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The effects of an online learning program as a tier II intervention for phonemic awareness development in kindergarten students

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The Effects of an Online Learning Program as a Tier II Intervention for Phonemic Awareness Development in Kindergarten Students

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ABSTRACT

Many early elementary students in urban schools are already below grade level in early literacy skills, putting them at risk for reading difficulties later. This study examined the effects of *Lexia*, a literacy-focused online learning program, as a Tier II intervention for struggling kindergarten learners. In this study, ten students were placed into either the experimental group which used *Lexia* for twenty minutes a day for eight weeks, or into the control group that was instead exposed to a math-based online learning program. Results showed greater growth among students in the intervention group on all dependent measures as compared to the control group. These results suggest a benefit in employing online learning programs as Tier II additional support for phonemic awareness remediation in young students.

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CHAPTER ONE: INTRODUCTION

The present study examines the efficacy of a computerized reading program as a Tier II intervention for struggling readers in kindergarten. Many school districts have adopted the Response to Intervention (RTI) approach to supporting students academically. According to the New Hampshire Department of Education, RTI is "the multi-step approach to providing educational support and instruction to children who are struggling learners". Students are placed into different tiers of support, and data is collected at each tier to ensure all needs are being met and students are progressing at an adequate pace. In Tier I, all students are provided high-quality instruction in the universal classroom setting. About 80-85% of the class generally stays (and is successful) in this tier. Tier II is the targeted instruction provided to the portion (usually about 10-15%) of the class who are not responding to the universal Tier I methodology. Lastly, Tier III is the intensive instruction given to the 1-5% of the class that still does not respond sufficiently to the Tier I or Tier II instruction. In this case of this study, 20% of each of my classes (the students in the study) were receiving Tier II small-group, teacher-led support. This study done in my classroom examined the effect of a different Tier II intervention for these struggling learners, namely a computer-based approach.

The present study includes ten kindergarten students from an urban public charter school in a Midwestern city in the United States. Of these ten students, seven of them attended our school for K4, and the other three attended a different school for their K4 experience. Two of the students were on medication (sometimes inconsistently) for Attention Deficit Hyperactivity Disorder (ADHD), but none had official Individualized Education Programs. Two of the students had fairly extreme, but sporadic, behavior problems, while other students had a

difficult time exhibiting pro-social behaviors when they were not on their medications, making learning difficult for them.

These students were chosen for this study because they were the five students in each of my classes that scored the lowest on various language arts assessments. All but one of them scored in the <25% on the Reading MAP test, a national norm-referenced assessment. None of these students had passed even the first level of the Phonemic Awareness Inventory at the time of the study except for two. This put them off-track to reach the Level 4 end-of-year (EOY) goal. On our Strategic Teaching and Evaluation of Progress (STEP) reading assessment, two had passed STEP 1, four had passed Pre-Reading, and the other two had not yet passed the Pre-Reading level (our EOY goal is STEP 3). By this point in the year (at the end of the second trimester), most other students in the class had achieved a STEP 2, which put the students in this study well behind their peers[1]. Among the students in the group, the average number of letters they knew was thirty, and the average number of letter sounds was ten. They also only knew, on average, six sight words (the class average at that time was 63 and the EOY goal was 100). Although they were so far behind the rest of the class, it seemed as though most of these students enjoyed attending school. They liked having animated, non-school-related conversations with me about things that were happening in their lives, and they had friends that they played with during recess and free time. Most of them were extremely interested and participatory in small-group instruction, and really loved listening to our read-alouds. Although

[1] The MAP and STEP tests are both national, norm-referenced assessments. The Phonemic Awareness Inventory is an assessment created, and used only, by our charter network. These assessments will be explained in greater detail in chapter three.

most of the students in this group had poor handwriting and spelling abilities, they loved expressing themselves through drawing.

Because these students were so far behind the rest of the class, and because of their tendency to get distracted in whole-group settings, I met with them every day for small group instruction to teach them some of these foundational reading skills in a slower manner. This seemed to be the most effective learning setting for them in my language arts block. These small groups presented a time when they were able to do more manipulative and kinesthetic tasks, which they enjoyed. Since many of the students in this group were English Language Learners, they did really well when there were pictures or kinesthetic motions attached to different processes or vocabulary terms. In general, these students were hesitant to participate in whole-group settings because of the difficulty level of many of the lessons. These small group lessons gave them a time to participate more frequently and freely. Because I was meeting consistently with these small groups in order to remediate skills they did not attain during our whole-group lessons, the small groups were considered an in-class Tier II intervention.

Although, as detailed above, these students had many academic challenges, the area of most concern in regards to this study was the need to learn phonemic awareness and letter knowledge in order to learn to read. According to the National Reading Panel (2000), phonemic awareness "refers to the ability to focus on and manipulate phonemes in spoken words". Phonemes are the smallest units of sound in a given language, which combine to make syllables and words. English has approximately 41 phonemes. Many times, the terms "phonemic awareness" and "phonological awareness" are used interchangeably. However, phonological awareness is the more general ability to identify and manipulate any unit of oral language (e.g.

words, syllables, etc.) versus just the individual phonemes/sounds. In other words, phonemic awareness is a type of phonological awareness, placing phonological awareness as the broader category. This study will reference both general phonological awareness, but also phonemic awareness specifically.

