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THE EFFECTS OF AMIRA LEARNING ON LITERACY DEVELOPMENT IN EARLY CHILDHOOD EDUCATION

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ABSTRACT

The aim of the present study was to investigate the effects of an Artificial Intelligence software, Amira Learning, on literacy development in early childhood education. Specifically, the research investigated the impact of Amira Learning software usage, the feedback it provided, and teachers' perspectives on its alignment with the Science of Reading. The study employed quantitative analyses of oral reading fluency outcomes and compared the pretest and posttest scores of the students after the 6-week usage of the software.

CHAPTER ONE. INTRODUCTION

The Covid-19 pandemic posed a challenge in education that no nation in the world was prepared to tackle. It took a toll on human resources, risking physical and mental wellbeing of students and teachers, disrupted the normal teaching and learning cycle, and had everyone thinking of ways to safely continue educating students. During this unprecedented event, leaders at the school, district, and state levels all turned to educational technology to try to create normalcy for teachers and students.

Although there were conflicting thoughts on the acceptance of educational technology (Straker, et al., 2018), the threats caused by the pandemic to the educational system opened the doors to what it has to offer. Technology was used in varied ways in education, even in early childhood education (ECE). It was used to deliver remote learning and to instruct in real time, to electronically store resources, assessments, and data, and for interventions or supplemental activities through applications and software. More recently, artificial intelligence (AI) for educational use also garnered attention from students, teachers, school leaders, and stakeholders because of its promising capabilities. The power of AI in education (AIEd) lies in its ability to allow teachers and students to use machines that mimic human intelligence in computer programs (McCarthy, 2007).

In ECE where high-quality learning experiences and interactions are a golden standard, programs that can replicate human intelligence such as intelligent tutoring systems (ITS) sound encouraging especially because Covid-19 depleted human capital in education with schools not allowing volunteers and members of the community to provide additional services for students. Covid-19 has been predicted to cause learning loss (Sabates, et al.., 2021) and believed to widen

already existing learning gaps especially for the most vulnerable groups (Hoofman & Secord, 2021; Van Lancker & Parolin, 2020). The present study aimed to investigate the effects of an AI program, Amira Learning software, on literacy development in early childhood education. Amira Learning software claims to help young learners develop their literacy skills through constant practice and interaction with the animated tutor, Amira.

Significance of Study

The significance of the present study was aimed at understanding the potential impact of using Amira Learning software on young learners' literacy development. As AIEd continued to play an increasingly significant role in the learning process (Broda & Frank, 2015; Touretzky, et al., 2019; Yang, 2022) and as educators drew more interest in using ITS in educational setting, a number of researchers offered meta-analysis and review of ITS and its effects on learning outcomes (Ma, et al. 2014; Mousavinasab, et al., 2021; Nickow, et al., 2020,; Su & Yang, 2022). The present study aimed to explore some of its important implications.

The findings of the present study may shed light on the effectiveness of an ITS in improving overall literacy of young learners as evidenced by improvement in oral reading fluency (ORF). This knowledge can be valuable for educators and educational institutions considering the integration of such technologies into their instructional practices. With Amira Learning software's promise of literacy growth, the present study can also contribute to evidence-based literacy instruction strategies and may provide insights into how ITS can support and enhance students' reading abilities. If the study revealed a positive relationship between time spent using Amira Learning software and oral reading fluency, it could emphasize the importance of personalized learning experiences tailored to individual students' needs and

learning preferences, through means other than the traditional, human tutor. Based on what the findings will be, educational institutions may consider allocating resources and time to incorporate Amira Learning software or similar technologies as part of their literacy curriculum.

Purpose of the Study

The purpose of this present study was to investigate the potential relationship between the amount of time students spend using Amira Learning software and their literacy development as measured by oral reading fluency (ORF) achievement levels. It also aimed to investigate how effective Amira Learning software's feedback was in improving students' oral reading fluency. The present study intended to collect and analyze survey data from teachers to understand their views on how well Amira Learning software incorporates evidence-based reading instruction methods outlined in the Science of Reading (SOR) framework. The present study hoped to have achieved the following objectives:

Examine the Use of Amira Learning Software. The present study gathered data on the time spent by students using Amira Learning software while practicing reading grade level texts. This data will help determine the extent of exposure to this ITS. The amount of feedback in minutes that Amira Learning software provided will also be collected and compared to students' oral reading fluency levels.

Assess Oral Reading Fluency Levels. The present study aimed to measure students' oral reading fluency levels before and after using Amira Learning software using the assessment and data management system, DIBELS Next (www.acadiencelearning.org, n.d.). By comparing the fluency levels to Amira Learning software usage and feedback given, the study sought to identify any potential relationship between the variables.

Analyze the Relationships. The present study statistically analyzed the data collected to determine whether there was a significant relationship between the time spent using Amira Learning software and learners' oral reading fluency achievement levels as well as amount of Amira Learning software feedback and oral reading fluency achievement levels.

Interpret Teacher's View on Amira Learning software and SOR Alignment. The present study investigated and assessed the level of agreement among teachers regarding Amira Learning software's alignment to SOR and its effectiveness in fulfilling the SOR objectives through an online survey.

Contribute to Educational Research. The present study investigated the impact of Amira Learning software, an AI-enabled ITS that claims to be aligned with SOR, to literacy development of students in first grade level in a suburban public school in Louisiana. Being aligned with the state's literacy vision and with the forward trend in AIEd, it was hoped that this study will set the foundation for further, wider scale research in the future. The impact of Amira Learning software to literacy development and teachers' perspectives on its alignment to SOR can have implications for the successful integration of AIEd, in the form of ITS, helping educators and researchers make informed decisions about the use of this technology in literacy instruction and supporting evidence-based practices in educational settings.

Research Questions

In order to investigate the effects of Amira Learning software, an Artificial Intelligence (AI) program, on the literacy development in early childhood education, the following questions supported this study:

RQ1: What is the relationship between the time spent using Amira Learning software and learners' oral reading fluency achievement levels?

RQ2: How effective is the feedback provided by Amira Learning software in improving students' oral reading fluency?

RQ3: What is the level of agreement among teachers regarding Amira Learning software's alignment to the Science of Reading and its effectiveness in fulfilling the Science of Reading objectives?

Theoretical Framework

To fully explore the relationship of Amira Learning software and early learners' reading skills, it was essential to consider two overarching concepts: the mastery learning (Bloom, 1968) and skilled reader (Gough & Tunmer, 1986; Scarborough, 2001; National Reading Panel, 2000).

The mastery learning theory aims to address individual learning differences, promote deeper understanding, and ensure that students are well-prepared for more advanced topics. It has been influential in shaping the field of education, particularly in the design of personalized and competency-based learning models (Guskey, 2005). Mastery learning is regarded as a means to promote educational fairness by enabling every student to attain a high level of expertise in the subject matter.

The Skilled Reader theory, often associated with cognitive psychology and reading research, seeks to understand and describe the cognitive processes and skills that proficient readers use when they read and comprehend text. It is supported by three distinct models , the Simple View of Reading (SVR) (Gough & Tunmer (1986), Scarborough's Reading Rope (2001),

and the Five Pillars of Reading (National Reading Panel, 2005), which collectively provide a comprehensive insight into the various components involved in the reading process. Although each of these models has its own unique characteristics, they all share a fundamental recognition that reading is a complex undertaking characterized by two essential elements: decoding and comprehension. Additionally, these frameworks all acknowledge that reading skills develop in a hierarchical fashion, with foundational skills forming the building blocks for more advanced ones.

Limitations & Delimitations

Although the real-world, quasi-experimental design has several advantages, specifically when conducting experimental control is challenging or unethical (Grimshaw, et al., 2000), it has some limitations that may affect the results of the present study. One of the limitations included not involving random assignment of participants to groups, which can lead to potential biases and can make it difficult to establish causal relationships between the independent variable and the outcomes. The non-random assignment of participants to groups may also result in systematic differences between the groups, affecting the internal validity of the study. Another limitation involved the participants selected based on extreme scores at the beginning of the study who may naturally move toward the average on subsequent measurements, leading to regression to the mean and potentially misinterpretation of the intervention's impact (Harris, et al., 2006).

Feasibility and practicality are two of the delimitations of quasi-experimental studies. It is often more practical and feasible than true experimental designs, especially in situations where random assignment to groups is not possible or ethical. This makes them more accessible for researchers working in real-world settings with existing groups or natural occurrences. This

design also allows researchers to examine cause-and-effect relationships without compromising ethical principles (Grimshaw, et al., 2000). Because the topic of AIEd in the form of ITS in early childhood education has not been fully explored yet, quasi-experimental studies can serve as a basis for generating hypotheses that can later be tested using more controlled experimental designs. Quasi-experimental design is best suited for the present study for these reasons.

Overall, quasi-experimental designs offer researchers a valuable approach to study causal relationships in situations where true experimental control is not feasible (Grimshaw, et al., 2000; Harris, et al., 2006). By understanding the strengths and limitations of these designs, researchers can use them effectively to address important research questions and contribute to evidence-based practices in various fields.

Definition of Key Terms

The following terms were used as they applied to this study. They are defined hereafter.

Artificial Intelligence (AI). McCarthy (2007), defined AI as “the science and engineering of making intelligent machines, especially intelligent computer programs" (p. 2). This definition seems to encompass a broad description of what AI truly is. It can be challenging to find a specific, direct definition for the term since AI has been around for more than a decade in many forms and applications (Lindner & Romeike, 2019). The common description of AI lies in its ability to understand and mimic human actions and thinking through reasoning, adapting, recognizing patterns, making predictions, recommendations, and decisions to solve complex problems (ISTE, 2019, 0:28; Lindner & Romeike, 2019; Unicef, 2020).

Artificial Intelligence in Education (AIEd). AIEd refers to the application of artificial intelligence (AI) technologies and techniques in the field of education. It aims to enhance and

improve various aspects of the educational process by leveraging AI's capabilities to analyze data, make predictions, and adapt to individual learners' needs (*Artificial Intelligence and the Future of Teaching and Learning Insights and Recommendations*, 2023)

Intelligent Tutoring Systems (ITS). ITS is an advanced educational technology that uses artificial intelligence (AI) and computer-based instruction to provide personalized and adaptive learning experiences to students. ITS is designed to simulate the role of a human tutor, delivering individualized instruction and support to learners based on their specific needs and progress (Luckin, et.al., 2016).

Science of Reading (SOR). The Science of Reading is an evidence-based approach to reading instruction that draws on extensive research from various disciplines, including cognitive psychology, linguistics, neuroscience, and education. It seeks to understand how reading develops in the brain and how best to teach reading skills effectively (Moats, 1999; Moats 2020; Science of Reading: Defining Guide, 2022).

Early literacy skills. Early literacy skills are the fundamental abilities that young children develop during their early childhood years, which are essential for future reading and writing success. These skills serve as the foundation for becoming proficient readers and writers as children progress through their education. The Science of Reading includes the following measures of early literacy skills: phonemic awareness, phonics, fluency, vocabulary, comprehension.

Dynamic Indicator of Basic Early Literacy Skills (DIBELS) Next edition. DIBELS Next are a set of research-based procedures and measures for assessing the acquisition of early literacy skills. They are designed to be short fluency measures used to regularly monitor the development

of early literacy skills and early reading skills (www. Acadiencelearning.org, n.d.). In first grade, DIBELS Next assess the measures of phoneme segmentation, nonsense word fluency, and oral reading fluency. It uses four levels of risk to categorize students' performance on the assessment. These risk levels help educators identify students who may need additional support or intervention in developing their early literacy skills. The risk levels are typically classified as follows: low risk (green and blue; students who are performing at or above grade level), some risk (yellow; students who are performing slightly below grade level), and at risk (red; students who are performing significantly below grade level).

Oral Reading Fluency (ORF). ORF as measured by DIBELS Next refers to a specific assessment used to evaluate a student's reading proficiency. In the DIBELS ORF assessment, a student is asked to read a grade-level passage aloud for one minute. The evaluator records the number of words the student reads correctly within that time frame. It focuses on accuracy and rate of reading.

Word Correct Per Minute (WCPM). WCPM is a metric used to measure ORF in educational assessments, particularly in the context of DIBELS Next. WCPM represents the number of words a student reads correctly in one minute during an ORF assessment. The assessment typically involves having the student read a grade-level passage aloud, and the evaluator records the number of words read accurately within the one-minute time frame.

Summary

This chapter presented the global challenges that Covid-19 posed in education. Amidst the challenges, educational technology emerged as a crucial tool to continue teaching and learning, although there were differing opinions on its acceptance, specifically in ECE.

Educational technology has advanced with AIEd which has opened a whole new way of enhancing learning experiences for young students with human intelligence capabilities. An AI program, Amira Learning software, promises to close learning gaps and support students' literacy development using explicit instruction and tutoring that is aligned with SOR. As Louisiana focused on improving the literacy rates of students from kindergarten to third grade through SOR, the impact of Amira Learning software on literacy development was worth investigating.

Chapter Two, a review of literature, the existing literature on the predicted effects of Covid-19 on education, the role of educational technology in ECE in relation to the pandemic, AI and ITS, Amira Learning software and SOR, as well as the theoretical framework for the present study are explored.

In Chapter Three, details about the present study and how the topic will be investigated are presented. The intended research paradigm, setting and context, ethical considerations, data sources, data analysis, and research design are included.

CHAPTER TWO. LITERATURE REVIEW

In December 2019, the entire world was shocked by the news of a new virus, Covid-19, that was highly contagious and caused infectious illness and sudden death. It claimed close to seven million lives worldwide and infected more than half a billion people from all walks of life (World Health Organization, 2023). In the first quarter of 2020, Covid-19 caused the world to completely shut down, disrupting every industry and challenging every aspect of the society, including the educational system. Since then, technology has come a long way and its adoption in different industries has speeded as part of the responses to the pandemic (LaBerge, et.al., 2020). This has also resulted in rapid advancements in educational technology. Currently, the most popular yet most controversial educational technology is artificial intelligence in education (AIEd). AIEd has raised both praises and disagreements especially in early childhood education (ECE). Nonetheless, developers continued to attempt to create appropriate AIEd tools in ECE (Broda & Frank, 2015; Touretzky, et al., 2019; Yang, 2022).

AIEd has made its way to many states. In Louisiana, the Department of Education (LDOE) promoted the use of Amira Learning software, an AIEd Intelligent Tutoring System (ITS) program to help English Learners (ELs) to master literacy skills necessary for school success. Amira Learning software claims to provide effective tutoring to young learners and to close learning gaps through instruction and feedback that are aligned with the Science of Reading (SOR). With about 900 school districts in 15 countries using Amira Learning software and a program that alleges to be backed by research (www.amiralearning.com, n.d.), independently published studies on the effects of Amira Learning software did not seem to be available on academic search engines yet. The present study aimed to investigate the effects of an AI program, Amira Learning, on literacy development in early childhood education.

To better understand and explain the importance of this study, this review of literature explored and analyzed current research associated with the effects of Covid-19 to the educational system, the different views on educational technology and AIEd, studies involving ITS and literacy development, and a brief overview of SOR. A wide range of scholarly sources including academic journals, books, and reputable online databases were used to provide a comprehensive understanding of this topic and to identify gaps or areas for future research. For the purpose of fairness, Amira Learning software inhouse, company-funded research on their program will not be presented in this chapter, but will be used to analyze data for the present study.

Covid-19 and Early Childhood Education

In December 2019, an unfamiliar strain of the airborne virus Severe Acute Respiratory Syndrome (SARS) was reported about 7,000 miles away from the United States in Wuhan, China. In a few months' time, the virus, now known as Covid-19, has caused a global pandemic and has shut the world down, significantly affecting all industries and sectors such as healthcare, manufacturing and retail, travel and tourism, labor and employment, and education.

Covid-19 undeniably threatened the physical and mental well-being of teachers and students, but research suggested that there were other pressing issues that the pandemic posed on the education system. Although the effects of Covid-19 can be observed in all levels in education, the extent to which the pandemic impacted each level of education varied. In ECE, where developmentally appropriate high-quality learning experiences are linked to children's holistic development and future success (Britto, 2015; Bredekamp, 2020, UNICEF, 2020), school closures in 2020 proved to be problematic.

