend on a concept, the more they are apt to master it. This holds true as students who participated in iLearn were provided in-depth lessons, feedback and ample amount of time to ensure they mastered mathematical concepts that they had previously not mastered.

Purpose and Design

The purpose of this causal-comparative study was to determine the effectiveness of iLearn as a formative assessment tool in terms of prediction accuracy and change in student achievement in middle school mathematics. This quantitative project study was to assess the use of iLearn as a means to increase mathematics achievement and prediction accuracy in middle school mathematics. This study was to also provide a means of professional development for teachers to better assist students with iLearn. The implementation of professional development would not only strengthen teacher's instructional practices but it would improve student's mathematical abilities to reason and solve problems. For this study, I used a quantitative post-hoc approach which consisted of a combination of correlational and causal-comparative design.

Findings

With respect to RQ1, iLearn scores (IV) significantly and negatively predicted EOG scores (DV) in grades 6 through 8. I used regression analysis to determine the outcomes which resulted in β = -.461, p = .000 and R^2 = .213. This explained over 20% of the variance in the DV. This result supported the alternative hypothesis (H_{1A}).

To answer RQ2, I conducted a separate regression analysis as to what extent did gender, ethnicity and socioeconomic status moderate the relationship between iLearn scores and end-of grade scores for 6^{th} through 8^{th} grade student. With respect to *gender*, I found that iLearn scores predicted the EOG scores more accurately for girls (β = -.657, p

= .000 and R^2 = .432) than for boys (β = -.511, p = .000 and R^2 = .261). This means that the regression coefficient was greater and the amount of explained variance higher. With respect to *ethnicity*, the prediction was more accurate for African American students (β = -.613, p = .000 and R^2 = .376) than for Hispanic students (the regression was non-significant with β = -.051, p = .475 and R^2 = .003). There was a smaller number of White and Multi-Racial students, therefore data could not be analyzed. With this factor, those particular subgroups were not moderating factors. With respect to *socio-economic status*, for students with free or reduced lunch the prediction was more accurate (β = -.619, p = .000 and R^2 = .383) than for students with no free or reduced lunch (β = -.258, p = .000 and R^2 = .066).

iLearn

ILearn is a computer-based program that helps elementary and middle school students improve their math strategies. The program builds math fluency through scaffolding to conceptualize mathematics. Students are provided personal instruction that is adaptive to their learning. ILearn has been around since 2014 as it started in Marietta, GA by Dr. R.L. Collins (2014). He wanted to present a unique form of education that specifically embodied high-quality research from cognitive psychology on multimedia instruction. He felt that iLearn was different than other computer assisted instructional tools in that it changed students' mindset. The program was developed with concept mastery in mind as students needed to master mathematical concepts before they progressed through iLearn. This simple idea made iLearn a valid and reliable computer assisted instructional program that is still being used locally.

Gender, Ethnicity and SES

Gender, ethnicity and socioeconomic status were three factors that moderated the relationship between iLearn scores and end-of grade scores for 6th through 8th grade students. There are mixed results as to how boys and girls may differ in their mathematical knowledge as they mature. Males tend to show strengths in mathematics as females show strength in reading and language arts (Geary et al., 2019). This concept has some input as to why males dominate the field of STEM and why females exhibit higher levels of anxiety in mathematics. Although this perception may be reality for some, there is also research supporting the concept that educating learners with strong self-confidence in mathematics and positive attitudes towards mathematics is the sole reason why males or females are successful in mathematics (Recber, Isiksal, & Koç, 2018). This confidence student's display in mathematics leads to self-efficacy which is a variable that possibly explains the difference in mathematics performance between males and females. The implementation of iLearn supports this idea as students are provided positive feedback and become self-directed learners.

Ethnicity is another factor that moderated the relationship between iLearn and EOG scores in mathematics. In 2019, Meshkinfam, Ivy, and Reamer conducted a longitudinal study to determine if ethnicity played a role in students' success. Historically, African American students performed lower than White students in mathematics (Meshkinfam, Ivy, & Reamer, 2019). Unfortunately, they discovered that this still exists as African American and American Indian students had a lower correlation than that of White and Asian students for their EOG scores. For my study, African American and Hispanic students benefitted from using iLearn as their EOG scores showed a positive correlation as opposed to White students.

Socioeconomic status is the last factor that moderated the relationship between iLearn and EOG scores in mathematics for my study. Family income, parent's education and jobs as well neighborhood characteristics define SES (Wang et al., 2015). Unfortunately, this study (Wang et al., 2015) stated that children who grew up in low SES were more likely to be exposed to health risks and poor housing conditions which may impair their cognitive development. These students who come from low SES families are more likely to live in dangerous neighborhoods and attend under-resourced schools. This has a negative impact on their ability to learn and retain information which will possibly lead to students dropping out of high school and entering a cyclical lifestyle that keeps them perished.

Regardless of gender, ethnicity or SES, iLearn provides a level playing field for all students as the program provides in-depth mathematical instruction and feedback to support each students' level of learning. As the program adapts to each child's learning level, students are able to succeed and reduce the achievement gap in middle school mathematics.

Recommendation

Within the study, I made a few recommendations to consider for future studies. Those recommendations were utilizing iLearn 45 minutes a day, consistently scheduling specific times for students to use iLearn and consistent professional development for teachers. Although those recommendations may be for local use, one recommendation that I would like for future researchers to consider is to encourage schools or school districts to consistently provide professional development for teachers to utilize the program with fidelity. Professional development was provided for teachers during the study, but teachers may benefit more when it is consistent. This stems from consistent planning taken by the school or school district to ensure teachers are informed of any changes that may occur with iLearn. Since iLearn is a computer assisted tool that is adaptive to each student's learning, students will have ease of access with respect to utilizing the program. Teachers play a vital role in ensuring they are abreast of how the program works and how it can have a positive impact on student achievement. If this is done, more students will benefit from using iLearn.

Conclusion

The vast amount of technology students' use on a daily basis to improve their education has grown over the last 20 years. From personal laptops to cell phones, students have technology at their fingertips. If they are using this ease of access to their advantage, they are able to overcome many technical endeavors that elder generations now face. iLearn is a great program to assist students who have deficits in mathematics. With the implementation of iLearn and teacher support, students will improve their foundational mathematics skills while in middle school and beyond.

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