Phonemic awareness and reading development make up a large part of kindergarten curriculum. The Common Core standards related to this study are as follows:

- CCSS.ELA.RF.K.2.A Recognize and produce rhyming words.
- CCSS.ELA.RF.K.2.B Count, pronounce, blend, and segment syllables in spoken words.
- CCSS.ELA.RF.K.2.C Blend and segment onsets and rimes of single-syllable spoken words.
- CCSS.ELA.RF.K.2.D Isolate and pronounce the initial, medial vowel, and final sounds (phonemes) in three-phoneme (consonant-vowel-consonant, or CVC) words.
- CCSS.ELA.RF.K.2.E Add or substitute individual sounds (phonemes) in simple, one-syllable words to make new words.
- CCSS.ELA.RF.K.3.A Demonstrate basic knowledge of one-to-one letter-sound correspondences by producing the primary sound or many of the most frequent sounds for each consonant.
- CCSS.ELA.RF.K.3.D Distinguish between similarly spelled words by identifying the sounds of the letters that differ.

These do not include the multiple standards that are indirectly affected by a student's level of phonemic awareness, including various writing and speaking standards. In other words, the skills and standards that were a focus in this study were numerous and foundational to kindergarten curriculum as a whole.

In Title I, Part B, Section 612 of the Individuals with Disabilities Education Act (IDEA 2004), the law states that students receiving special academic services need to be kept in the least restrictive environment to the maximum extent appropriate. The least restrictive environment means that children with disabilities are also educated with children who are not disabled, and that "removal of children with disabilities from the regular educational

environment occurs only when the nature or severity of the disability of a child is such that education in regular classes with the use of supplementary aids and services cannot be achieved satisfactorily" ("Building the Legacy"). Although the students in this study were not specifically receiving special education services, the same considerations were applied to these groups. Their entire school days were spent with the rest of their classmates. The only difference was that students in this study were using a different computer program for a small portion of the day. However, the other students in the class were on computers during this time as well. Therefore, the differences in instructional treatment of these students versus the general class were minimal.

The next chapter will describe the prior research that has already been done regarding both the importance of phonemic awareness development, and the potential benefits and setbacks related to computer program use in classrooms. This research, coupled with the academic standing of my students (explained above), inspired the development of the current study. The procedures of the study will be explained in detail in chapter three. The final two chapters will describe the results of the study, and the conclusions and implications drawn from these results.

CHAPTER TWO: A REVIEW OF THE LITERATURE

Extensive research on literacy instruction over the last few decades has proven that phonological awareness is critical in reading development in young children. In fact, studies have shown that a student's phonological awareness ability in kindergarten and first grade can be a good estimate of their success in reading in third grade and beyond ("Teaching Children to Read", 2000). Since this rise in the focus on phonological awareness in early literacy instruction, there has been an ongoing debate on the details of how and when this instruction should be presented. Then, with the increased availability of different technological devices in classrooms, the use of computers in different capacities to augment phonological awareness instruction was entered into the debate. This chapter, for practical reasons, will not attempt to describe every argument that has ever been made on the subject. It will begin with a brief description of the link between phonemic awareness instruction and reading. It will then continue to describe current research on computer-assisted early literacy instruction and related Tier II interventions. Lastly, it will provide an overview of the present study which, inspired by the prior research explained above, measured the effectiveness of an independently used computer program as tier II phonemic awareness remediation.

Phonemic Awareness and Reading

As mentioned above, there has been extensive research on the strong connection between phonemic awareness instruction and reading achievement in elementary-aged children. Much of this research has focused on phonemic awareness instruction in kindergarten through second grade students because this is when a large part of reading development occurs. These studies have looked at a variety of aspects of phonemic awareness instruction,

including timing (when it is introduced), frequency (how often and for how long it is taught), and instructional design (how it is administered). For the purposes of the present study, I have included three studies in this section whose main purpose was to establish the importance of *any* phonemic awareness instruction in kindergarten by measuring its effect on students' reading achievement, as compared to classrooms who did not include explicit phonemic awareness instruction at this age.

In the 2007 study, *Phonemic Awareness: When and How Much to Teach?*, Reading & Van Deuren were interested in seeing whether it made a difference if phonemic awareness instruction was introduced in kindergarten, rather than first grade. The participants in this study were ninety-two kindergarten children in an urban Midwest area. The study took place over a two-year period in order to track them in both kindergarten and first grade. There were two cohorts of children, so the whole study took place over a three-year window. All children in the study were Caucasian, monolingual, and middle class. To compare differences in mastery between the groups, all students were assessed using the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) three times: in the beginning, middle, and end of first grade. The phonemic awareness portion of the DIBELS includes letter naming, phoneme segmentation, alphabetic principle, and oral reading fluency.

Two classes of children were enrolled during the 2002-03 school year and were assigned to one of the two teachers. Both of these classes used the Getting Ready to Read program, which did not include explicit phonemic awareness instruction. These were called the "no phonemic awareness in kindergarten", or "NPAK", groups. In the 2003-04 school year, two more classes worth of kindergarten children were enrolled and assigned to one of the same

two teachers. Both of these classes used the Open Court Reading program which did include explicit phonemic awareness instruction. These were called the "phonemic awareness in kindergarten", or "PAK", groups. In first grade, both groups received direct instruction in phonemic awareness. External factors such as parental involvement, access to reading materials, etc. were considered to be similar for both groups.