Early Childhood Education, Remote Learning, and Educational Technology

Remote Learning

School closures disrupted social interactions, isolated young students, and limited their learning experiences which presented threats to their overall welfare and academic achievement (Golberstein & Miller, 2020). At the midst of the pandemic, the majority of the countries in the world opted for remote learning to continue educating students safely from their home. However, only 60% of these countries implemented support for ECE, despite recognizing the crucial development of young children during these early stages (UNICEF, 2020). At that time, young children were believed to be at a lower risk of developing and transmitting the virus, hence, they were not at the center of public discussions and planning (Dias, et al., 2020).

For countries that implemented remote learning in ECE, the challenge was on adult engagement because young students were not able to manage remote learning independently, therefore, their online learning experiences mainly depended on the adults at home. During this time, the inequities in ECE were also observed in the areas of teacher training, technology availability, and quality of resources and materials for use while students were at home (Dias, et al., 2020; Ford, et al., 2021). All of these affected the standard of teaching and learning during the pandemic.

The absence of high-quality enriching activities and experiences in ECE during the peak of the pandemic was beyond concerning. At that time, young children were not believed to be super transmitters of Covid-19, which naturally led state leaders to deal with the more vulnerable groups putting ECE on the backburner of Covid-19 discussions(Dias, et al., 2020). Interestingly, a published study by the Journal of Pediatrics “refuted the idea that children were at minimal

risk, providing new evidence that children can have higher levels of virus and transmit COVID-19 more than adults in intensive care units" (Dias, et.al., 2020, p. 39). This played a role in decisions about continuing remote learning or reintroducing face-to-face instruction.

Learning Loss

It was presumed that when students are given extended breaks, whether it be weather-related disruptions or summer vacation, they experience the usual learning loss where they are predicted to regress and lose some knowledge and skills that were previously acquired during the school year (Dorn, et al., 2021; Poletti, 2020). With about five months of school closures and remote learning, education experts predicted that Covid-19 will cause learning loss (Sabates, et al., 2021) and will widen already existing learning gaps especially for the most vulnerable groups (Hoofman & Secord, 2021; Van Lancker & Parolin, 2020).

In an analysis of Covid-19's effect on K-12 students, Dorn, et al.. (2021), found that the impact on their learning was substantial with an average setback of five months in mathematics and four months in reading by the end of the 2020-2021 school year. The authors also confirmed that the pandemic exacerbated the already existing learning gaps due to factors such as economic status, disabilities, students' primary language, and other physical, mental, or emotional issues. The widening of the existing academic gaps was also observed by Dias, et al. (2020). The authors interviewed 26 early childhood teachers from different countries across Latin and North America about their experiences in teaching during the pandemic. They emphasized that remote learning, to provide young children with meaningful learning experiences, had to be "more dynamic and less teacher-centered" (p. 41). In a study that Hoffman and Secord (2021) conducted, they suggested that Covid-19 "will continue to affect the delivery of knowledge and

skills at all levels of education" (p. 1076) and although some students may adapt to new modes of learning, they still need the guidance and support to continue with the new normal.

Educational Technology

Despite facing the adverse effects of the pandemic, early childhood educators and advocates strived to find ways to provide the youngest students the developmentally appropriate, high-quality learning experiences that they deserve while maintaining their safety from the virus (Ford, et al., 2021). As a solution to this dilemma, world leaders opted for remote learning using educational technology during the pandemic.

For the past few decades, there has been an ongoing dispute about the benefits and consequences of integrating technology in the classroom, and whether or not to accept technological transformation (Straker, et al., 2018). Although this topic remained open to discussions (Jeong & Kim, 2017), current developments and circumstances have shifted the focus of educational technology. As early as April 2020, UNESCO (2020) identified the use of information and communications technology (ICT) to continue student learning while the schools were closed and expressed the urgency to "ensure that the youngest learners are not neglected and receive the stimulation they need to set the foundation for learning in their future" (p. 1).

Although promising, not everyone believed that technology was the solution in closing learning gaps as a result of the pandemic. In a literature review conducted by Jalongo (2021) about Covid-19 research and resources in ECE, the author noted that while relying on technology allowed for continuous learning during the pandemic, it may intensify the already existing gap especially for disadvantaged students- those who belong to high-poverty, low income families,

who belong to subgroups such as ELs or those with disabilities (Bailey, et.al., 2021; Dorn, et.al., 2021; UNICEF 2020). Therefore, it was critical to consider the educational technology that will support the implementation of high-quality learning experiences for all students (UNICEF, 2020) and will help them become productive citizens in the future (NAEYC, 2022; UNICEF, 2017).

After the pandemic, educational technology has been continuously used in many different ways. In ECE, teachers and students utilized it as online platform tools for synchronous and asynchronous learning, as learning management systems or hubs for resources, materials, and apps, as tools to communicate with parents and families, as assessment portals, as and even as personalized intervention programs. Due to the special developmental characteristics and needs of young children, selecting the most appropriate educational technology in ECE can be tricky. The developments in neuroscience have offered a better understanding of how the young brain works and how the quality of early learning experiences can either leave a positive, lifelong impact on children's growth, development, and success (NAEYC, 2022; UNICEF, 2017) or cause lifetime adverse effects (NAEYC, 2022; Knudsen et al., 2006). ECE is also linked to a grander idea of global development. It is associated with sustainable development and future economic growth (Britto, 2015; Samuelsson & Kaga, 2008) and is believed to contribute around $163 billion to the US gross domestic product (GDP) (LeMoine, 2020). With investing in high-quality ECE for children considered being high stakes, there is a need to ensure that the technology that will be used by young children will support them in reaching their full potential. A prospective educational technology that supported these objectives is artificial intelligence in education (AIEd).

Artificial Intelligence in Early Childhood Education

Recently, the use of computers and digital devices in the early childhood classrooms has been taken over by the use of AI. Artificial Intelligence (AI) has enabled machines to act and think like humans (ISTE, 2020, 0:28; Lindner & Romeike, 2019; Unicef, 2020), something that was thought to be impossible until the last few decades. AI is seen as a major contributor to economic growth with the expected total contribution of $15.7 trillion by 2030 (PwC, 2017). In 2025, it is predicted that AI will displace 85 million jobs, but at the same time, add about 12 million AI-related jobs globally (Russo, 2020). Most businesses will have to reskill or upskill their current employees (Russo, 2020) to ensure that they are equipped to do the work of the future, today. With the shift in skills in workforce and training, the top universities from around the world have increased their AI investments over the past few years, offering a 102.9% undergraduate and 41.7% graduate increase in the number of courses that teach necessary skills to build or use a practical AI model (Zhang, et al., 2021).

With the universities acting quickly to support this fourth industrial revolution, most k-12 schools were called to support this movement, hence, many k-12 schools have started using AI enabled programs to facilitate teaching and learning. Among the top skills needed to thrive in 2025 included analytical thinking, creativity, and flexibility (Russo, 2020), all of which are skills that AI enabled programs are capable of supporting and honing (ISTE, 2019).

AI has already made its way into every doorstep of homes, job sites, and schools around the world. It can be visibly seen in gadgets such as smartphones, smart speakers, and programmable robots or it could be working invisibly in the background in search engines and social media search recommendations, in email filters for spam or inbox-worthy messages, or in

the amount of support tutoring software provides students based on their responses. Whether we see it or not, or whether we like it or not, AI is here and will also be in the future.

AI Capabilities

Most k-12 students will enter the workforce when AI is deeply rooted in jobs and has been well-established (Passow, 2019), this means that all students, including those who are in ECE, have to explore and manipulate AI enabled programs to acquire soft skills associated with working with them in the future. It is also necessary that in their young age they become fully aware and begin to understand how these programs work and how they can be used in their chosen careers in the future. AIEd brings a lot of possibilities and offers capabilities that promise to provide differentiation and support for all students. In early childhood settings, the AI capabilities below are the most commonly used.

Data Collection and Management using Educational Data Mining (EDM)

Part of the most challenging tasks of a teacher, aside from the actual act of teaching, includes collecting, recording, analyzing, and reporting data. EDMs are programs and applications that are used to collect, analyze, and track students' achievement and behavior and convert them to useful and meaningful information (Luckin, et.al., 2016; Zorić, 2020). This information is readily available for teachers, administrators, and parents to use. EDM is useful for early childhood teachers because of its ability to collect uniform data for all students and to precisely and efficiently analyze them. Some EDM programs like ESGI and DIBELS Next have the ability to produce detailed reports based on student data that can be used for intervention and early identification. Reports can also be used to communicate student progress with parents and

other professionals. EDM can also collect and analyze students' attendance and behavior and predict possible issues that may occur based on the trends and patterns.

Production of Smart Content

Many early childhood students and teachers have yet to discover individual students' learning preferences and needs. In order to provide differentiation and promote a love for learning, teachers need to provide students with choices on how to access and learn new information. AI has enabled teachers to customize lessons by producing smart contents through digital platforms, information visualization, and learning content update (Plitnichenko, 2020). Several digital platforms offer lessons in various formats, complexities, and languages, customizable visuals to represent the lessons, and automatically updates the information to keep abreast with the latest, most relevant information. Learning A-Z, NewsELA, and Zearn Math are some examples of digital platforms that offer smart contents.

Accessibility and Support

Perhaps one of the best capabilities of AIEd is its accessibility. The Covid-19 pandemic caused several sectors, including education, to lean on technology tools, specifically the use of human-like helpers like AI (Zorić, 2020). The need to remotely work and study forced many school districts to offer synchronous and asynchronous virtual lessons for all students in k-12. The Louisiana Department of Education (LDOE) opted not to require synchronous lessons for pre-k and younger students for many reasons, including the lack of parental availability to support students in online learning communities during school hours (J. Board, personal communication, February 2020). AI has made it possible for parents to conveniently and easily access lessons, materials, and resources in their children's grade level that students can do at

their own time and pace. Chatbots and online assistants are also able to support parents and students in answering questions they may have at any time.

Automated Assessments

Teachers and students can take advantage of AI's ability to provide automated assessments that will immediately grade and provide feedback to both teachers and students. Google Forms, Mentimeter, and Kahoot are some programs that can be used in the early childhood classroom that will do this task while adding additional tools for students such as links to videos or other resources. Some of these programs can even be fun and celebrate student success by enabling teachers to add special animations or sounds when students get correct answers.

Personalization and Feedback through Intelligent Tutor System (ITS)

In ECE, it is important that one-on-one attention is given to students because of their unique developmental characteristics and learning differences. Unfortunately, in some states like Louisiana, kindergarten to 2nd grade classrooms in public schools have an average teacher-to-student ratio of 1:25. This makes it almost impossible for the teacher to provide this one-on-one attention consistently and on a daily basis. Luckily, AIEd has made it possible for ITS to provide all students the attention and support they need, whenever they need it. ITS uses "AI techniques to simulate one-to-one human tutoring, delivering learning activities best matched to a learner's cognitive needs and providing targeted and timely feedback, all without an individual teacher having to be present" (Luckin, et.al., 2016, p. 25).

Amira Learning Software

Benefits and Challenges in Tutoring

The present study focused on an ITS program, Amira Learning software, and its impact on young children's literacy development. Before exploring the impact of intelligent tutors, it is imperative to understand the significant role of a human tutor to the academic growth of students. Merriam- Webster defines a tutor as a person in charge with the instruction and guidance of another. In K-12, learning from a knowledgeable and skilled tutor is an invaluable tool. It can particularly be beneficial for children who are experiencing academic challenges so they can build resilience and perseverance. In some cases, tutoring can be what separates academic achievement from academic failure. Perhaps the most astounding characteristic of tutoring is the ability of tutors to provide immediate feedback and adjust instruction accordingly to meet the needs of the individual student. Just like in any capacity, expertise plays a big role in the success of tutoring. A highly-skilled tutor can influence learners in many positive ways, but on the other hand, "human tutors who are not experts and yet tutor in academic areas can do more harm than good" (Graesser, et al., 2012). It is expected that when tutors have the expertise in the subject they teach, students will yield positive results.

In a meta-analysis with 96 past sample studies, Nickow, et al.. (2020) confirmed the outstanding claims that tutoring produced significant positive outcomes for students. In addition to this, they emphasized that tutoring was more effective when facilitated by teachers and paraprofessionals as compared to paraprofessionals and parents, which again highlights the point of a subject-area expert tutor. The authors also expressed that tutoring has a greater effect in early grades and that customization, the ability to gear instruction based on the students' level,

may have been the main reasons why tutoring is effective. They also added that the one-on-one nature of tutoring allows students to be more engaged in the lesson while at the same time enabling the teacher to provide more feedback. This leads to more opportunities for students to practice the skills they are learning. Nickow, et al. (2020) also believe that the interactions between the tutor and the students allow them to develop a healthy, positive relationship which results in academic success.

Despite the positive effects of tutoring in K-12, there are a few challenges in this form of instruction. The first issue can be linked to the cost of the program. While traditional tutoring has been proven to work, the one-on-one sessions can be very costly compared to small group instructions. Another hurdle is time management. In a classroom setting with roughly between 20-30 students with varying levels and needs, it can be difficult to find the time to meet with individual students for tutoring with only one teacher present without sacrificing regular instruction time. The last but not the least of the concerns will be customization (Bloom, 1984). Planning for actual tutoring instruction for each individual student can also be taxing to teachers, especially for lower grade teachers who teach all contents.

Intelligent Machine

The conditions explained above make AI a perfect candidate for a human-like tutor that will be more cost effective and manageable than employing real teachers. As a result of Covid-19 pandemic, educators and stakeholders have been exploring ways to help close learning gaps without over exhausting the human and financial resources the school systems have. AI was initially explored to serve the role of a tutor in the 1970's when J. Carbonell introduced SCHOLAR, an intelligent tutor (Guo, et al.., 2021; Mousavinasab, et al.., 2021). With the known

success rate of one-on-one tutoring, many academic institutions have been working hard to develop new and polish existing ITS.

ITS are advanced AIEd tools that resulted from the collaborative efforts of researchers in the fields of Education, Psychology, and AI (Atun, 2020). ITS are human-like computer programs or tutors that have the ability and knowledge of the subject they teach (Alkhatlan & Kalita, 2018). They are designed to facilitate personalized adaptive learning experiences and unlike conventional educational technology tools, ITS possess a distinct characteristic of being able to modify their own behavior based on the information they receive from the student and teacher users, programmed to learn the cognitive patterns of students, and provide individualized instruction to help them learn specific skills in different subject areas (Atun, 2020; Ma, et al., 2014). ITS "know what they teach, whom they teach, and how to teach" (Alkhatlan & Kalita, 2018, p.2). What sets ITS apart from other AIEd programs is that these tutors have the ability to process the students' learning and provide instant, automated feedback to support learning (Alkhatlan & Kalita, 2018; Roscoe, et al., 2014) similar to human tutors.

Intelligent Reading Tutor

As a reading tutor, ITS has proven its positive impact on elementary-aged students. Wijekumar (2012, 2013, 2018) has been a part of a number of studies on ITS and its impact on reading comprehension. In 2012, Wijekumar, et al. conducted a randomized controlled trial to investigate if 4th grade ITS classrooms outperform control classrooms in expository reading comprehension as measured by standardized and researcher-designed tests. There were a total of 60 rural and 71 suburban classrooms that participated in the study. The experimental conditions were randomly assigned to the schools. After the teachers have been notified of the assignments,

the ITS classroom teachers were asked to use the program for 30-45 minutes each week as a substitute for a portion of the regular language arts instruction. Total instruction time for both ITS and control classrooms were planned to be the same. The teachers who were assigned to ITS classrooms were given professional development training prior to the beginning of the next school year. A pretest was administered to all participants and a posttest at the end of the school year after the experiment.

Pretests revealed no significant differences in students' comprehension level, which make them comparable groups before the experiment. Results of the study suggested that students who were in the ITS group who used the program for about 30-45 minutes per week over a span of 6 months displayed significantly improved performance, as evidenced by the research-designed posttest, compared to their counterparts in the control group. On the other hand, a small effect size with the ITS group was observed on the standardized multiple choice comprehension test given during the posttest.

In 2013, Wijekumar, et al.. conducted a multi-site cluster randomized trial to investigate whether there was a connection between fidelity in using ITS and improvement in reading comprehension of 4th and 5th grade students. The researchers used both standardized and researcher designed measures in their study. The experimental and control groups used the same curriculum, with the exception of one class period each week because of the random ITS and control classroom assignments. For the ITS classroom, one language arts class was substituted with the web-based program for 30-45 minutes each week.

A total of 131 4th grade teachers and 128 5th grade teachers were randomly assigned to ITS and control groups. The ITS classrooms that were selected in the study after random

assignment were the ones who implemented the ITS software with fidelity. Students were administered a pretest at the beginning of the academic year and a posttest at the end of the academic year. Researchers noted that there were no significant differences between the ITS and control groups on the pretest, which indicated that both classrooms were comparable before the implementation of the experiment.

The analysis revealed that the use of ITS with a high level of fidelity, including sufficient time used, teacher monitoring, and teacher engagement in 4th and 5th grade classrooms resulted in moderate to large effects on the researcher-developed measures. On the standardized test, the effect sizes were small, but still notable considering the nature of the multiple choice format of the reading comprehension test. The effect sizes were particularly impressive for 4th grade students.

In a similar study from 2012, Wijekumar, et al. (2018) conducted a large scale randomized controlled trial to examine the impacts of a web-based instruction structure on the reading comprehension of struggling fourth and fifth grade readers. The researchers used standardized and researcher designed tests. A total of 45 schools, consisting of 22 rural and 23 urban schools, volunteered to participate in the study. There were a total of 725 fourth grade students and 717 fifth grade students from both school settings. The students were administered a pretest at the beginning of the school year and a posttest at the end of the school year. Students who scored at the lowest 25% percentile on reading comprehension pretest were chosen to participate in the study.

The regular instruction was based on the structure strategy, an instructional approach that was text structure-based for improving reading comprehension in the content area. The ITS

modeled how to identify signaling words, classify text structure, write a main idea, construct a recall of text, generate inferences, and monitor comprehension using an AI agent, I.T. Both the ITS and the control classrooms had an equivalent amount of language arts instructional time, averaging 450 minutes per week or around 90 minutes per day. In the ITS classrooms, the students received 30-45 minutes of language arts instruction each week using the software, replacing traditional teacher instruction.

The findings in the study of Wijekumar, et al. (2018) indicated that the implementation of the web-based ITS for teaching structure strategy has demonstrated a positive impact and holds potential for further improving instruction for students who struggle with reading comprehension.

The studies presented above investigated the effectiveness of ITS in reading comprehension of upper elementary grades. Although the results were significant and instrumental in the present study, the positive outcomes of ITS in these levels cannot be used to generalize and suggest positive impacts on foundational literacy skills, which the present study investigated. Searches on academic databases for studies on the impact of ITS on foundational literacy skills did not yield a wide range of results, but Amira Learning software's webpage (https://www.amiralearning.com/research.html) listed titles of articles and field trials published and funded by the company, in conjunction with Amira Learning software, or were about Project LISTEN, which where Amira Learning software reportedly originated from. Some of these studies were used as references in the present study but were purposely not presented in the literature review for fairness.

Amira the Intelligent Tutor

Amira Learning software claims to be the world's first intelligent reading assistant that offers personalized tutoring to help students improve their reading fluency. Amira, an animated young lady, interacts with the students by initiating conversations, asking questions, and providing feedback while students are reading. Amira has the ability to filter discussions and is programmed to respond and talk only about the story students are reading (www.amiralearning.com, n.d.).

Amira Learning software's technology has its roots in research spanning two decades under the sponsorships of Carnegie Mellon University's (CMU) Project LISTEN (Literacy Innovation that Speech Technology ENables). Originally known as "RoboTutor " during its tenure within Project LISTEN, this software underwent rigorous development and refinement after being licensed from CMU. The objective was to make sure that students, educators, and families could access and utilize this extensively researched and evidence-based platform on a large scale (Meta-Analysis of Research on Amira Intelligent Tutoring's Impact, 2022).

Project LISTEN is a research initiative developed by CMU. The primary focus of Project LISTEN is to improve literacy skills, especially reading, using speech technology. An overview of the technology typically used in Project LISTEN included (https://www.cs.cmu.edu/~listen/):

Automatic Speech Recognition (ASR). ASR technology is used to convert spoken language into written text. In the context of Project LISTEN, ASR is employed to transcribe and analyze students' spoken responses to reading exercises.

Intelligent Tutoring Systems (ITS). Project LISTEN often utilizes intelligent tutoring systems to provide personalized instruction to students. These systems adapt to individual learners and provide feedback and guidance based on their performance.

Speech Processing Algorithms. Various speech processing algorithms are used to analyze students' pronunciation, fluency, and comprehension while reading. These algorithms can help identify areas where students may need improvement. Project LISTEN converts speech input (Sphinx) to usable data.

Machine Learning and Data Analytics. Project LISTEN employs machine learning and data analytics to assess and track student progress, identify learning patterns, and adapt instruction accordingly.

Educational Data Mining. The technology in Project LISTEN includes interactive educational software and applications designed to engage students in reading activities and provide a dynamic learning experience. It uses data to learn about students and instruction to predict students' behavior, assess their needs, and evaluate the intelligent tutor's teaching.

Amira Learning Platform

Amira claims to offer support to both students and teachers. When students log in to the portal, Amira, the animated tutor, provides them with a variety of books to choose from. She then activates her AI technology to listen to students read. Amira begins conversations with the students and takes notes of reading patterns and their responses to help identify reading skills gap. Amira uses AI-powered, perfectly-timed micro-interventions aligned with SOR to support foundational reading skills (phonics, phonemic awareness, decoding, and vocabulary) and later

on, comprehension, to provide tutoring to the students. As students progress with their tutoring sessions, Amira celebrates the completion and presents their reading data (average speed and average correct) to show their reading progress.

To support teachers, after students' reading sessions, updated, detailed reports which track student progress and identify struggles while students are reading are readily available for analysis. Aside from the reports, Amira Learning software also offers the teachers access to instructional links, resources, and activities that they can use when students are not practicing with the software.

The Science of Reading

Louisiana Literacy Initiatives

During its 2021 Regular Session, the Louisiana Senate approved Act no. 108. This new law mandated early literacy training for all subject area K-3 teachers, as well as principals and assistant principals who serve students in these grade levels. The training focused on SOR, an extensive and interdisciplinary collection of scientifically-grounded research on literacy instruction (Moats, 1999; Moats 2020; Science of Reading: Defining Guide, 2022). It has been an area of study for several decades now, but its implications on education have been questioned and a subject of debate (Petscher, et al.., 2021; Seidenberg, 2013; Shanahan, 2020). It was not until the late 1990's when SOR began to gain popularity and recognition in the field of education and literacy instruction. During this time, there was a growing emphasis on evidence-based practices and scientific research in understanding the processes involved in reading development. Additionally, there was an emphasis on the importance of effective reading instruction to match the knowledge of reading (Shanahan, 2020; Moats 2020).

Back in 1999, Moats stressed that even with the scientific knowledge of how the brain works when one reads and despite Scientists' claim that 95% of children can learn how to read, "statistics reveal an alarming prevalence of struggling and poor readers that is not limited to anyone segment of society" (p. 7).

With the promising research but insignificant outcomes, SOR must not only provide information to educators and stakeholders, instead, it should support in identifying the most effective methods to expand literacy opportunities, enhance literacy achievement levels, promote equitable access, and improve efficiency and effectiveness of reading instruction (Shanahan, 2020). This should include focusing on teacher preparation programs and professional development for teachers to provide them with a more rigorous and closely aligned guidance to instructing through SOR (Moats, 2020).

It was not until after more than a decade when the first state in the US embarked on SOR. Mississippi was the first state to support literacy initiatives aligned with SOR in 2013. The state mandated that school systems provide teachers with training in evidence-based reading instruction and intervention while obtaining support from school-based reading interventions. Students with reading difficulties received individualized reading plans and retention policy and support for third grade students who were retained were enforced. The US Department of Education, National Assessment of Education (NAEP) report showed that Mississippi went from the second lowest ranked state in reading scores for low-income 4th grade students in 2013 to the 21st state in the rankings (Lurye, 2023). This significant improvement has gradually influenced other states to adopt SOR, but in 2021, year after the Covid-19 school year, there was a significant increase in the number of states in a year (11 states) that got on board with SOR. This included the state of Louisiana. At present, there are a total of 31 states together with the District

of Columbia, that have mandated laws or introduced new policies regarding evidence-based reading instruction (Schwartz, 2022).

As established earlier in the present study, the impact of Covid-19 on education extends beyond the physical and mental health risks faced by teachers and students. It has also resulted in learning loss and gaps that have adversely affected students' academic progress, specifically growth in math and literacy. Mastery in both math and literacy can be considered as essential components for students to succeed in various aspects of life. However, literacy skills, including reading, writing, and comprehension, are crucial for effective communication, critical thinking, and accessing information across various subjects. Literacy is fundamental for academic success, as it forms the basis for learning and understanding other subjects beyond just language arts (Moats, 1999; Moats 2020). Therefore, anything that negatively affects literacy development is never good news for any state in the nation, but its effects are most daunting on the states like Louisiana which have been at the bottom of the national literacy ranking list for decades (Chavez, 2021). Thus, it was a turning point for many educators when Louisiana decided to be on board with training K-3rd grade teachers and administrators with SOR.

Theoretical Framework: Amira Learning

The present study aimed to investigate the effects of an AI program, Amira Learning, on literacy development in early childhood education. To fully explore this topic, it was essential to consider two overarching concepts: mastery learning (Bloom, 1975) and skilled reader (Gough & Tunmer, 1986; Scarborough, 2001; National Reading Panel, 2000).

Theory of Mastery of Learning

The theory of mastery learning in ITS stemmed from the work of educational psychologist Bloom, who developed the concept of mastery learning in the 1960s. Mastery learning emphasized that all learners can achieve mastery of a subject if provided with appropriate instructional strategies, feedback, and time for learning (Guskey, 2005). Bloom's (1968) theory of mastery learning presumed that students should attain a specified level of mastery on prerequisite knowledge or skills before moving on to more advanced material. This approach contrasted with traditional instructional models that relied on fixed time periods for learning. Mastery learning promoted individualized instruction and allowed learners to progress at their own pace, ensuring a solid foundation before advancing to higher-level concepts.

In the context of ITS, mastery learning theory influenced the design and implementation of instructional sequences, assessment strategies, and feedback mechanisms. ITS based on mastery learning provided learners with tailored instruction and practice opportunities, continually assessing their understanding and providing personalized feedback to address knowledge gaps or misconceptions. These systems monitor learner progress, identify areas of weakness, and offer remediation or additional learning resources to support mastery.

Mastery learning was built upon several fundamental principles that align with the pedagogical principles of ITS. These principles included the following (Abdelsalam, 2014):

- Time is a crucial factor in the learning process. Teachers should allocate sufficient time for each learner, recognizing their varying levels of achievement.

- The quality of teaching significantly influences learning outcomes. If teaching quality is low, learners may require more time to grasp the material effectively.
- Motivation and the learners' ability to comprehend are essential foundations for successful learning. Tasks are accomplished by considering these basics.
- Learners progress at different rates based on their individual capabilities and characteristics.
- Immediate feedback assists learners in identifying and rectifying their mistakes promptly.
- Alignment of the learning objectives with the breakdown of topics and tasks to help in learning the materials.
- Continuous assessment is crucial for attaining the objectives of mastery learning. Diagnostic, formative, and summative assessments are employed to ensure ongoing evaluation.

The present study delved into the alignment between Amira Learning software's instructional design and three of the principles of the mastery of learning. These principles served as a guide when assessing the effectiveness of Amira Learning software in facilitating mastery-oriented learning experiences and improving students' literacy outcomes. The three principles that were used were 1) Learning time and achievement: Bloom's theory recognized the variability in learners' pace of learning and the importance of allowing sufficient time for mastery. The present study investigated the relationship between the time spent using Amira Learning software and learners' achievement levels. 2) Immediate feedback: Bloom's theory highlighted the importance of continuously assessing students' learning to monitor their progress and provide timely feedback. The present study explored the effectiveness of the feedback

provided by Amira Learning software in guiding learners towards mastery and facilitating their learning progress. 3) Alignment of learning objectives with the topics and tasks: Bloom's theory emphasized the importance of clearly defined learning objectives. The present study explored how teachers rate Amira Learning software's feedback and lessons as they align with SOR and its objectives.

The Skilled Reader

The Simple View of Reading (SVR), Scarborough's Reading Rope, and the Five Pillars of Reading are three frameworks that provide a comprehensive understanding of the various components involved in the process of reading. While they have distinct characteristics, they all recognize that reading is a complex process that involves two fundamental practices, decoding and comprehension. They also recognize that reading skills develop hierarchically, with foundational skills serving as building blocks for more advanced ones.

Simple View of Reading

SOR instruction supports the delivery of explicit, systematic literacy lessons to students followed by multiple opportunities to practice reading and obtain feedback from the teacher (Shanahan, 2020; Moats, 2020, Petscher, et al.., 2021; Science of Reading: Defining Guide, 2022). While SOR is not attached to a single ideology or philosophy or program of instruction (Science of Reading Defining Guide, 2022), there are two theoretical models that have been used in professional developments about SOR to explain the complexity of reading, the Simple View of Reading (SVR) and Scarborough's Reading Rope.

Gough & Tunmer (1986) developed and proposed SVR. SVR is a theoretical model that explains reading comprehension by breaking it down into two components: decoding and language comprehension. SVR suggested that reading comprehension is a product of the interaction between these two essential factors (Decoding x Language Comprehension= Reading Comprehension). In this model, both decoding and language comprehension are considered critical for reading success. A reader must possess adequate decoding skills to accurately read words, and at the same time, they need strong language comprehension abilities to understand and make meaning from the text.

Decoding refers to the ability to convert written or printed words into spoken words. It involves recognizing and understanding the individual sounds (phonemes) that make up words and blending them to form meaningful units, such as syllables or words. Decoding skills are primarily associated with phonics instruction, which teaches the relationship between letters and their sound correspondence. Decoding involves phonological awareness, decoding, sight word reading, and fluency.

Language comprehension encompasses the broader understanding of spoken or written language, including vocabulary knowledge, syntax (grammar), semantics (word meanings), and background knowledge. It involves making sense of the words, sentences, and ideas encountered while reading. Language comprehension incorporates background knowledge, syntax, vocabulary, and text structure

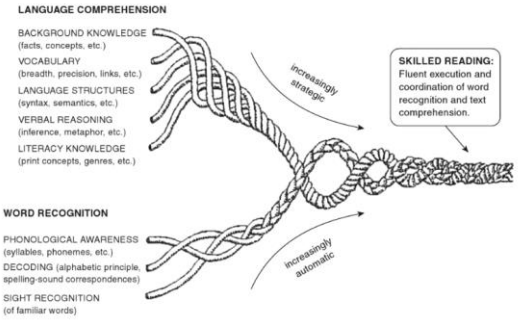
Scarborough's Reading Rope

Scarborough (2001) offered a more thorough representation of the skilled reader through the Reading Rope Model or Scarborough's Reading Rope. The present study referred to it using

the latter. In Scarborough's Reading Rope, the two essential components of reading comprehension have been broken down into individual strands that are interwoven to represent the strong bond that needs to be present in order for students to become skilled readers. This model presented a view of reading comprehension which includes various sub-skills within word recognition (phonological awareness, phonics, fluency) and language comprehension (vocabulary, background knowledge, verbal reasoning, literacy knowledge).

Scarborough's Reading Rope emphasized the reciprocal relationship between word recognition and language comprehension, with both strands intertwined and mutually supportive. It has helped inform instructional practices for phonological awareness, phonics, fluency, vocabulary development, background knowledge, and comprehension strategies.