As mentioned above, mastery comparisons between the groups were made with results from the DIBELS assessment. In the beginning of first grade testing window, there were no significant differences between the NPAK and PAK groups for letter naming fluency or nonsense word fluency. However, the PAK children performed significantly better on the phoneme segmentation fluency portion of the assessment. There were also fewer children that required "Instruction recommendations" in the beginning of first grade in the PAK group than the NPAK group. This means there were more children considered to be "on or above grade level" in phonemic awareness skills. In the testing window in the middle of first grade, phoneme segmentation fluency was still better among the PAK children. At the end of first grade, there were no significant differences between groups for any portion of the assessment. However, there were still more students in the NPAK group who needed instructional recommendations than in the PAK group.

This study showed that systematic phonemic awareness instruction in kindergarten has a positive effect on students. Even though similar systematic phonemic awareness (PA) instruction in first grade is also effective in catching NPAK students up to their PAK peers, students who are explicitly taught phonemic awareness skills in kindergarten were able to reach first grade benchmarks sooner.

A few years later, in a 2013 study, Carson & Boustead worked only with kindergarten students, but were interested in the importance of having explicit, intensive phonemic instruction instead of merely a whole-language literacy approach. They studied whether having this type of instruction would improve literacy outcomes in kindergarten student, both with language impairments and without. This intensive instruction came in the form of an adapted existing phonemic awareness program (the PAT program), and exposed children in the treatment group to lessons that specifically focused on onset-rime knowledge, phoneme analysis, phoneme identify, segmentation, blending, and linked speech to print. In the classrooms they used in their study, a whole language approach was usually used for literacy instruction that did not include a specific focus on phonemic awareness. They were interested in measuring both the existence of a difference in achievement with the control group (that used just the usual whole-language approach), and also the difference in students with these language impairments.

Carson and Boustead performed their study with twelve classrooms across ten schools in New Zealand. This included 129 kindergarten children in total (fifty-four boys and seventy-five girls), aged between 5:0 and 5:2. Two of these classrooms (Group A and Group B) were experimental groups and the other ten classrooms served as the control (Group C). Groups A and B were from high-middle socio-economic status (SES) areas, and Group C represented an equal spectrum of SES backgrounds. All teachers were around the same age and had around the same experience levels, but the experimental group teachers were exposed to eight hours of training on the PAT program to ensure treatment fidelity.

The experiment took place over the course of a full school year which is divided into four terms in New Zealand. During Term 1, all groups were exposed to the usual whole-language literacy curriculum. During Term 2, the PAT program was used for Group A and the usual curriculum was used for Groups B and C. During Term 3, PAT was used for Group B and the usual curriculum was used for Groups A and C. During Term 4, the usual curriculum was used for all four groups. The experimental group was exposed to the PAT program four times per week in thirty-minute sessions for ten weeks during their respective treatment terms. Baseline testing was given to students in all three groups to assess language, phonemic awareness, and early literacy skills at school entry, and follow-up testing was done with all students at the middle and end of the year. For experimental groups, additional testing was given at the beginning and end of each term.

The results from the experiment suggest that short-duration, high-intensity phonemic awareness programs can be extremely effective in improving reading outcomes in kindergarten students both immediately and six months after instruction. Only 5.88% of children who received the teacher-directed classroom PA instruction scored below grade level in word decoding whereas 26.3% of children in the control group were below grade-level. Overall there was a 20% reduction in the number of children with reading difficulties by first grade amongst the experimental vs. control groups.

These results are significant because it shows that these types of short-duration PA programs are both effective for student growth in reading and easier for teachers to integrate into their existing literacy programs than other more comprehensive programs. This study also shows that PA instruction can be effective for whole-group if there are resources in place for

teachers to be able to differentiate instruction for different levels within the lesson. Lastly, the study suggests that it may be more effective for phonemic awareness instruction to concentrate on phoneme-level skills as opposed to a wide range of phonological awareness tasks like syllables, onset-rime, and phonemes. All groups had similar achievement in onset-rime skills even though the treatment groups only specifically focused on these skills for the first week of the 10-week program. This shows that normal classroom instruction might be enough for students to develop this awareness of larger chunks of sounds.

Lastly, aside from the general benefits that phonemic awareness instruction has been shown to have on the general classroom population of primary students, Roberts & Corbett (1997) completed a study on the effect of explicit phonemic awareness instruction on students with limited English proficiency. Their study took place in a community in California that served a large Hmong population. Therefore, they were comparing student achievement and proficiency in oral language skills, primary language, and verbal memory amongst children who were monolingual versus those who spoke Hmong as their primary language. To do this, they exposed different groups of children to distinct literacy programs: one that only taught the alphabetic principal, and one that taught both the alphabet principal and phonemic awareness.

The study was composed of kindergarten children in an elementary school in California. Of the twenty-seven children in the intervention class, sixteen spoke Hmong as their primary language and thirteen were monolingual English speakers. Of the twenty-nine kindergarten students in the control group, seventeen spoke Hmong as their primary language, one spoke Lao, and the other eleven were monolingual English speakers. All students in the study qualified for free/reduced lunch.

At the onset of the study, all students were given a pre-test to assess rhyming, segmentation, blending, and letter name/sound knowledge. All the Hmong-speaking students were also tested on English proficiency using the pre-Language Assessment Scales (LAS) test. Then, the researchers spent four weeks merely observing the children in class and acquiring more information on their academic and cultural backgrounds. Next, the adapted phonemic awareness program was given to the intervention group. These children received twenty-minute lessons on both phonemic awareness and the alphabet principle that were developed by the researchers to ensure a consistent structure. These lessons were delivered in English by the researchers. The children in the comparison group received their usual literacy instruction which consisted of a daily alphabet song/chant, a thirty-minute whole group lesson on letter names/sounds related to their literature selection, and a "letter of the week" activity. There was no instruction on segmenting or blending in the control group.