Figure 1. The Scarborough's Reading Rope



The Five Pillars of Reading

Another theoretical framework that has been linked to SOR is the concept of the Five Pillars of Reading. This was originally based on research by the National Reading Panel ([NRP] National Institute of Child Health and Human Development [NICHD], 2000), a group of highly-qualified scholars bringing together their expertise in the field of science-based research reading and instruction which started in 1997. In NRP NICHD's final report published in 2000, they

identified the five essential components of reading instruction, phonemic awareness, phonics, fluency (also oral reading fluency), vocabulary, and comprehension (Shanahan, 2005).

Shanahan (2005) summarized and explained each component of effective reading instruction below.

Phonemic awareness. Phonemic awareness is the ability to identify, manipulate, and work with individual phonemes, which are the smallest units of sound in spoken language. It is a critical precursor to reading and is considered one of the foundational skills for literacy development. Phonemic awareness goes beyond simply recognizing individual letters or sounds. It involves understanding that words are made up of individual phonemes and being able to manipulate and blend them to form words. Phonemic awareness tasks do not involve printed text; they are focused solely on oral language.

Phonics. Phonics is a method of teaching and learning reading that focuses on the relationship between letters (graphemes) and sounds (phonemes). It involves teaching children to understand and use the systematic connections between written letters and the sounds they represent. In phonics instruction, children learn to associate individual or groups of letters with specific sounds. They learn the phonetic rules and patterns that govern the English language, such as letter-sound correspondences, syllable division, and spelling patterns. Phonics instruction typically starts with simple letter-sound relationships and progresses to more complex ones.

Oral Reading Fluency. Oral reading fluency refers to the ability to read aloud with accuracy, speed, and expression. It involves the smooth and fluent delivery of text, where the reader demonstrates proficiency in decoding words, maintaining an appropriate pace, and using expressive intonation and phrasing. Oral reading fluency is typically assessed by having students

read a passage aloud while being timed. The assessment measures factors such as reading words correct per minute (WCPM), accuracy, and prosody (expression, phrasing, and intonation). The goal is to determine how well a reader can read aloud with both accuracy and fluency.

Vocabulary. In this context, vocabulary pertains to the meanings of words, and vocabulary instruction involves teaching those meanings. However, it is worth noting that reading instruction often concentrates heavily on various aspects of words, such as recognizing them, sight words, strategies for approaching unfamiliar words, word structure, and organizing words based on shared characteristics. As a result, the term "vocabulary" is sometimes used interchangeably to refer to both word recognition and word meaning.

Reading Comprehension. Reading comprehension involves the process of comprehending and interpreting the information presented in a text. Rather than passively remembering information, comprehension focuses on actively constructing meaning. It requires active and dynamic thinking, including interpreting information based on one's own knowledge and beliefs, using the text's organizational structure to analyze information (or applying one's own structure to the ideas), making inferences beyond explicit statements by the author, and engaging in various cognitive processes. Effective comprehension depends on the engaged interaction between the reader and the text, where the reader actively processes and interacts with the information presented.

Using these three literacy concepts as a theoretical framework, the present study analyzed the impact of Amira Learning software on literacy development of first grade students. Oral Reading Fluency (ORF) is an important component of reading as it allows students to practice fluency and develop vocabulary and comprehension.

Summary

The impact of Covid-19 affected everyone around the world, disrupting all aspects of life. In the field of education, it has widened pre-existing learning gaps and has created new challenges (Sabates, et al.., 2021; Hoofman & Secord, 2021; Van Lancker & Parolin, 2020), including providing individualized instruction to meet students' new needs. Fortunately, AIEd has the ability to think and function like a human (McCarthy, 2007) as an intelligent tutor and provide personalized instruction geared to the individual needs of students (Atun, 2020; Ma, et al.., 2014). In states like Louisiana where reading proficiency has traditionally been low (Sentell, 2022), reliance on SOR, a research-based scientific knowledge in teaching students how to read, has been necessary. This present study investigated the impact of Amira Learning software, one of the pioneering intelligent tutors aligned with SOR, to young students' literacy development.

The second chapter of this research presented an extensive review of relevant literature about intelligent tutors and their influence on literacy development. In Chapter Three, various components of the study are introduced such as the research paradigm, setting and context, ethical considerations, data sources, data analysis, and research design.

CHAPTER THREE. METHODOLOGY

The present study aimed to investigate the effects of an AI program, Amira Learning, on literacy development in early childhood education. Amira Learning software is a web-supported Artificial Intelligence in Education (AIEd) Intelligent Tutoring System (ITS) designed to improve oral reading fluency of early learners. With the rapid development of AI technologies and a continuously growing interest in their application in educational contexts, there has been significant growth in the scientific literature in relation to the application of AIEd (Broda & Frank, 2015; Ma, et al. 2014; Mousavinasab, et al., 2021; Nickow, et al., 2020,; Su, et. al 2022; Touretzky, et al., 2019; Yang, 2022). The threats on human capital caused by Covid-19 has also increased research interest in AI as intelligent tutors. To make informed decisions about the research methods to be used in the present study, previous studies were examined. Quantitative research involves the collection and analysis of numerical data to answer research questions. This method provided a systematic and objective way to gather and analyze data, as it allowed for the use of statistical analysis to draw conclusions (Eyisi, 2016; Queiros, et al.., 2017).

A quantitative methodology was used to answer the research questions, with the focus on whether an AI application was effective in improving oral reading fluency in early learners. As planned, the present study focused on following a statistical approach to ensure fairness, validity, and reliability of the data analysis. The research paradigm outlined below provided the theoretical foundation for the study and shaped its direction and goals. The research design constituted a comprehensive plan that systematically addressed the research question. This design served as an overarching framework that guided the selection of appropriate data collection and analysis methods (Spatz, 2019). The research design also outlined the general

approach that was employed in answering the research questions which provided a roadmap for a quantitative investigation. By adhering to a well-articulated research design, it was hoped that the present study ensured the rigor and coherence of the data collection and analysis processes, which led to meaningful conclusions. The data collection section included methods that will be used to retrieve the necessary information to conduct the research (Spatz, 2019). The statistical section explicitly explained the tests that were used to determine the statistical approach that most effectively answered the research questions. The statistical tests that were chosen for the present study were based on the type of data being analyzed and the research questions being asked. The statistical tests helped the study determine the statistical methods that were deemed to provide the most accurate and meaningful results, allowing it to draw valid conclusions about the differences in the data. The careful selection of the appropriate statistical tests helped to produce accurate and reliable results that were useful in answering the research questions and ensured that the findings were as accurate and reliable as possible (Spatz, 2019).

Research Paradigm

The present study used quantitative research methods to examine the effectiveness of the Amira Learning software among first grade students within a suburban school district in Louisiana. As an intelligent tutor, Amira has been designed to provide students with feedback to improve their oral reading fluency (ORF). ORF has been identified as one of the literacy measures that predict literacy success (Shanahan, 2020; Moats, 2020, Petscher, et al.., 2021; Science of Reading: Defining Guide, 2022). The Dynamic Indicators of Basic Early Literacy Skills Next edition (DIBELS Next) has measured ORF beginning in first grade. In the present study, DIBELS Next was used to assess and compare the students' progress before and after the use of the Amira Learning software tutoring software for six weeks.

Because the present study aimed to focus on establishing a specific relationship between two measurable variables (time spent using Amira Learning software and ORF achievement levels), a positivist approach was valuable. Positivism emphasized the use of quantitative methods to gather data and establish causal relationships. The hope was that the findings of the study will be useful and applied in other similar situations to impact research in literacy education. The positivist paradigm enabled researchers to observe occurrences within the particular phenomenon they have studied and draw conclusions about what can be expected in similar cases (Kivunja & Kuyini, 2017).

While there was available research on the effectiveness of AIEd learning applications (Chen et al.,2020; Dong et al., 2022), there was limited information about the Amira Learning software (Loble & Hawcroft, 2022), with the exception of a few research conducted by Amira Learning software in conjunction with other educational organizations. The present study wished to contribute to the body of research that explored the effects of the ITS in improving literacy development in early childhood education (ECE).

Research Questions

The research questions that were investigated in the present study were:

RQ1: What is the relationship between the time spent using Amira Learning software and learners' oral reading fluency achievement levels?

RQ2: How effective is the feedback provided by Amira Learning software in improving students’ oral reading fluency?

RQ3: What is the level of agreement among teachers regarding Amira Learning software's alignment to the Science of Reading and its effectiveness in fulfilling the Science of Reading objectives?

Setting and Context

Setting

The present study investigated the literacy development of first grade students who used Amira Learning software for six weeks. The data that was used for the present study was obtained from one of the suburban elementary schools in Louisiana serving students from Pre-K 3 to 5th grade. Students at the school had access to high-speed internet as well as 1:1 technology device (Chromebook) from kindergarten to 5th grade. The school was the first in the district to use Amira Learning software and pilot-tested the program for all students in K-5th grade during the 2022-2023 school year. During the same school year, the state of Louisiana piloted the program to support English Learners (ELs) and currently had sixteen districts using Amira Learning software for their EL population (www.amiralearning.com).

Population

During the 2022-2023 school year, the school site had a total population of 598 students, with 52% considered economically disadvantaged who received free or reduced lunch. The school was comprised of 54.8% white students, 32.6% black, 11% Hispanic, and 1.6% Asian/ Pacific Islander. For two consecutive years, the school has had the highest EL population in the district. The teacher-to-student ratio in K-5th grade classes ranged from 1:18 to 1:25. The ratios of the five first grade classes that were used in the present study were 1:17, 1:19, 1:21, 1:21, and 1:22.

Participants

The data that was used for the present study was obtained from five classes in the first-grade level. Although data for first grade students was used, the students were not directly involved in the study. The present study used data collected on the DIBELS Next and Amira Learning software platforms. The researcher of the present study adhered to ethical guidelines for using secondary data and identified the original data sources (see *Ethical Considerations*, below).

There were a total of 101 students in first grade at the school site, but data was analyzed only from 79 students. Data from 21 students were excluded if they fell under one or more of the following categories: did not take the DIBELS Next ORF pretest or posttest, was not present, at school, or in class for a total of 5 or more instructional days (equal to 1 week of Amira Learning software usage) during the six-week pilot testing period for Amira Learning software, or had an average Amira Learning software usage of 0 minutes in 6 weeks.

To answer research question 3, purposive and convenience sampling were used to identify the teacher participants. The researcher of the present study chose participants who, because of their background and expertise, were believed to have valuable input on the topic. Teachers at the school site were included if they were certified in early childhood or elementary education (grades pre-kindergarten to 3rd grade), had experience in the early childhood classroom (grades pre-kindergarten to 3rd grade), had experience using Amira Learning software, and had the training in the Science of Reading (SOR) and Amira Learning software. Under these conditions, 17 teachers at the school site were included to answer the two-question online survey.

Ethical Considerations

The researcher of the present study applied for an approval to conduct the study from the Institutional Review Board (IRB) at Louisiana State University (LSU) before conducting the research. An IRB exemption application was granted for the present study after IRB determined that the study posed little to no risk to human subjects.

Even with using secondary data from two online platforms, DIBELS Next and Amira Learning software, the researcher of the present study ensured that safety and security measures were observed throughout the process. A signed consent form was sent to the district superintendent of schools, data administrator, and school administrator. The consent forms described the process of the research, including its purpose, risks, benefits, and their right to withdraw at any time without consequences. The same was done for the teacher participants. The anonymity and confidentiality of data and participants were also discussed. After the consent was signed by the district and school administrators, the data was provided to the researcher of the present study.

No identifying information was used in the study and data security was ensured to protect it from unauthorized access, loss, or disclosure. The data was saved in a password protected electronic device and online information was obtained and stored in a secured online data management system. It was known to the teacher participants that the researcher of the present study was the person who reached out to Amira Learning to pilot-test the software. The researcher of the present study completed the SOR and Amira Learning software training prior to teachers' completion. The participants were informed that the researcher of the present study did not receive any benefits from the company at any time during the pilot testing and while

conducting the present study. In using the secondary data, appropriate credit to the original data collectors or sources in any research outputs or publications were cited as needed.

Amira Learning Software

Amira Learning software claims to offer support to both students and teachers. When students log in to the portal, Amira, the animated tutor, provides them with a variety of books to choose from. She then activates her AI technology to listen to students read. Amira begins conversations with the students and takes notes of reading patterns and their responses to help identify reading skills gaps. Amira uses AI-powered, perfectly-timed micro-interventions aligned with SOR to support foundational reading skills (phonics, phonemic awareness, decoding, and vocabulary) and later on, comprehension, to provide tutoring to the students. As students progress with their tutoring sessions, Amira celebrates the completion and presents their reading data (average speed and average correct) to show their reading progress.

To support teachers, after students' reading sessions, updated, detailed reports which track student progress and identify struggles while students are reading were readily available for analysis. Aside from the reports, Amira Learning software also offers the teachers access to instructional links, resources, and activities that they can use when students are not practicing with the intelligent tutor.

Tools

The present study investigated the use of Amira Learning software (www.amiralearning.com) on student reading skills as measured by DIBELS Next ORF measure (www. acadiencelearning.com).

Dynamic Indicator of Basic Early Literacy Skills (DIBELS) Next edition

DIBELS Next assessments are a set of research-based procedures and measures used to evaluate students' acquisition of early literacy skills. They are designed to be short fluency measures used to regularly monitor the development of early literacy skills and early reading skills (www. acadiencelearning.org, n.d.). In first grade, DIBELS Next assess the measures of phoneme segmentation, nonsense word fluency, and oral reading fluency. It uses four levels of risk to categorize students' performance on the assessment. These risk levels help educators identify students who may need additional support or intervention in developing their early literacy skills. The risk levels are typically classified as follows: low risk (green and blue; students who are performing at or above grade level), some risk (yellow; students who are performing slightly below grade level), and at risk (red; students who are performing significantly below grade level).

Oral Reading Fluency (ORF). ORF as measured by DIBELS Next refers to a specific assessment used to evaluate a student's reading proficiency. In the DIBELS ORF assessment, a student is asked to read a grade-level passage aloud for one minute. The evaluator records the number of words the student reads correctly within that time frame. It focuses on accuracy and rate of reading.

Procedures

The present study used a quasi-experimental design and did not alter any grouping, testing, data collection, and Amira Learning software usage protocols. The school site strictly followed the DIBELS Next (www. acadiencelearning.org, n.d.) testing protocols and had expectations in place for these processes. Student testing and collection of data for DIBELS Next

ORF pretest and posttest followed standardized procedures that included scripts for teachers to use to give the timed test for all literacy measures. This ensured that each student was given the same directions, equal amount of time to complete the tasks, exact materials, similar conducive environment, and consistent score reporting. The test was administered by DIBELS Next trained, certified teachers. Teachers were not allowed to test their own students.

At the school site, the researcher of the present study was responsible for disseminating information to teachers and administrators about Amira Learning software. To ensure that teachers and students get equal opportunities in using the software and that they receive a uniform message about the usage, limitations, and benefits of the program, a 30-minute training was conducted by the researcher of the present study to communicate the program expectations set by the school administrator. The school expectations for usage included allowing students to use Amira Learning software for at least 30 minutes per week for six weeks. The teachers were expected to allot 15-20 minutes each day during their small group English Language Arts (ELA) block for students to use Amira Learning software.

After discussing the usage expectations for the school site, the teachers were given an overview of Amira Learning software using presentation slides shared by the representative from the company. The slides covered topics such as how Amira Learning software works, what the student experiences look like, what reports can be generated from the platform, and how to troubleshoot common issues about the use of the program.

A follow-up online training sponsored by Amira Learning University, the company's professional development platform (www.amiralearning.com), was completed by every teacher who was asked to use the program. The follow-up teacher training took about 30 minutes to complete. Topics covered included usage logistics, sample videos of students interacting with

Amira, information on the program's alignment with the Science of Reading (SOR), and additional training courses available for teachers and leaders. Teachers started using Amira Learning software the following week after the teacher training was completed.

Data Sources

Aligned with quasi-experimental uncontrolled before and after research methods, the effects of Amira Learning software on the literacy development of first grade students were explored without a control group for comparison (Grimshaw, et al., 2000). The following data sources were used in the present study.

First data source. DIBELS Next Oral Reading Fluency (ORF) pretest and posttest were administered to all first-grade students by certified teachers who were members of the school level DIBELS Next team. The data was collected before and after the six-week Amira Learning software usage. Student data were entered to the DIBELS Next portal where pre-generated score reports were downloadable. The reports included all measures of DIBELS Next assessment that were administered to students. The researcher of the present study was provided with the DIBELS Next report by the school district data administrator.

Second data source. The second data source that was used was the total amount of time students used Amira Learning software in minutes. The total amount of time spent in the software was calculated by adding the amount of time students spent reading books and the amount of time students interacted with Amira the avatar during tutoring and feedback sessions .

This data was collected by and stored on the Amira Learning software platform. The researcher of the present study was provided a copy of the report by the school district data administrator.

Third data source. After the six-week period of using Amira Learning software, the teacher participants were asked to answer these questions: “How would you rate the effectiveness of Amira Learning software in accomplishing the goals of the Science of Reading?” and “How aligned is Amira Learning software with the Science of Reading?”. Teachers were provided with an online link to the survey to share their insights.

Data Analysis

In this section, the statistical methods employed to investigate the research questions and hypotheses in this study were outlined. The present study focused on the effectiveness of Amira Learning software usage and feedback in improving students' oral reading fluency and its alignment with the SOR framework. Descriptive statistics were initiated to gain a comprehensive understanding of the central tendencies of the study variables, which provided an initial insight into the data's characteristics. Subsequently, an assessment of the normality of the data distribution was conducted through histogram visualizations and the Kolmogorov-Smirnov test. These assessments indicated that the study variables did not adhere to a normal distribution, leading to the selection of the Wilcoxon Signed Rank test, a non-parametric statistical test that is better suited to analyze the change in oral reading fluency scores from pretest to posttest.

For research question one, the goal was not only to assess the relationship between DIBELS Next ORF pre and post test scores (dependent variable) and Amira Learning software usage in minutes (independent variable) but to also predict and model the oral reading fluency achievement levels based on the time spent using Amira Learning software. To explore the

relationship between Amira Learning software usage and learners' oral reading fluency, a simple regression analysis was conducted. This enabled the ascertainment of the extent to which Amira Learning software usage was associated with improvements in oral reading fluency. The regression analysis provided insights into how the time spent on the platform affected the oral reading fluency scores, considering other potential factors that might be influencing fluency. Regression analysis allowed the researcher of the present study to estimate the strength and direction of the relationship, identify any significant predictors, and generate a regression equation that was used for predictions (Hinkle, et al., 2003).

To address the second research question regarding the effectiveness of Amira Learning software's feedback in enhancing oral reading fluency, new variables representing the difference between pretest and posttest oral reading fluency scores were derived. This allowed the quantification of the degree of improvement in oral reading fluency over the study duration. The paired t-test was initially chosen as a statistical method in the present study to compare the means of two paired measurements taken from the same individual. Two statistical analyses, linear and multiple linear regressions, were conducted to ensure validity of the results of the study.

For research question 3, teachers' insights on the alignment and effectiveness of Amira Learning software with the SOR framework were examined through chi-square goodness-of-fit analyses. These analyses provided valuable insights into teachers' perceptions regarding Amira Learning software. Pie charts were used to show how teachers responded to the two questions.

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 29.0.0.0. This program has been believed to facilitate a thorough examination of the research questions and enabled a robust and systematic analysis of the

collected data. The SPSS software has been a widely used statistical analysis tool in the social sciences and has offered a comprehensive suite of techniques for analyzing and visualizing data. The utilization of this software in the present study ensured a rigorous and systematic examination of the data, thereby contributing to the robustness and credibility of the findings. A predetermined significance level of 0.05 was used in the present study. The chosen analytical approaches were carefully selected to ensure the validity of the findings and to effectively address the specific research questions.

Research Design

The present study used a quasi-experimental quantitative research design to explore the research questions. Quantitative designs are fixed and deductive, with variables and hypotheses designed prior to data collection. For research questions one and two, quasi-experimental design was used; specifically, an uncontrolled quasi-experimental before and after design to measure the improvement in oral fluency due to time spent within Amira Learning software, and Amira Learning software feedback. The present study did not alter any protocols at the school site to obtain data for the study. Instead, secondary data from the school was used and analyzed. After receiving an exemption for the study from the Institutional Review Board (IRB), the researcher of the present study obtained permission from school and district level administrators to use their previously collected DIBELS Next and Amira Learning software data. The data used in the present study were analyzed using the Statistical Package for the Social Sciences (SPSS) version 29.0.0.0.

For research question 1, the impact of Amira Learning software usage on students' ORF scores, the student data that was used were collected immediately before, and immediately after the use of the Amira Learning software using DIBELS Next ORF measure. Tests of assumptions

were performed to ensure the validity and reliability of the regression model and its results. Regression analysis made several assumptions about the data and the relationships between variables. By testing these assumptions, the researcher was able to assess whether the model was appropriate for the data and whether the results can be trusted (Hinkle, et al., 2003). Any observed differences in performance were assumed to be due to the Amira Learning software usage and tutoring. It was hypothesized that, assuming there was a moderate to high positive relationship between ORF scores and Amira Learning software usage, high usage of Amira Learning software will result in high posttest ORF scores.

For research question 2, the effects of Amira Learning software's feedback on students' reading skills, data used was also collected from DIBELS Next ORF and Amira Learning software platforms. The degree of correlation between ORF score and Amira Learning software feedback in minutes was originally planned to be analyzed using paired t-tests on SPSS 29.0.0.0. Tests of assumptions were performed using the program. Similar to regression analysis, conducting assumption checks are also important when performing a paired t-test. A paired t-test is a statistical test used to compare the means of two related groups or conditions, often before and after an intervention or treatment (Hinkle, et al., 2003), and in this case, after receiving feedback from Amira Learning software. Because the assumptions for normality for this data were not met, an alternative non-parametric test, the Wilcoxon signed-rank test was considered and the data was analyzed using linear regression.

For research question 3, Amira Learning software's alignment with SOR and its objectives, classroom teachers were asked to participate in a brief online survey. Teachers were sent a Microsoft Forms online link to answer a two-question survey about their insights on the level of alignment of Amira Learning software and the Science of Reading (SOR). The survey

asked the teachers, “How would you rate the effectiveness of Amira Learning software in accomplishing the goals of the Science of Reading?” and “How aligned is Amira Learning software with the Science of Reading?”. For each question, the teachers were provided the categorical measures to represent their responses. The first question had teachers choose one of the following responses: not effective, effective, highly effective. The second question had the teachers choose from the following responses: no alignment, moderate alignment, high alignment. Descriptive statistics were used to analyze the teachers’ responses on this survey.

Summary

The present study sought to investigate the effects of an AI program, Amira Learning software, on literacy development in early childhood education. Amira Learning software is an Artificial Intelligence in Education (AIEd) Intelligent Tutoring System (ITS) designed to improve oral reading fluency for early learners. The study used a quantitative research methodology to systematically collect and analyze numerical data to answer the research questions. The focus was on whether the AI application was effective in enhancing oral reading fluency in early learners. To ensure rigor and coherence, the study followed a statistical approach and adhered to a well-articulated research design, which served as a comprehensive plan to address the research questions. The data collection methods retrieved the necessary information for the study, and the chosen statistical tests were based on the type of data and research questions to provide accurate and meaningful results. The present study's use of quantitative methods and statistical analysis aimed to draw valid conclusions and produce accurate and reliable findings to contribute to the growing interest in AIEd and its potential applications in education, especially in response to the challenges posed by the Covid-19 pandemic on human capital.

This chapter provided an overview of the present study, covering essential aspects like research paradigm, definition of key terms, setting and context, ethical considerations, data sources, data analysis, and research design. In Chapter Four, the quantitative results of the present study are discussed.

CHAPTER FOUR. RESULTS

Effects of Amira Learning on Pre and Post Test Oral Reading Fluency Scores

The present study aimed to investigate the effects of an AI program, Amira Learning, on literacy development in early childhood education. The impact of Amira Learning was explored through analysis of the difference in the students' pretest and posttest oral reading fluency scores following the 6-week usage of the software.

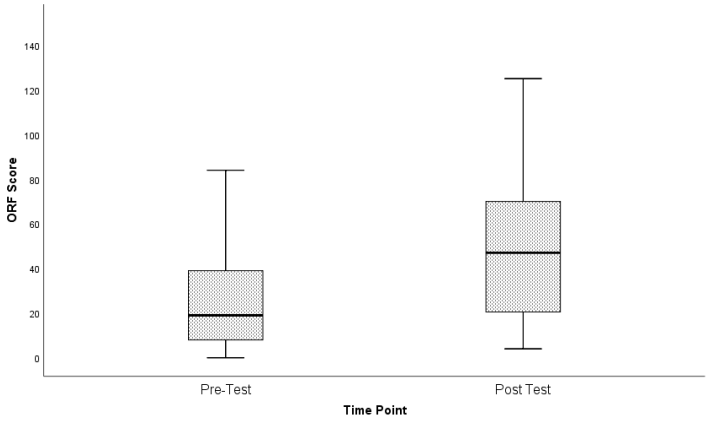
A Wilcoxon Signed Ranks Test was conducted to evaluate the efficacy of the Amira Learning software in enhancing the oral reading fluency (ORF) of first-grade students. This analysis compared pretest and posttest ORF scores, providing valuable insights into the impact of the usage. The results revealed a substantial and statistically significant difference in ORF scores between the pretest (*Mdn* = 19.0, *IQR* = 0-126) and posttest (*Mdn* = 47.0, *IQR* = 4-149) conditions, Z= -7.67, $p < .001$. There was a notable increase in the median ORF score from 19.0 before the usage to 47.0 after its completion. The accompanying rank results provided additional insights into the comparison of ORF scores: notably, there were no negative ranks, indicating that in all instances, the ORF posttest scores surpassed their corresponding pretest scores. A total of 78 positive ranks were observed and one tie was recorded between ORF pretest and ORF posttest scores, which was a singular instance of identical scores. The improvement in scores ranged from 0 (from pretest and posttest tied) to 61 words correct per minute (WCPM). Table 1 presented Oral Reading Fluency (ORF) scores for first-grade students in a suburban Louisiana school district (*N* = 79) before (Pre) and after (Post) a six-week usage of Amira Learning software.

Table 1. Comparison of Oral Reading Fluency (ORF) Scores Before and After Amira Learning Usage

	Pretest		Posttest	
Variable	M (SD)	Mdn (IQR)	M (SD)	Mdn (IQR)
Oral Reading Fluency Score	29.57 (30.02)	19.0 (0-126)	49.05 (31.63)	47.0 (4-149)

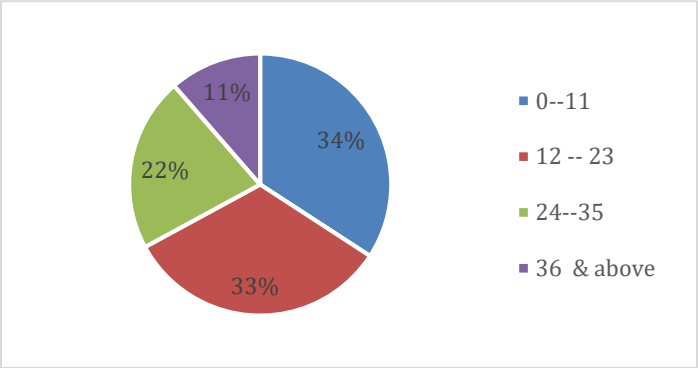
The box plot, Figure 2, illustrated the distribution of ORF scores for first-grade students before (pretest) and after (posttest) usage of Amira Learning Software, which was conducted over a 6-week period. The central line within each box represented the median ORF score, while the box itself spanned the interquartile range (IQR). Whiskers extend to the minimum and maximum values within 1.5 times the IQR. This revealed a substantial improvement in ORF scores among first-grade students following the six-week usage of the Amira Learning software. The median ORF score post-usage notably surpassed the pre-usage median.

Figure 2. Effects of Amira Learning Usage on First-Grade Students' Oral Reading Fluency (ORF) Scores



The pie chart, Figure 3, showed the percent per category increase in the ORF scores of first grade students. The trajectory for average growth was to see an improvement in ORF scores by about 2 WCPM per week (Hasbrouck & Tindal, 2017). A total of 34% (27/79) of the students gained between 0-11 word correct per minute (WCPM) in ORF after the 6-week usage of Amira Learning. Out of the 79 students, 33% (26/79) were reported to have increased their scores by 12-23 WCPM, 22% (17/79) increased their scores by 24-35 WCPM, and 11% (9/79) gained 36 or more WCPM in their ORF posttest.

Figure 3. Growth in Oral Reading Fluency (WCPM scores)



Relationship Between Time Spent on Amira Learning and Oral Reading Fluency

The first research question addressed in the present study was "What is the relationship between the time spent using Amira Learning software and learners' oral reading fluency achievement levels?" This research question aimed to examine the relationship between the amount of time students spent using the Amira Learning software over a six-week period (Amira Learning average usage in minutes) and the improvement in their ORF scores as measured by DIBELS Next (www.acadeincelearning.org, n.d.). Specifically, it sought to understand whether there was a connection between the extent of software usage and the degree of improvement in reading fluency. Additionally, the research question aimed to assess the predictive value of Amira

Learning average usage in determining the enhancement in oral reading fluency scores. In essence, it explored the role of software usage in influencing learners' reading fluency improvements.

A linear regression analysis was performed to assess the relationship between Amira Learning software usage, specifically Amira Learning average usage in 6 weeks (in minutes), and learners' ORF improvement scores. The study included a sample of 79 participants, and ORF improvement scores denoted the difference between pretest and posttest assessments. The dependent variable in this analysis was ORF improvement.

Table 2 displayed the results of a linear regression analysis examining the relationship between Amira Learning average usage in 6 Weeks (in minutes) and learners' ORF improvement scores. Figure 4, the scatter plot, illustrated the relationship between Amira Learning average usage in 6 weeks (in minutes) and learners' ORF improvement scores. Each point on the plot represented an individual participant within the sample of 79. The x-axis denoted the time spent using Amira Learning, while the y-axis represented the improvement in ORF scores. The scatter plot demonstrated a scattered distribution of points, suggesting that while there was a modest positive association between Amira Learning average usage and ORF improvement, there was variation in improvement scores among participants.

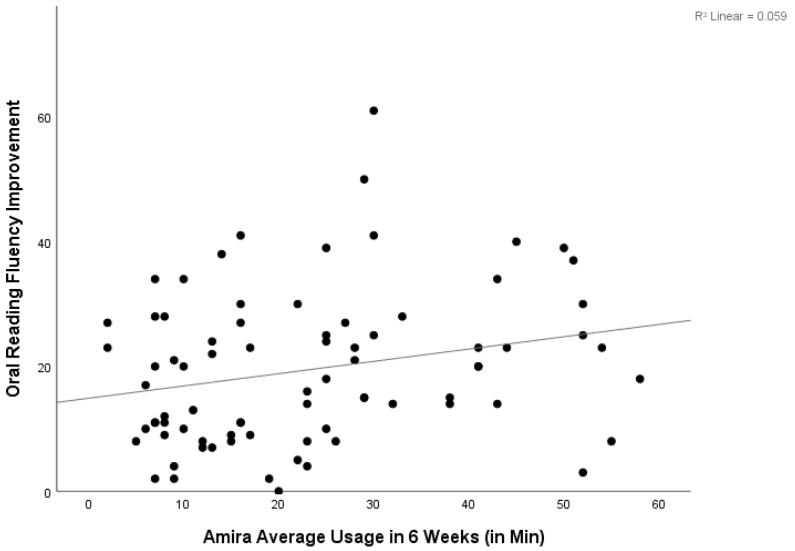
The results of analysis revealed a significant model effect, F (1, 77) = 4.79, p = .032. This indicated that the model, which included Amira Learning average usage as a predictor, provided a statistically significant explanation for variance in the ORF improvement scores. R^2 value of 0.059, suggesting that approximately 5.9% of the variance in the ORF improvement scores can be attributed to the independent variable, Amira Learning average usage. Subsequently, unstandardized coefficients demonstrated that, after controlling for the constant, each additional minute allocated to using Amira Learning over a six-week period was associated with an

increase of 0.20 units in ORF improvement scores (B = 0.20, SE = .09, t = 2.19, p = .032). Additionally, a standardized coefficient (β = 0.24) indicated a positive and moderately strong relationship between Amira Learning average usage and ORF improvement scores.