At the end of the study, the researchers gave students the same assessments that they used for the pre-tests. From these results, they saw significant improvement in children's rhyming, blending, and segmenting skills in the intervention group by both English and non-English speakers. Additionally, the intervention class outperformed their comparison class counterparts on the phonemic awareness measures but not the letter name/sound measures. The study also suggested that the intervention was especially beneficial for English learners because the English learners in the intervention class scored significantly higher than the English learners in the comparison class, and were not significantly different from the English speakers in either class. Lastly, the researchers found no significant correlations between English oral proficiency and phonemic awareness performance at the end of the study. This

suggests that beginning reading-related instruction can proceed in tandem with oral language development. The study also shows that students at the very early stages of English language acquisition can benefit greatly from explicit phonemic awareness instruction.

This study added to the wealth of evidence that suggested that explicit phonemic awareness instruction was critical to literacy development. Once this had been established, researchers started to focus more on the various techniques teachers could use to make this instruction more effective and efficient. Increased accessibility of technology in classrooms made computers an appealing avenue to look into. The following section offers various studies that describe the effectiveness of computer-assisted instruction (CAI) in general, and also some specific strategies that have been found especially effective in the CAI field.

Benefits of Computer-Assisted Instruction

When computer-assisted instruction was first put into the spotlight of literacy research, the available computer programs were significantly less sophisticated than the ones we have now. Thus, much of the initial research centered around comparing the results of using computerized (vs. traditional) versions of an already-established instructional technique to improve skill retention. For example, in the 2000 study, Hitchcock & Noonan studied the effectiveness of using computers to help young children practice and retain pre-academic skills using the constant time delay strategy. For the purposes of this study, they defined "pre-academic skills" as mastery of basic shapes, letters, colors, and numbers. They used a computer program called *Intellipics* that addressed each of those four skills separately and was able to be individualized for each student's needs.

The sample consisted of five preschoolers who had been identified as having an "early childhood learning impairment". The students attended a rural public school in Hawaii and were in a self-contained special education classroom. The target skills for each student were chosen by both the parents and teachers. The researchers adapted an Alternating Treatments Design (ATD) for the study which means that students were exposed to both computer and traditional practice for their respective sets of target skills. A pretest was given to see if a student had already mastered any of the skills, because only unknown skills were selected for participants.

Each treatment "segment" was broken into three experimental phases that looked the same for all five participants. First was the baseline phase where students were exposed to direct instruction on the specific skill they were working on. Then, they practiced the skill with alternating treatments of traditional (TAI) and computer-assisted instruction (CAI). Third, there was follow-up practice with the treatment that was found to be most successful in that particular session. The researchers were interested in the students' abilities to make both correct matches and naming of the selected skill (shapes, letters, colors, or numbers).

During the lessons, students had the opportunity to respond to three to five trials on five to six days of instruction. The researchers were interested in the percent correct for both matches and naming of that particular skill during the lesson and at the end of the intervention. The results for shapes and colors were similar: direct instruction produced mixed results and low motivation; both TAI and CAI were shown to be effective for promoting retention of the skill; and CAI had higher results than TAI for three of the students. For numbers, CAI was shown to be effect. For letters, response accuracy was similar between CAI and TAI.

Overall, Hitchcock & Noonan found that computer-assisted instruction practice was at least, if not more, effective at promoting retention for all of the skills. This was most likely due to the computer's ability to be an individualized practice for each study, and the fact that it was very motivating for students. Later, other studies used this knowledge to expand the research on CAI to various different computerized learning games/programs. In his study, *The Long Term Effect of Computer Training*, Segers (2005) studied the effect of computer training on phonological awareness development and retention in Dutch Kindergartners. He looked at two different variables when he did this study: intervention (experimental vs. control group) and ethnicity (native vs. immigrant). He not only wanted to see if exposure to the computer program had an effect on phonological awareness, but also if that effect was the same or different in native versus immigrant children.

The study was composed of one hundred kindergarten students across two schools. Both the experimental and control groups consisted of about one-third native children, and two-thirds immigrant children. Their average ages were 5 years 6 months, and both groups had a slightly higher number of girls than boys. Across the two groups, 79% of mothers and 73% of fathers had a lower level of education.

During the 40-week time period of the study, students in the experimental group used the computer program one time per week for fifteen minutes. For the last ten weeks of the year, they were allowed to use the programs three times per week. The computer program was essentially a collection of different education games that were divided into "discovery games" (rhyming, blending, songs, rhymes, book creation, coloring) and "learning games" (rhyming and blending, CVC word spelling, letter sounds, 1:1 correspondence, etc.). Students were able to

choose which games they completed, and on average, they played on the software for a little over four hours over the course of the study.

The researchers gave each participant a pretest at the beginning of the school year and compared these scores with both the interim test taken just after Christmas, and the post-test taken just before summer vacation. Phonological awareness retention testing occurred four months into first grade. After comparing these scores, the greatest effects of the computer programs on phonological awareness development were seen in the immigrant children. There were also greater effects between the first two data points (pretest and interim) than between the interim and posttests. Also, negative effects were seen between time spent on "discovery games" (vs. learning games) and progress in phonological awareness. Lastly, the experimental group scored higher than the control group in the decoding task administered in first grade.