Table 2. Linear Regression Analysis: Relationship Between Amira Learning Usage and ORF improvement

Predictor	Unstandardized Coefficients		Standardized Coefficients		R^2	F
	B	SE	β	t		
					0.06	4.79*
Constant	14.90	2.48		6.01***		
Amira Average Usage in 6 Weeks (in Min)	.20	.09	.24	2.19*		

Figure 4. Scatter Plot - Relationship Between Amira Average Usage and ORF improvement



Amira Learning's Feedback and Improving Oral Reading Fluency

A second research question was investigated in the present study. This research question asked "How effective is the feedback provided by Amira Learning in improving students' oral reading fluency?". Amira Learning tutoring was equated to the feedback that Amira Learning provided the students, hence, the association between Amira Learning tutoring and the improvement in ORF scores among learners was explored. This research question sought to understand whether increased engagement with Amira Learning tutoring, as indicated by additional tutoring time, was linked to significant improvements in ORF scores. Additionally, the question studied the predictive value of Amira Learning tutoring time in determining the enhancement in learners' oral reading fluency.

Table 3 displayed the results of a linear regression analysis examining the relationship between Amira Learning tutoring time in 6 weeks (in minutes) and learners' ORF improvement scores. The sample size consisted of 79 participants. ORF improvement scores represent the difference between pretest and posttest scores. Dependent variable was the *ORF improvement*. *b* represented unstandardized regression weights. *SE* indicated standard error of *b*. β indicated the standardized regression weights. R^2 indicated variances predicted by the independent variables. *****Indicated $p < .05$, ******indicated $p < .01$****** indicated $p < .001$

Figure 5, a scatter plot, showcased the connection between Amira Learning tutoring time in 6 weeks (in minutes) and learners' ORF improvement scores. Each data point corresponds to a participant from the sample of 79 individuals. The x-axis represented the time invested in Amira Tutoring, while the y-axis displayed the enhancement in oral reading fluency scores. The scatter plot revealed a dispersed arrangement of data points, indicating variability in improvement scores among participants. However, the linear regression analysis uncovered a significant

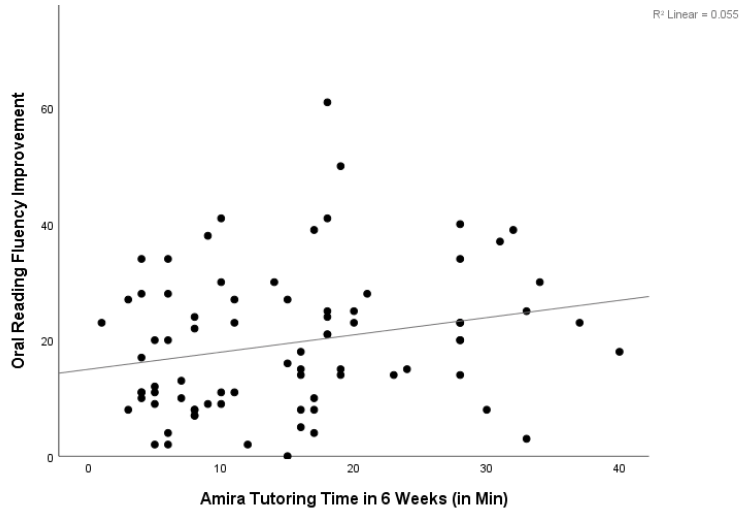
relationship ($p < .05$), demonstrating that greater time spent with Amira Tutoring corresponded to substantial improvements in oral reading fluency.

The second results of a linear regression analysis examining the association between Amira Learning tutoring time in 6 weeks (in minutes) and learners' ORF improvement scores were presented in Table 3. The model's overall statistical significance was evaluated using an F-test, which yielded a significant result, F (1, 77) = 4.46, p = .038. This indicated that the model, including Amira Learning tutoring time as a predictor, held explanatory power. The R^2 value (0.05) illustrated that approximately 5.5% of the variance in ORF improvement scores can be attributed to the independent variable, Amira Learning tutoring time. The regression coefficients showed that, after controlling for the constant, for every additional minute spent using Amira Tutoring over a six-week period, there was an associated increase of 0.30 units in ORF improvement scores (B = 0.30, SE = 0.14, t = 2.11, p = .038). The standardized coefficient (β = 0.23) indicated a positive and moderate relationship between Amira Learning tutoring time and ORF improvement.

Table 3. Linear Regression Analysis: Relationship Between Amira Learning Tutoring Time and ORF Improvement

Predictor	Unstandardized Coefficients		Standardized Coefficients		R^2	F
	B	*SE*	β	*t*		
					0.05	4.46*
Constant	14.98	2.52		5.94***		
Amira Learning tutoring time in 6 Weeks (in Min)	.30	.14	.23	2.11*		

Figure 5. Scatter Plot - Relationship Between Amira Learning tutoring time and ORF improvement



To further investigate the relationship between Amira Learning tutoring time in 6 weeks (in minutes) and learners' ORF posttest (Post-ORF) scores, while controlling for ORF pretest (Pre-ORF) scores, a multiple linear regression was conducted . A two-step multiple linear regression analysis was conducted to explore the relationship between Amira Tutoring Time in 6 weeks (in minutes) and learners' post-ORF scores, while considering pre-ORF scores. In the first model, it was observed that both pre-ORF scores ($B = 0.95$, $SE = .05$, $\beta = 0.90$, $t = 20.46$, $p < .001$) and Amira Tutoring Time ($B = 0.34$, $SE = .15$, $\beta = 0.10$, $t = 2.33$, $p = .022$) significantly predicted post-ORF scores. This initial model accounted for a substantial proportion of the variance in post-ORF scores ($R^2 = 0.86$). Subsequently, a second model introduced an interaction term between pre-ORF scores and Amira Tutoring Time to examine whether Amira Learning feedback impact on performance differed depending on the learners' initial fluency levels. In this second model, pre-ORF scores ($B = 0.95$, $SE = .05$, $\beta = 0.90$, $t = 19.19$, $p < .001$) and Amira Tutoring Time ($B = 0.34$, $SE = .15$, $\beta = 0.10$, $t = 2.31$, $p = .023$) remained significant predictors

of post-ORF scores, while the interaction term was not significant *(t* = -0.005, *p* = .996). Table 4 showed the results of the multiple linear regression.

Table 4. Multiple Linear Regression Analysis: Relationship Between Amira Tutoring Time and Post Oral Reading Fluency Score While controlling Pre- Oral Reading Fluency Score

Predictor	Unstandardized Coefficients		Standardized Coefficients		R^2	F
	B	*SE*	*β*	*t*		
Model 1						
					0.86	237.04***
Constant	49.05	1.34		36.61***		
Pre-ORF	.95	.05	.90	20.46***		
Amira Tutoring	.34	.14	.10	2.33**		
Model 2						
					0.86	155.95***
Constant	49.05			35.53***		
Pre-ORF	.95		.90	19.19***		
Amira Tutoring	.34		.10	2.31**		
Pre-ORF *X* Amira Tutoring	-.0002	.01	.000	-.005		

Teachers' Perceptions on Amira Learning and Science of Reading

A third research question focused on the topic of Amira Learning and its alignment with the Science of Reading. The question that was explored in the present study was: "What is the level of agreement among teachers regarding Amira Learning's alignment to the Science of Reading (SOR) and its effectiveness in fulfilling the Science of Reading objectives?". The question sought to understand the collective viewpoint of teachers regarding Amira Learning's alignment with SOR and its effectiveness in fulfilling SOR objectives. It explored teachers'

perspectives on the extent to which Amira Learning has aligned with the Science of Reading and its perceived role in achieving these educational goals.

In the final research question, two separate chi-square goodness-of-fit analyses were conducted to assess the level of agreement among teachers regarding Amira Learning's alignment with the Science of Reading and its effectiveness in achieving Science of Reading goals.

Alignment Rating

Regarding the alignment of Amira Learning with the Science of Reading, participants were asked to rate the alignment as no alignment, moderate alignment, or high alignment. Results indicated that 3 teachers (17.6%) perceived moderate alignment, while a significant majority of 14 teachers (82.4%) perceived high alignment. None of the teachers who participated perceived low alignment with SOR. A chi-square test was performed, revealing a statistically significant result $\chi^2(1) = 7.12$, $p = .008$.

Effectiveness Rating

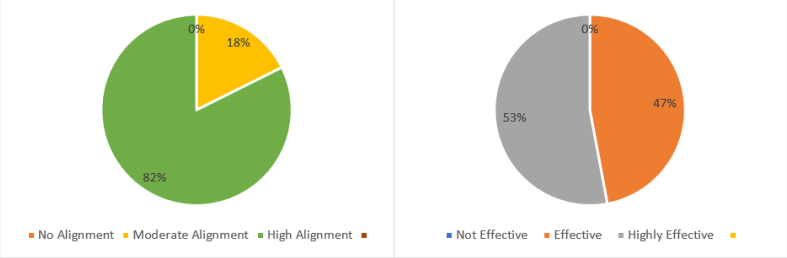
For the question concerning the effectiveness of Amira Learning in achieving Science of Reading goals, teachers were asked to rate the AIEd as either not effective, effective, or highly effective. The observed frequencies indicated that 8 teachers (47.1%) rated it as effective, while 9 teachers (52.9%) rated it as highly effective. A chi-square test yielded a non-significant result $\chi^2(1) = .059$, $p = .808$, indicating no significant deviation from the expected distribution. These results suggest that teachers generally agree on the effectiveness of Amira Learning in achieving SOR goals. A chi-square test yielded a non-significant result $\chi^2(1) = .059$, $p = .808$, indicating no significant deviation from the expected distribution. These results suggest that teachers generally agree on the effectiveness of Amira Learning in achieving SOR goals.A chi-square test yielded a

non-significant result $\chi^2(1) = .059$, $p = .808$, indicating no significant deviation from the expected distribution. These results suggest that teachers generally agree on the effectiveness of Amira Learning in achieving SOR goals.

Table 5. Teachers' Ratings of Amira Learning's Alignment and Effectiveness in Achieving Science of Reading Goals

Variable	N	%
Alignment Rating of Amira Learning with the Science of Reading		
Moderate Alignment	3	17.6
High Alignment	14	82.4
Effectiveness Rating of Amira Learning in Achieving Science of Reading Goals		
Effective	8	47.1
Highly Effective	9	52.9

Figure 6. Amira Learning’s Alignment and Effectiveness Rating



CHAPTER FIVE. DISCUSSION AND IMPLICATIONS

The purpose of the present study was to investigate the effects of Amira Learning, an Artificial Intelligence (AI) program, on the literacy development in early childhood education. Specifically, it sought to determine 1) the relationship between the time spent using Amira Learning and learners' oral reading fluency (ORF) achievement levels; 2) the effectiveness of the feedback provided by Amira Learning software in improving students' oral reading fluency; and 3) the level of agreement among teachers regarding Amira Learning software's alignment to the Science of Reading and its effectiveness in fulfilling the Science of Reading objectives.

Amira Learning and Oral Reading Fluency

The present study delved into investigating the effects of an Artificial Intelligence in Education (AIEd) program on oral reading fluency (ORF) of first grade students. ORF has been established in the literature as a critical measure of overall reading success and an indicator of reading progress (Hintze et.al., 2002; Jenkins, et.al., 2003; Schatschneider et.al., 2002; Speece & Ritchey, 2005). In the early stages of reading, children learn to decode words and understand the relationship between sounds and letters. Fluent reading at this stage is crucial because it allows students to focus less on decoding individual words and more on understanding the meaning of the text. Fluent readers are better equipped to comprehend what they read, which has also been a fundamental goal of reading instruction.

The results of the Wilcoxon Signed Ranks Test (Wilcoxon, 1945) to evaluate the efficacy of Amira Learning software in enhancing ORF of first-grade students suggested a statistically significant difference in ORF scores between the pretest and posttest median scores. The substantial increase in postest median ORF scores of the students after the 6-week usage of Amira Learning software denotes the positive effect of using AIEd to improve ORF, one of the

foundational literacy measures. What was also notable about this increase in median scores was the change in the DIBELS Next benchmark bands from *Below Benchmark* at pretest to *At Benchmark* at posttest.

DIBELS Next (www.acadiencereading.org, n.d.) establishes benchmark scores for each grade level to serve as reference points for assessing students' reading skills. The benchmark categories have been used to help educators assess and monitor students' reading proficiency to determine when intervention is needed. These categories are based on grade-level expectations and provide a framework for understanding students' progress in early literacy skills. Each category indicates how students perform on the assessment based on grade-level expectations and each score represents the predicted literacy outcomes for the students. The DIBELS Next categories *Above Benchmark, At Benchmark, Below Benchmark,* and *Well Below Benchmark.*

Students in *Above Benchmark* category perform at a level that exceeds grade-level expectations. They demonstrate strong proficiency in the assessed skill, and their performance suggests a high level of competence. Students in *Above Benchmark* may not require additional intervention or support in the assessed skill. Students in *At Benchmark* category perform at a level that aligns with grade-level expectations. They meet the expected standard for their grade in the assessed skill. Being *At Benchmark* is an indicator that a student has achieved a reasonable level of proficiency and is on track for reading success at their grade level.

Students in *Below Benchmark* category perform below the grade-level expectations for the assessed skill. They may be struggling with the skill to some extent, and their performance suggests that they may benefit from additional support or targeted instruction. Being *Below Benchmark* indicates a need for closer monitoring and possibly intervention.

Students in *Well Below Benchmark* category are significantly below the grade-level expectations for the assessed skill. They have typically been at the greatest risk for reading difficulties or literacy challenges. Students in *Well Below Benchmark* require intensive and specialized intervention and support to improve their skills and catch up to their peers (www.acadiencereading.org, n.d.).

Prior to the use of Amira Learning software, the average score of the students was *Below Benchmark* which predicted that typical students in the grade level will likely need additional support, such as intervention or tutoring, to become successful in reading. Students who were unable to receive the support needed will likely be at more risk of reading deficits in the future. Providing this level of support to individual students can be labor-intensive for teachers and their class size and daily schedule may prevent them from providing the level of support and feedback that each student needs. After the 6-week usage of and interaction with Amira Learning software, the average ORF score of the students was a level higher which was *At Benchmark* category, which predicted successful achievement of reading outcomes provided that the students receive high-quality core English Language Arts (ELA) instruction. Using the Amira Learning software as an intelligent reading tutor allowed all students the support and feedback that they needed to progress in their reading skills without providing additional teaching staff or using extensive class periods to attend to individual student needs.

Another noteworthy effect of Amira Learning software on the students' ORF scores was the amount of growth on individual scores that were recorded from pretest to posttest. Amira Learning software was able to positively affect the students' accuracy and rate of reading as measured by the number of words correct per minute (WCPM). Consistent with the principles of the Skilled Reader, these gains in ORF posttest meant that students will be more equipped for language comprehension. This result suggested positive effects of Amira Learning software

on ORF even when used in a relatively short period.

To address the first research question "What is the relationship between the time spent using Amira Learning software and learners' oral reading fluency achievement levels?" A linear regression analysis was conducted to assess this connection, which focused specifically on Amira Learning software average usage over a six-week period. The analysis demonstrated a significant model effect and implied that the inclusion of Amira Learning software usage as a predictor in the model offered a statistically significant explanation for the variance observed in the ORF improvement scores. In other words, there was a meaningful relationship between how much time students spend using Amira Learning software and their ORF score improvements. This underscored the potential benefits of incorporating Amira Learning software into reading instruction to support students in developing their reading skills effectively.

These findings were consistent with the results of a study by Consortium for Policy Research in Education (2021) when Savannah-Chatham County Public School (SCCPSS) partnered with Amira Learning software to improve literacy outcomes. The study explored the effects of Amira Learning software on four literacy outcomes, including ORF. The study span over two different periods, fall to winter and winter to spring. The findings of this study shed light on the connection between the frequency of Amira Learning software usage and the growth in WCPM over the fall-to-winter period. Specifically, for each additional week of usage, there was a statistically significant increase of 0.030 standard deviations in WCPM scores ($p < .001$).

The results of the present study found a correlation between the amount of time students spent using Amira Learning software and the notable improvement in their ORF scores. This implied Amira Learning software, as an ITS, has acknowledged that learning should be an ongoing

process. Amira Learning software's approach has encouraged continuous improvement by adapting content and difficulty levels based on individual progress, thus supporting the idea that learning to read has never been a one-time event but a continuous journey that will impact overall reading success with consistent use. These can be related with the theory of mastery of learning which has acknowledged the differences in the pace at which learners acquire knowledge and has highlighted the significance of allowing students ample time for achieving mastery (Bloom, 1968; Guskey, 2005).

Amira Learning Feedback and Oral Reading Fluency

To fully investigate Amira Learning software's impact on students' ORF scores, two statistical analyses were conducted. These ensured the credibility of the results that the improvement in ORF posttest scores can be attributed to Amira Learning feedback. Results of the present study demonstrated that Amira Learning software tutoring time or feedback, was responsible for the increase in DIBELS Next ORF scores of the first grade students. This result aligned with the theory of mastery learning (Bloom, 1968) which has underscored the significance of ongoing evaluation of students' learning to track their advancement and deliver prompt feedback. The present study investigated the efficacy of the feedback offered by Amira Learning software in directing learners toward mastery and supporting their learning outcomes in early reading. When students do not achieve mastery at first, Bloom (1968) suggested that feedback and opportunities for remediation should be offered to students. In the light of the present study, Amira Learning software's feedback mechanisms and adaptive nature allowed students to receive feedback and additional practice when needed, supporting the concept of revisiting and reinforcing learning until mastery has been achieved. Although not all students achieved *At Benchmark* status on the DIBELS ORF posttest, a notable 66% of the students who used Amira Learning software and engaged in the feedback process increased their ORF scores

by 12 points or more, denoting a positive literacy outcome in just six weeks.

The findings also supported Blooms' (1968) theory which emphasized progressing from lower-order thinking skills (e.g., in literacy decoding and blending) to higher-order thinking skills (e.g., fluent reading and comprehension). Amira Learning software's approach has been designed to scaffold learning, starting with foundational skills and gradually moving students toward more complex reading tasks and higher-order thinking, thus aligning with Bloom's taxonomy. Amira Learning has claimed to offer feedback and support, while also allowing the students the opportunity to engage in productive struggle and to practice their reading skills (www.amiralearning.com, n.d.).

In the context of the Skilled Reader theory, the findings of the present study indicated that Amira Learning software, as an Intelligent Tutoring System (ITS), effectively offers instruction and feedback to support the development of individual students into skilled readers. The study's results highlighted the efficacy of Amira Learning software software's feedback in improving students' ORF. Amira Learning software has followed the research around skilled readers and has conformed to SOR principles as evidenced by the results of the present study, which has also been consistent with the research by Consortium for Policy Research in Education (2021). Amira Learning software has taken pride in encouraging students to use their abilities to read and not rely on the cueing system to guess and has worked on individual students to strengthen their ORF skills (www.amiralearning.com, n.d.).

The results of the present study demonstrated that Amira Learning software's feedback was consistent with the principles of Simple View of Reading (SVR), Scarborough's (2001) Reading Rope, and the Five Pillars of Literacy as evidenced by the growth in WCPM across the board, regardless of students' pretest score. In other words, Amira delivered the mix of

what was necessary for reading success, decoding and language comprehension which resulted in increased ORF posttest scores.

Teachers' Insights on Amira Learning and the Science of Reading

The third research question of the present study explored teachers' insights regarding Amira Learning software's alignment with the Science of Reading (SOR) and its effectiveness in fulfilling SOR objectives. The teachers who participated in the present study recently completed SOR training that consisted of 50 hours of asynchronous, modular work and 6 1-hour synchronous discussion sessions with other participants and the facilitator of the training. At the time of participation, the teachers had completed Amira Learning software implementation training and had the opportunity to use Amira Learning software for a period of six months.

The teachers' responses to the online survey showed teachers' belief in Amira Learning's ability to teach young students according to SOR. In both of the questions they had to answer, there was no recorded response that negatively associated Amira Learning software with SOR. This supported the idea of teachers' insights that Amira Learning software was designed and implemented in a way that was consistent with the scientific understanding of how reading skills are acquired and developed. SOR has an evidence-based approach to literacy instruction that has drawn from decades of research in cognitive psychology, linguistics, neuroscience, and education (Moats, 1999; Moats 2020; Science of Reading: Defining Guide, 2022). Based on these responses, teachers felt that the software has followed the evidence-based practices and principles that have been shown to be effective in teaching reading skills to young students.

The results of the teacher survey also suggested that the teachers had high confidence in allowing Amira Learning software to instruct and provide feedback to their students despite the

controversies surrounding using AIEd in early childhood education. Although the teachers were not asked to explain their responses, the inclusion criteria ensured that all teachers who participated had sufficient knowledge of the objectives of SOR and Amira Learning software, following the intensive training they completed for SOR and Amira Learning software implementation.

As teachers expressed their confidence regarding the alignment of Amira Learning software with SOR and its effectiveness in fulfilling its objectives, the present study has also acknowledged its connection to the mastery learning theory (Bloom, 1978). Consistent with Bloom's (1978) theory, the teachers' responses highlighted how Amira Learning software provided students with instruction using well-defined learning goals, sequential progression, individualized pacing, and using assessments to drive instruction.

In essence, both SOR and mastery learning principles have emphasized the importance of clearly defined and specific learning objectives. SOR has placed great importance on foundational skills such as phonological awareness, phonics, vocabulary development, and fluency, recognizing them as essential components for achieving overall reading proficiency. This alignment with the mastery learning approach, which has established explicit and measurable goals for students, was evident. While Amira Learning software has not offered whole group, explicit instruction, as an intelligent tutor, it has provided individualized opportunities for students to practice their reading skills while receiving timely, focused feedback based on their reading needs.

SOR has recognized the significance of a structured progression aligned with the developmental stages of reading acquisition. This progression was based on research into how children learn to read and the cognitive processes involved. While the exact progression may

vary based on student individual needs, the general progression has been from less complicated reading skills to the more sophisticated ones. This suggested that phonemic awareness comes first before fluency, which will come first before comprehension. Similarly, mastery learning has often organized objectives in a sequential manner, ensuring that students have achieved mastery of prerequisite skills before moving on to more advanced ones. This alignment has reinforced the concept that students established a solid groundwork before engaging in more complex reading tasks. Amira Learning software has pledged to provide the right amount of scaffolds through feedback that has been aligned with SOR to meet students' reading needs.

Both SOR and mastery learning have promoted individualized pacing. SOR has recognized that students may progress at different rates and require different levels of support. In the same manner, mastery learning has allowed students to proceed at their own pace, receiving additional instruction and support as needed until they achieve mastery. This individualized approach has ensured that all students have had the opportunity to master the content. Amira Learning, as it has advertised, has offered personalized instruction while adapting content and difficulty levels based on each student's performance. This individualized approach has been aligned with the customization of instruction in both SOR and mastery learning.

SOR and mastery learning have both emphasized the alignment of assessments with learning objectives and have used them to guide future instruction. In SOR, assessments have been used to monitor student progress and identify areas of strength and weakness in reading skills. SOR has placed a strong emphasis on providing feedback and support to students to help them develop reading skills. In mastery learning, assessments have been closely tied to specific objectives, ensuring that students meet predefined criteria for

mastery. Mastery learning has also highlighted the importance of feedback and has offered opportunities for remediation when students do not achieve mastery on assessments. This feedback loop has been essential for both approaches to support student learning. Both SOR and mastery learning have recognized that learning is an ongoing and continuous process, therefore, assessments should be used to inform future instruction. Amira Learning software actively listened as students read aloud, capturing the session and producing an objective running record that was free from subjective inaccuracies and testing biases. Its AI capability made it possible for Amira Learning software to adjust the rigor of stories and feedback based on previous reading sessions.

Ultimately, the goal of reading instruction has been to develop skilled readers who are fluent, are able to comprehend what they read, and apply their knowledge of reading into different context or content, demonstrating mastery of their learning. The principles of skilled reader and mastery learning both have supported the idea that all learners can become skilled readers when provided with appropriate instruction, feedback, assessment, and time for learning. They have recognized that reading proficiency is a developmental process and that strong foundational skills are crucial for success in reading and overall academic achievement.

Limitations

The present study has acknowledged the possible biases in data analyses due to the limited access to data. Other variables and external factors not considered in this study could have influenced the outcomes of the study. Some of these factors include student demographics such as age, socioeconomic status, or educational background, variations in teacher competence, differences in the teaching pedagogies, and additional services received by students such as small group instruction, interventions, or human tutoring outside of

school. Given that the present study did not use a control group nor controlled variables when running data analyses, the results yielded may have been affected. The duration of the study was relatively short and could have been extended to capture longer-term effects or changes that could occur over time.

Responses from teacher participants may have been partial because of the teachers' relationship with the researcher, who was their curriculum specialist. Although the participants were assured that the survey was anonymous and confidential, their responses might have been influenced by their worry of being judged because of their knowledge of Amira Learning software or SOR or being identified based on their responses because of the small number of participants in the study.

Clinical Implications

The positive effects of Amira Learning software on literacy development in early childhood education are multifaceted and can have several significant clinical implications for educators, administrators, policymakers, stakeholders, and AI program creators. As Amira Learning has been considered a determinant in improving ORF scores, the present study has highlighted the importance of early intervention and feedback in literacy development (Guskey, 2005). The present study supports previous research that recognizes that identifying and addressing reading difficulties in early childhood can prevent future, long-term academic challenges (Shanahan, 2020; Moats, 2020, Petscher, et al.., 2021; Science of Reading: Defining Guide, 2022).

The results of the present study implied that incorporating an AIEd intelligent tutor into early childhood education can lead to improved reading and literacy outcomes for young learners. Amira Learning software's adaptive nature could allow early childhood educators to

better tailor their instruction to individual student needs, promoting personalized learning experiences (Wijekumar, et al., 2018) without the burden of planning and facilitating one-on-one sessions with every student every day. Using Amira Learning software can also suggest that early intervention using technology-based literacy programs can be effective. Educators can consider incorporating software such as this into early childhood interventions to prevent having students who will be at risk of literacy difficulties in the future. Amira Learning software may underscore the importance of data-driven assessment and progress monitoring. Educators can use the reports generated from the platform to track children's literacy development over time, enabling more informed decisions about intervention strategies and classroom instruction. Amira Learning software's data collection and analysis capabilities can enable educators a low labor-intensive, yet accurate measure to make data-driven decisions about students' progress. This implies a need for data literacy among educators.

Administrators can benefit from the results of the present study by using the information presented in making informed decisions about technology purchases and staffing. Administrators who wish to use Amira Learning software should consider other factors related to the use of the software such as access to high-speed, reliable internet, dependable electronic devices, and other additional supplies such as headsets with a microphone. The aftermath of Covid-19 depleted the workforce and made it hard for administrators to find teachers and support staff. Amira Learning software can be utilized as a low-cost, non-labor intensive personalized reading tutor to address the staffing issue without sacrificing the quality of support offered to the students.

This study also has the potential to influence policymakers in their decisions to allocate resources for schools and early childhood education centers to acquire and implement educational technology like Amira Learning software. Although the present study only

measured results for first grade students, the results show promise and could be scaled across the state for all students. The present study's findings may also shed light on potential disparities in access to educational technology. In light of the positive results found in this study, policymakers should consider issues of equity to ensure that all students, regardless of their background, can have access to AIEd and that technology infrastructures, such as the internet and computers, are available to our most vulnerable populations.

The positive effects of Amira Learning software may have encouraged parents to engage with their children's education by using the software or similar technology at home. Using Amira Learning software or other literacy-based AIEd may provide parents the supplemental tool to support their child's literacy development at home. It can serve as an additional resource to reinforce what children are learning in school. The interactive nature of Amira Learning software and the immediate feedback given to students may help in motivating young children to engage in educational activities at home. At the time of writing the present study, home access to Amira Learning software was available for students via the district's online learning platform. The platform can only be accessed through the district-provided Chromebook, which was not sent home to students in the early grades. The results of the present study may drive parents to become advocates for equitable access to technology-based learning tools, ensuring that all children have the opportunity to benefit from effective resources regardless of their background or location.

AI creators may have also been influenced by the alignment of Amira Learning software with SOR and be inspired to create similar technology to support early readers. The positive impact of AI-powered educational tools like Amira Learning software on early childhood literacy development suggests that AI creators should focus on continuous improvement, ethical considerations, and collaboration with educational stakeholders to maximize the benefits of AI

in education while addressing challenges and ensuring accessibility and inclusivity.

Recommendations for Future Research

The findings from the present study revealed critical information on using an AIEd in the form of an intelligent tutor to improve literacy outcomes for young children. Several future research can be done based on the results of the present study to further expand understanding of the potential benefits and challenges associated with integrating AIEd during this crucial stage of learning.

Longitudinal studies to examine the long-term effects of Amira Learning software on literacy development can help determine whether early gains in literacy skills are sustained over time. An investigation on whether the effectiveness of Amira Learning software varies across different demographic groups, such as students from diverse socioeconomic backgrounds or with varying levels of prior literacy skills would be valuable. Future researchers can conduct comparative studies to evaluate the effectiveness of Amira Learning software in comparison to other literacy interventions and instructional approaches commonly used in early childhood education. Exploring the impact of teacher training and ongoing support in maximizing the benefits of Amira Learning software can also be a topic of interest in the future. Additionally, research can focus on how well-prepared educators are in integrating AIEd effectively into their teaching practices. A study on motivation and engagement to investigate the impact of Amira Learning software on students' motivation, engagement, and attitudes towards reading and literacy can also be explored.

Conducting qualitative studies to gain deeper insights into the experiences of teachers and students using Amira Learning software should be considered. Qualitative data can provide

a richer understanding of the learning process and can enable researchers to investigate the challenges and barriers that educators may face when integrating Amira Learning software into their curriculum, including technical issues, time constraints, and resource limitations.

By addressing these research areas, future studies can provide valuable insights into the role of an intelligent AIEd tutor like Amira Learning software in early childhood education and inform best practices for leveraging technology to support literacy development in young learners.

Conclusion

Overall, the results of data analyses and the evaluation of the connections to the theoretical frameworks of the present study have indicated that Amira Learning software, as an AI intelligent tutor, provided students with a strong foundation in ORF, feedback, and ongoing assessment information to teachers. Additionally, teachers confirmed this program as being in alignment with the Science of Reading literature. The Amira Learning software platform's individualized instruction has prioritized student learning and achievement as the central goals of its tutoring sessions while continuously growing individual students based on their unique needs. Amira Learning has given the students the 1-on-1 attention they need, something that would have not been possible if not for the power of AI.

Summary

The present study sought to answer the following questions to explore the overarching goal of the study which was to investigate the effects of Amira Learning software on literacy development in early childhood education.

RQ1: What is the relationship between the time spent using Amira Learning and learners' oral reading fluency achievement levels?

RQ2: How effective is the feedback provided by Amira Learning in improving students' oral reading fluency?

RQ3: What is the level of agreement among teachers regarding Amira Learning's alignment to the Science of Reading and its effectiveness in fulfilling the Science of Reading objectives?

This chapter discussed the results of the data analyses, answered the research questions, and offered explanations on the findings as they relate to the theoretical frameworks of mastery learning (Bloom, 1968) and the skilled reader. It also discussed the limitations of the study, the implications for practice, and recommendations for future research to inform practice in the areas of early childhood education, educational technology, and literacy development.