Overall, there were smaller effects than were hoped for. There was not a significant effect of these computer programs on blending or segmentation, but there was a positive effect for rhyming, especially for immigrant children. There was also a positive effect for grapheme knowledge for all students. This suggests that the computer programs can have a positive effect when used as an additional support to classroom/teacher instruction, but should not be relied upon for all phonological awareness development. The study also showed that the type of computer program was important, and the ability to track which games the students were actually playing. Lastly, this study showed that these programs could have great effects for immigrant children and those who were lowest academically.

In another study, Wild (2009) studied whether or not there would be a difference in benefit of the same skill practice done on the computer instead of in traditional worksheet

form. In this study, Wild analyzed the effect of structured literacy software exposure on phonological gains in Year 1 (kindergarten-equivalent) students. Whereas many studies on online learning programs have looked at the effect of these as general classroom supplements, Wild was comparing the effects of the computer programs as a different medium through which to deliver the same traditional practice. In other words, the groups in his study were practicing the exact same skills presented in the same way, but one group was practicing it on the computer whereas the other group was practicing it on worksheets.

The participants in the study were 127 Year 1 children across six primary schools in the United Kingdom. These schools were randomly chosen from the pool of schools within the Oxfordshire geographical region, and all students were between five and six years of age. Students within the schools were also allocated randomly to one of three groups. The first group was the treatment group that was exposed to the computer literacy program. The second group completed the same literacy practice activities as the first group, but on paper instead of on the computer. The last group was the control group. They had no extra literacy practice after the whole-group lesson that all the children received, and instead, they were exposed to unrelated math computer programs. The experimental sessions for all groups occurred once a week for twenty minutes each across of span of ten weeks. Students were exposed to the same whole-group Rhyme Book, and then each group completed their respective practice activities.

All groups were given two assessments, the Phonological Assessment Battery (PhAB) and Marie Clay dictation test, to gain pre- and post-test results. The PhAB assessed six different components of phonological awareness skills, and the Marie Clay test assessed the students'

abilities to apply their knowledge in a written form. Although the PhAB had six different components, it was divided into three different subgroups for the purposes of analysis: rhyme, alliteration, and fluency. There were no significant differences found between the groups' performance on the pretest.

Analysis of the post-test results for the PhAB assessment showed significantly higher gains made by the computer-based intervention group versus the other two groups. Although this difference was seen across the whole assessment, the greatest gains were seen in the rhyming subtests. Furthermore, girls were seen to have greater gains from the computer program than boys. Also, there were no significant differences seen between the worksheet group and the control group. This begs to question whether or not worksheet practice is effective for children of this age. Lastly, the computer programs had a greater impact on raw skill knowledge than in the students' abilities to apply that knowledge, i.e. on the Marie Clay dictation test. However, there were still significant gains made on that assessment.

Overall, the study suggests that structured computer learning programs can serve as an effective tool for the practice and development of foundational phonological skills. This is especially so if these programs are focused on particular skills, and are supplements to classroom instruction.

As the computer technology in schools started becoming both more sophisticated and more readily available, researchers started studying the effects that increased exposure to these programs could have on literacy development in young students. This was in contrast to the original studies that generally only had students on computers one to two times per week. In their 2008 study, Macaruso and Walker studied the effects of CAI as a supplement to

phonics-based reading instruction on kindergarten students' phonological awareness levels if they were exposed two to three times per week. They were especially interested in the effect of CAI exposure on a class's lowest-performing students. Their research specifically tested the effect of exposure to *Lexia*, an online program that exposes children to literacy development activities at their specific level, over the course of six months on growth in literacy scores on the DIBELS and Gates-MacGinitie assessments.

In this study, they included six kindergarten classes across two elementary schools. These six classes were taught by three teachers which meant that each teacher had both one experimental group and one control group (their morning and afternoon classes were randomly selected to a group). This minimized the effects that varying teacher styles of instruction could have on academic gains. In the end, one morning and two afternoon classes were treatment groups, and the other two morning and one afternoon class were the controls. Forty-seven students were in treatment groups, and forty-seven were in control groups. Of these students, fifty percent qualified for free/reduced lunch.

Because each set of experimental and control group was taught by the same teacher, all aspects of instruction and daily schedule were the same except for the addition of the treatment in the experimental group. All students in both groups were exposed to the regular, systematic phonics instruction program, Scott Foresman Reading. However, students in the treatment group were exposed to additional 15-20 minute sessions of *Lexia* two to three times a week. During this time, students in the control groups were completing other normal classroom literacy activities.

Only students who completed at least forty-five sessions of the computer program were included for purposes of data analysis. All students in the study were assessed for pre-test scores using the DIBELS initial sound fluency (ISF) and letter name fluency (LNF) subtests. Post-test scores were measured using the LNF and phoneme segmentation fluency subtests of the DIBELS, but also from the Gates-MacGinitie Reading Test (GMRT) for norm-referencing purposes. It would have been ideal to use the same assessments for the pre- and post-test scores, but the ISF subtest was not suitable for end of kindergarten, and the GMRT was not intended for beginning of kindergarten use. However, baseline levels of phonological awareness were tested by the same DIBELS subtest for all students and were seen to be about the same for both groups.

After analyzing the data on the LNF, PSF, and GMRT tests, it was seen that the treatment group significantly outperformed the control group on the Gates-MacGinitie Reading Test. Among the subtests of this test, the biggest discrepancy between the groups (highest growth of treatment vs. control group) was seen on the subtest for phonological awareness. This was especially true for students who had the lowest pre-test scores. There were not significant differences in scores between the treatment and control groups on the other subtests. However, these results show that consistently using CAI programs such as Lexia as a supplement to a traditional, yet systematic phonics program can have a significant positive impact on students' phonological awareness ability. This is significant because early development in phonological awareness is an extremely strong predictor of success in reading later on. However, this experiment showed that it is also extremely important to make sure

students are using these programs consistently, and that it is coupled with systematic phonics instruction.

Soon, it became generally accepted that computers could serve as a beneficial supplement to classroom instruction. Multiple studies had shown that there were at least some increases in mastery, especially of literacy skills, in students who had access to computerized instructional activities. A wider variety of CAI programs were also being developed. However, it also became clear that it would be impractical to expect for every student in every school to have indefinite and unrestricted access to computer programs throughout their school day. Thus, as detailed in the following section, many studies started to focus on finding populations of students who would benefit most from computer use. Many times, this ended up being English Language Learners, special education students, and other students who were struggling academically.

Computers-Assisted Instruction as Tier II and III Interventions

As explained in the previous chapter, the response to intervention (RTI) model has become popular in schools across the country. In this model, Tier I is considered to be the universal population of the class and the general instruction that is given to the whole group. Tier II is the targeted instruction given to the 10-15% of students who do not respond well to the universal instruction. Tier III is the intensive instruction given to the 1-5% of students who also do not respond adequately to the Tier II intervention. Because of the importance of phonemic awareness to reading achievement, Tier II intervention time is used often for phonemic awareness development for students who are struggling with mastery of those skills. In his 2009 study, "The Effect of Tier II Intervention on Phonemic Awareness", Koutsoftas was

interested in seeing whether or not using a Tier II intervention approach for phonemic awareness development was effective in closing the gap between "at-risk" students and the general population of the class.

This study is unique in its focus on tier II interventions instead of randomly assigning students in the general class population to the control or experimental groups. Instead, Koutsoftas was looking at the differences between at-risk students who received the intervention (in the study), and their counterparts in other comparable schools across the district. The study was composed of 3- and 4- year olds from three public schools and two Head Start classrooms in Tempe, AZ. Each class ranged from nineteen to twenty-four children. General (Tier I) literacy programs were the same across the program because all of the chosen classrooms were participants in the Early Reading First, and their teachers received extensive professional development which controlled classroom differences.

All children were given the Early Language and Literacy Classroom Observation (ELLCO) as a pretest at the onset of the study, and then again as a posttest measure at the end of the six weeks. This was done to ensure that all classrooms were providing high-quality Tier 1 instruction which is essential baseline information to have in order to compare tier 2 efficacy. Children were selected for Tier II instruction based on their score on the beginning sound assessment in January (the third time they took it). Those who scored below the "cut-point" qualified for the Tier II intervention. In this case, thirty-four students qualified and twenty-six did not.

Aside from the ELLCO and beginning sound assessments, the Phonological Awareness Literacy Screening (PALS) was also used to measure different applications of onset fluency

knowledge. The results from the final assessments in the study showed that 71% of the children in the study had medium to large treatment effect sizes for onset fluency mastery. Furthermore, fewer children fell into the "at-risk" category at the beginning of kindergarten than other students who had not received this Tier II intervention in preschool.

This study has many possible implications for Tier II intervention in early childhood education. First, it suggests that there could be an extremely beneficial effect of focused intervention, i.e. just focusing on onset fluency as was done in this study. Second, the children who qualified for Tier II intervention were, on average, younger than the students who did not meet the criteria for Tier II intervention. However, within the intervention group, the children who grew the most were the youngest students which means that young children may really benefit from this smaller-group environment. Lastly, this study could highlight the importance of teacher training in Tier II intervention efficacy. As mentioned above, all of the teachers in this study were highly trained in both high-quality Tier I instruction and this specific Tier II approach. It calls to question whether or not the intervention would have been as effective if the teachers had not been as trained in the intervention, or as reflective of their children's progress and specific needs.

Obviously, not every school even has the resources to hire extra teachers or train the ones they have to deliver effective Tier II intervention to the many students who need it. Because of this, and because most schools are starting to acquire at least a small number of computers or tablets to use with their students, researchers started looking at the effect of computer-assisted instruction as a Tier II intervention option. This would address the problem of not having the time or resources to use teachers for all Tier II intervention and would also let

the available computers to be used by students who would benefit from them most, since schools also do not have the resources to make them available to the entire school population on a consistent basis.

In their 2014 study, DuBois et al tested whether a computerized version of incremental rehearsal (IR), a proven instructional technique, could serve as an effective and efficient way to improve letter-sound fluency and letter-sound expression for struggling students. Incremental rehearsal is a variation of the traditional drill method wherein students are shown a specific mixture of known and unknown words/sounds/etc., instead of practicing with all unknowns. Although studies have shown incremental rehearsal to, in fact, be effective when used as a flashcard method, there has been criticism that the procedure takes too long to be used as a realistic classroom remediation tool. The researchers in this study were looking at whether a computerized version of IR, *Tutoring Buddy*, could be used to remedy this problem of inefficiency.

The participants of this study were twelve kindergarten and eighteen first-grade students from a low-income, urban elementary school. Participants were nominated by their classroom teachers as students who were struggling and/or at risk for developing reading problems. These students were then randomly assigned to either the treatment or control groups. The treatment groups were exposed to the *Tutoring Buddy* program via short-term extra tutoring sessions, whereas the control group was exposed merely to the normal classroom curriculum and activities.