APPENDIX A. CENTRAL TENDENCY TABLES AND FIGURES

Figure A1. Frequencies of the Oral Reading Fluency (ORF) Scores at Pretests

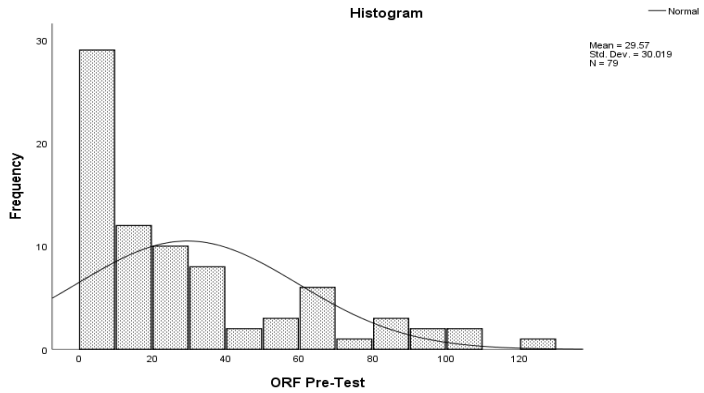


Figure A2. Frequencies of the Oral Reading Fluency (ORF) Scores at Posttests

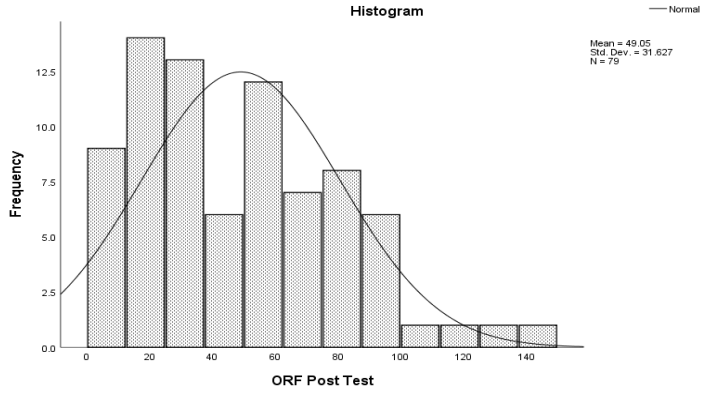


Figure A3. Frequencies of Amira Average Usage Minutes in 6 Weeks

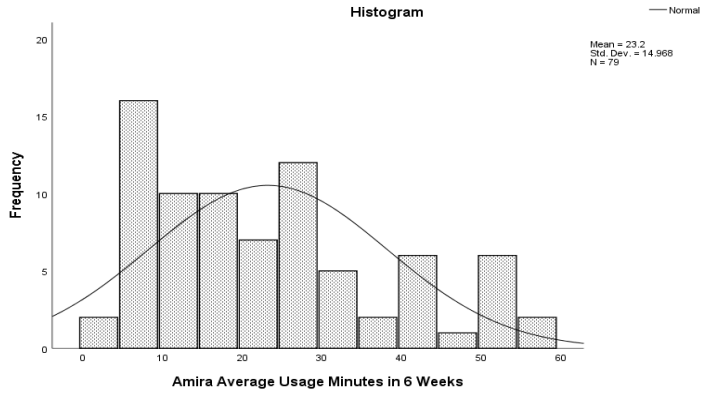
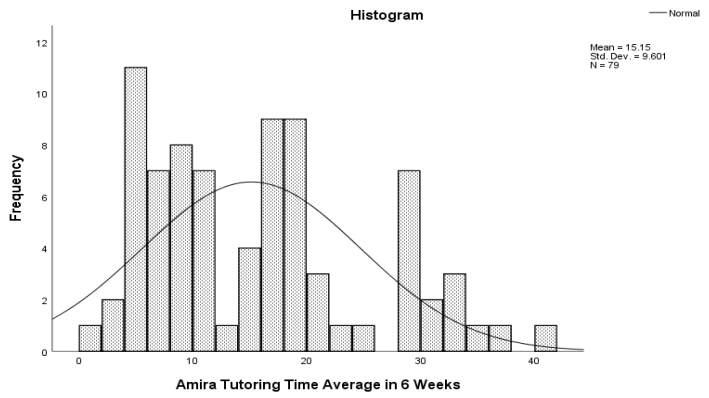


Figure A4. Frequencies of Amira Tutoring Time Average in 6 Weeks



Regression Model 1 – IV: Amira Average Usage in 6 Weeks (in Min

Figure A5. Histogram of Regression Standardized Residual of ORF Improvement

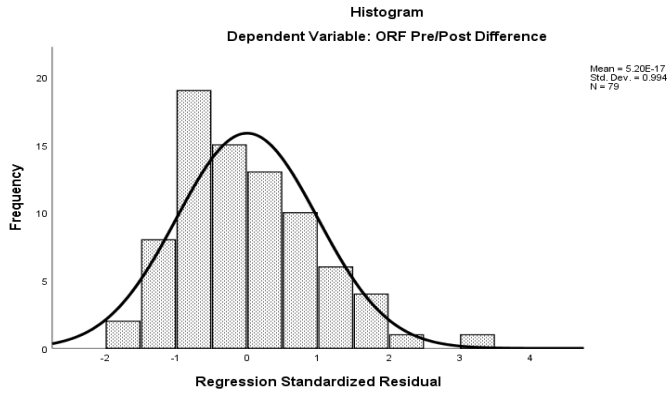


Figure A6. Normal P-P Plot of Regression Standardized Residual of ORF Improvement

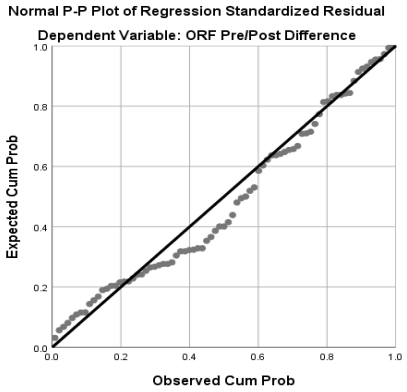
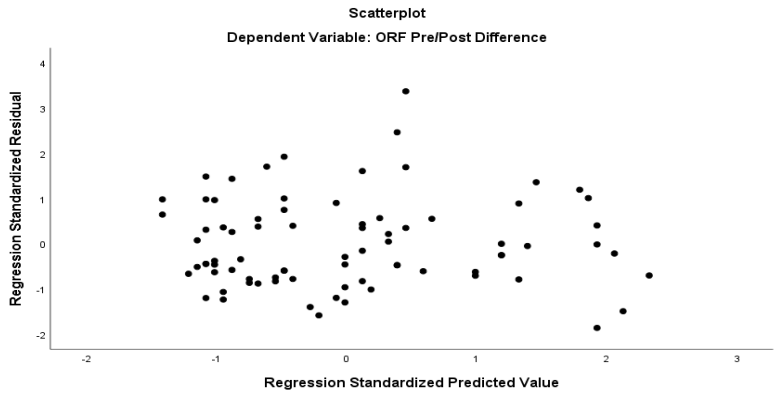


Figure A7. Testing the Homoscedasticity Assumption for Regression of ORF Improvement



Regression Model 2 – IV: Amira Tutoring Time in 6 Weeks (in Min)

Figure A8. Histogram of Regression Standardized Residual of ORF Improvement

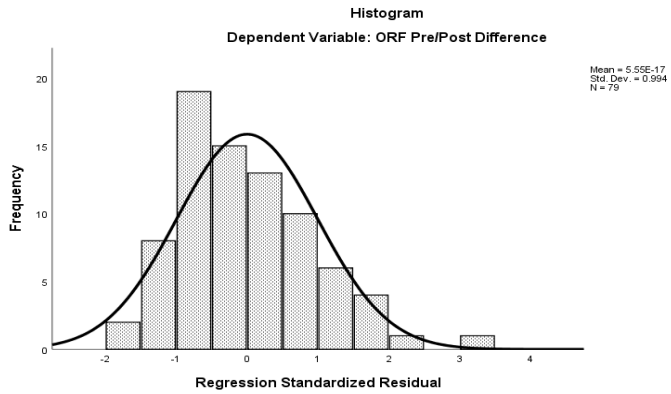


Figure A8. Normal P-P Plot of Regression Standardized Residual of ORF Improvement

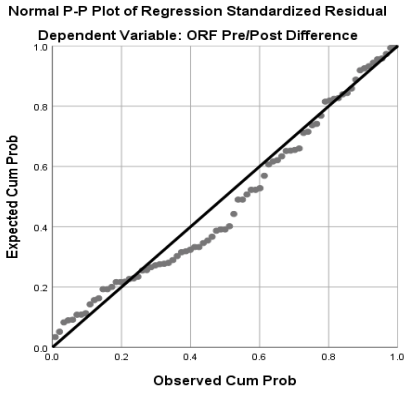
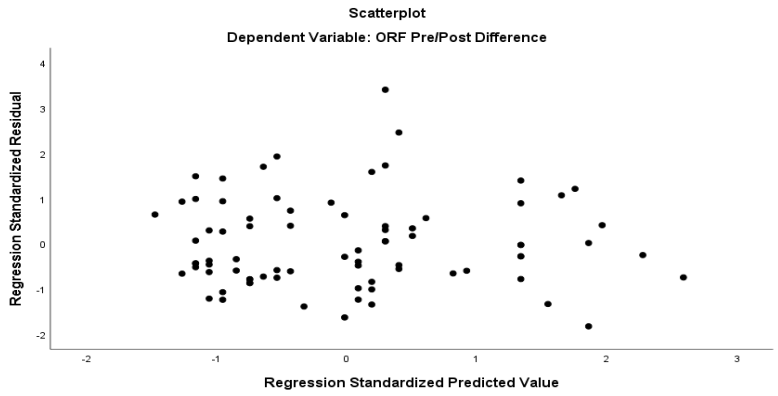


Figure A9. Testing the Homoscedasticity Assumption for Regression of ORF Improvement



APPENDIX B. INSTITUTIONAL REVIEW BOARD

LSU | Office of Research & Economic Development

TO:	Cynthia F DiCarlo LSUAM | Col of HSE | Education | CC00165
FROM:	Alex Cohen Chairman, Institutional Review Board
DATE:	12-Sep-2023
RE:	IRBAM-23-0954
TITLE:	The Effects of Amira Learning on Literacy Development in Early Childhood Education
SUBMISSION TYPE:	Initial Application
Review Type:	Exempt
Risk Factor:	Minimal
Review Date:	12-Sep-2023
Status:	Approved
Approval Date:	12-Sep-2023
Approval Expiration Date:	11-Sep-2026
Exempt Category:	1
Requesting Waiver of Informed Consent:	No
Re-review frequency:	Three Years
Number of subjects approved:	17
LSU Proposal Number:	
By:	Alex Cohen, Chairman

Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. **SPECIAL NOTE: When emailing more than one recipient, make sure you use bcc. Approvals will automatically be closed by the IRB on the expiration date unless the PI requests a continuation.**

** All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at http://www.lsu.edu/research*

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APPENDIX C. INFORMED CONSENT FORMS

School/ District Administrator Consent Form

1. Study Title: The Effects of Amira Learning on Literacy Development in Early Childhood Education

2. Purpose of the Study: The main purpose of this study is to assess the effectiveness of an Artificial Intelligence program, Amira Learning, on literacy development of first grade students. Secondary data will be used to delve into this goal. As part of exploring this main goal, the study also aims to understand teachers' insights on Amira Learning's alignment with the Science of Reading. Teachers will be asked to take a two-question survey to rate their agreement on the alignment of Amira Learning with the Science of Reading. The survey should take no more than 5 minutes to take and will be administered using a secured, protected platform (MS Forms). The teachers will not be asked any identifying information during this survey.

3. Risks: There is no anticipated risk associated with participation in the study.

4. Benefits: There will be no direct benefit to the subjects for participating in this study. However, it is hoped that the information obtained from this study may drive district's future decisions on obtaining programs that support teachers and in exploring additional online classroom resources and interventions.

5. Investigators: The following investigators are available for questions about this study, please contact Dr. Cynthia DiCarlo (cdicar2@lsu.edu) or Ms. Caroline Tolentino (ctolen2@lsu.edu)

6. Number of Subjects: 17

7. Inclusion Criteria: Teachers who hold a valid Louisiana teaching license, who are over the age of 18, and who have been trained in the Science of Reading. To participate in this study, the requirements of both the inclusion and exclusion criteria must be met.

13. Exclusion Criteria: Teachers without a valid Louisiana teaching license, are under the age of 18, and have not been trained on the Science of Reading.

14. Right to Refuse: Subjects may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled. information will be included for publication.

15. Privacy: Results of the study may be published, but no names or identifying information will be included in the publication. Subject identity will remain confidential unless disclosure is required by law.

16. Financial Information: There is no cost for participation in the study, nor is there any compensation to the subjects for participation.

17. Signatures:
_____ I consent for the researcher to use secondary data requested and for teachers to participate in the study if they wish to. The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigator. If I have questions about subjects' rights or other concerns, I can contact Alex Cohen, Chairman, Institutional Review Board, (225) 578-8692, irb@lsu.edu, or www.lsu.edu/research. I will allow the use of students' data in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

_____ I do not consent to participation in this study.

Superintendent Name (printed or typed): _____

Superintendent Signature: _____ Date:_____

Teacher Consent Form

1. Study Title: The Effects of Amira Learning on Literacy Development in Early Childhood Education

2. Purpose of the Study: The main purpose of this study is to assess the effectiveness of an Artificial Intelligence program, Amira Learning, on literacy development of first grade students. Part of exploring this main goal is to understand teachers' insights on Amira Learning's alignment with the Science of Reading. Your participation is needed to accomplish this secondary goal.

3. Risks: There is no anticipated risk associated with participation in the study.

4. Benefits: There will be no direct benefit to you for your participation in this study. However, it is hoped that the information obtained from this study may drive district's future decisions on obtaining programs that support teachers and in exploring additional online classroom resources and interventions.

5. Investigators: The following investigators are available for questions about this study, Dr. Cynthia DiCarlo, (cdicar2@lsu.edu) or Ms. Caroline Tolentino (ctolen2@lsu.edu)

6. Number of subjects: 17

7. Inclusion Criteria: Teachers who hold a valid Louisiana teaching license, who are over the age of 18, and who have been trained in the Science of Reading. To participate in this study, you must meet the requirements of both the inclusion and exclusion criteria.

8. Exclusion Criteria: Teachers without a valid Louisiana teaching license, are under the age of 18, and have not been trained on the Science of Reading.

9. Right to Refuse: Subjects may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled.

10. Privacy: Results of the study may be published, but no names or identifying information will be included in the publication. Subject identity will remain confidential unless disclosure is required by law.

11. Signatures:

    The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. For injury or illness, call your physician, or the Student Health Center if you are an LSU student. If I have questions about subjects' rights or other concerns, I can contact Alex Cohen, Institutional Review Board, (225) 578-8692, irb@lsu.edu, or www.lsu.edu/research. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

Subject Signature: _____ Date: _____

The study subject has indicated to me that he/she is unable to read. I certify that I have read this consent form to the subject and explained that by completing the signature line above, the subject has agreed to participate.

Signature of Reader: _____ Date: _____

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VITA

Caroline C. Tolentino, a native of the Philippines and naturalized citizen of the United States, received her bachelor's degree from the University of the Philippines, Diliman in 2004. She taught in the Philippines from 2004 until right before she migrated to Baton Rouge Louisiana in 2008. She became a kindergarten teacher and instructional specialist in Baton Rouge where she served for more than 10 years before moving to Ascension Parish. Caroline's passion for educating young students and her love for learning made her decide to pursue her graduate degree. In 2015, she was admitted to the master's program at the Louisiana State University, College of Human Sciences and Education. She obtained her master's degree in 2017 and educational specialist degree in 2020.

Caroline has taught undergraduate courses, teaching preservice teachers in PK3 Early Childhood Program since 2020. In 2021, she became an instructional coach in Ascension Parish supporting teachers and students in the elementary grades. In her career as an educator, she has presented at numerous conferences, published academic articles, received several teaching awards, and wrote a number of grants. Caroline intends to obtain her Ph.D. in Curriculum and Instruction in December 2023.