The *Tutoring Buddy* program was delivered to students one-on-one on laptops. Students in the intervention group received tutoring on eight consecutive school days over the course of

two weeks. The elements of the intervention were as follows: the pre-intervention assessments (to determine which letters the child knew or did not know at that time), the set-up screen (where the interventionist could choose four known and two unknown letters to use in the practice), and the computerized IR practice (using the letters chosen in the set-up procedure). There were four official assessment windows in the study, using the DIBELS and AIMSweb letter-sound expression (LSE) and letter-sound fluency (LSF) probes. There was a pretest at the beginning of the study, one assessment window in the middle of the study (end of week one), a posttest at the end of the intervention (end of week two), and a one-week follow up.

The results from the pretest showed no significant differences between the groups at the onset of the study. The treatment group performed significantly better than the control group on both LSE and LSF at the next three assessment times. Although the control group also showed linear growth across all the variables over the course of the study, the rate of growth for the treatment group was significantly higher. There also seemed to be no average loss in skills obtained between the time of the posttest and the one-week follow-up. The effects of the intervention seemed to be greater for the English Language Learners (ELLs) in the sample; however, the small number of ELLs makes it difficult to be statistically sure.

As mentioned above, the incremental rehearsal technique, although having been proven effective, has not come into popular use because of its relative inefficiency to other techniques. In other words, it requires time and resources that most school do not have. The results of this study suggest that a computerized adaptation of the IR technique can be equally efficient while being significantly more efficient than the traditional flashcard method. This

could allow IR to become a realistic and practical alternative for teachers as an effective Tier 2 intervention in schools with limited resources.

Similarly, in 2010, Torgesen et al looked at whether or not computerized literacy programs could benefit young students with dyslexia or other reading disabilities in their phonemic awareness development. In this study, the researchers looked at the efficacy of two different computer programs as an instructional supplement to support this development. Both computer programs that were chosen were aimed at supporting the development of general phonemic awareness, phonemic decoding, and text reading accuracy. The first program, *Read, Write, and Type (RWT)*, had a foundation in directly teaching the spelling of phonemes to help students master the alphabetic principal. The second program, *The Lindamond Phoneme Sequencing Program for Reading, Spelling, and Speech (LIPS)*, was focused more on developing oral motor awareness as an aid to processing phonological information. Although two different programs were used, the main purpose of the study was to see whether any program was more beneficial for struggling students than no program at all. The researchers were also interested in the longevity of the results, and analyzed whether the benefits (if any) persisted a year after the intervention was over.

The participants of this study were two cohorts of first graders (across three elementary schools) who were labeled as being "at risk" for developing reading problems. All first graders were screened with four different assessments at the beginning of each of two years, and students who scored under a specific score were chosen to participate in the study. The sample was 55.6% male, 33.1% minority, and 35% free/reduced lunch qualifiers. The schools, as a whole, were 50% male, 15% minority, and 17% free/reduced lunch qualifiers.

Students were randomly assigned to one of three groups for the study: RWT intervention, LIPS intervention, or an instruction-as-usual control group. For seven months, students in the intervention groups were taught in groups of three by teachers who were trained specifically for this study. The groups received four 50-minute sessions per week over the course of the year, and most of these sessions occurred outside of the regularly scheduled reading block of time. The first half of each session was devoted to direct instruction in various early reading skills from the teachers. The other half of the session was spent practicing those skills on the student's respective computer program. Outside of these sessions, all students were exposed to the *Collections for Young Scholars* classroom reading curriculum.

All students were assessed three times over the course of the study: prior to the reading instruction (pre), at the end of the instructional year (post), and one year following instruction (post2). These tests included assessments of phonological processing abilities, word-level reading measures, phonemic decoding accuracy and fluency, text reading measures, spelling, and verbal ability. The results showed no significant differences between the results of the two computer programs, but students in both intervention groups showed significantly higher results on all measures than the treatment-as-usual group. There were similar, but less robust, differences found at the one-year follow up (post2) assessment; significant differences were found for phonemic decoding accuracy/fluency, rapid naming, and spelling. Lastly, the control group had more children at the end of first grade who performed below the 30th percentile on important reading measures than children in the intervention groups. This discrepancy persisted at the end of second grade (post2) as well.

The results of this study had a few important implications First, there were no significant differences between the LIPS and RWT interventions, which means there were not any significant benefits to either the reading-connect text or explicit oral motor awareness approaches. However, students that received one of the interventions performed reliably better on various reading measures than students in the control group, and continued to perform better at the end of second grade. It is important to note that these interventions were given as a supplement to the normal reading curriculum. Therefore, it is possible that the gains just occurred because these students were receiving more reading instruction, not necessarily because of the type of intervention. However, it does suggest that computer interventions are, in fact, an effective supplement to improve reading outcomes for struggling students. This study could also suggest that it is important for the computer practice to be integrated (or at least closely related) with teacher instruction, since every treatment session included both teacher modeling of a skill *and* computer practice of that same skill.

Although many studies have suggested this importance of a strong linkage between the computer programs and teacher instruction, some researchers wanted to test other features of the computer programs that make them so successful. In 2000, Mioduser et al completed one such study, where they looked at the effect of computer-based instruction on early reading skill acquisition while focusing on the effects of specific features of computer technology on early reading skill performance. They were specifically researching students with learning disabilities, so both interventions were based off the "I have a secret – I can read!" special education curriculum. Although the study was completed in Israel with Hebrew language acquisition,

there were many aspects of the intervention that are applicable in other early childhood education settings.

Forty-six children ages 5-6 in special education kindergarten classrooms were included in the study. The students were of average socioeconomic status, and all were considered "at high risk" for developing learning challenges in reading and phonological awareness. The students had no social/emotional or physical disabilities.

For the study, the children were divided into three groups of fifteen to sixteen groups each. The "computer" group received instruction in reading with the "I have a secret" program, and included both printed and computer-based materials. The "printed-only" group learned only with the printed materials of the special reading program. The "control" group was only exposed to the regular special education program, without the specific reading instruction components.

All study treatments were administered by the regular kindergarten teacher, and it was broken into two stages. The first was focused on reading readiness, including letter recognition, visual discrimination, etc. The second stage was a progression of reading activities organized into blocks, where each block comprised of four tutorial sessions followed by practice sessions. These practice sessions were composed of either computer materials or printed materials, depending on the group. For each session, the teacher was able to select the appropriate level of difficulty for the child and the skills to be practiced.

Four assessments were given to the children both at the onset and conclusion of the study: The Phonological Awareness Test, the Word Recognition Test, the Letter Naming Test, and the Peabody Picture Vocabulary Test. No significant differences were found between the

groups on pretest measures. For the posttest results, comparisons were then made by looking at "improvement proportions" for each skill (the percentage of improvement of scores from pre- to post-test). The improvement of the computer group was significantly higher than that of the other two groups on six of the eleven tasks. In two other tasks, the reading intervention (groups 1 and 2) outperformed the control group. In two other tasks, there were no significant differences between the three groups.

These results suggest that computer-based materials can lead to increased retention of early reading skills in kindergarten students, and can also lead to increased motivation and self-confidence levels. There were also many components of the program that could have attributed to the high improvements. These components include: the sound response (for delivering task instructions, returning feedback to student response, etc.), the fact that the information on the screen was presented by multiple means (text, sound, and images), and the variety of learning modes (exercises, tutorials, practice games, etc.). Also, the computer program was able to keep detailed records of how students performed on each skill and type of learning mode so that teachers could use the information to individualize the lesson based on the students' needs for the next time.

Similarly, Van der Kooy et al (2012) studied the effectiveness of the *Living Letters* computer program on letter-name and -sound remediation in Dutch kindergarteners that were delayed in this area. *Living Letters* is an adaptive program that helps children make connections between how a letter name sounds, and how the letter looks. Through this technique, it aims to remediate/teach three skills: (1) recognizing one's name in print; (2) associating the initial name letter with its sound; and (3) identifying the sound of the initial name letter in other orally

presented words (2012). Like Mioduser, they were interested in what aspects of this, and other, computer programs made it such an effective intervention.

This study included children from across fifteen schools. From these schools, 404 children were screened using pre-reading assessments. Children were chosen for this study if they scored in the lowest 30% on these assessments. Of the 110 students who ended up being eligible and participating in the study, about two-thirds were male and one-third was female. The number of eligible children varied from 3 to 15 per school. These children were randomly assigned to one of three groups: The *Living Letters* (LL) group; The *Living Books* (LB) group, which was a treated control program that focused on story comprehension; or, a combined LL and LB group. Each group was exposed to their particular treatment once a week for fifteen weeks.

Students assigned to the intervention (LL) group participated in a series of games in order of increasing difficulty. First, there were 22 games that provided practice in recognizing the child's name. Then, there were 6 games that focused on recognizing the first letter of the child's name. Last, there were 12 games that practiced identifying pictures that start or end with the first letter of the child's name. Each task is adapted to the specific child's name. Also, the directions and feedback given by the program to the child become increasingly supportive depending on the child's success with that task. Children assigned to the control (LB) group listened to five grade-level electronic books that consisted of illustrations and oral narration, but no printed text. Each session lasted about 10 minutes, and consisted of one book and four follow-up comprehension questions. Each book was repeated three times across the fifteen sessions, and four new questions were asked after each repeated reading.

Students were given pre/post assessments to determine the effects of the intervention. The skills that were tested were: letter knowledge (name and sound), phonological skills (beginning sound awareness, ending sound awareness, and phoneme segmentation), invented spelling (CVC or CVVC words), and decoding (post-test only). Students were assessed immediately prior to the start of the intervention (winter 2006), immediately after the intervention (spring 2007), and 18 months after instruction (April 2009).

The researchers used the Cohen's coefficient to measure the effect size of the treatment on all assessments. The strongest effect size was found in word recognition, followed by phonological awareness, invented spelling, and decoding. Significant differences in scores between the treatment and control groups were found in word recognition, phonological awareness skills, and invented spelling. Marginal significance was found for decoding, and there were no significant differences for letter knowledge. The researchers also found significant differences in treatment vs. control students' scores when tested 18 months after instruction.

The results of this study suggest that students can be positively affected by computerized intervention in various aspects of literacy development at the young ages. This is especially true for word recognition, phonological awareness, and invented spelling. Van der Kooy also suggests that having the connection to their personal name in the computer program stimulates the young child's attention and increases their motivation. The fact that there were no differences between the groups in letter knowledge suggests that baseline letter knowledge is not required for learning associations between letters and their sounds. These last two findings could have implications for the types of computer programs that teachers and schools are using to supplement literacy instruction. Overall though, these researchers found that the

increase in motivation (measured by task completion per session) provided by the computer program played a large role in the benefits each child obtained out of the treatment.

Conclusion and Present Study

Overall, a review of the literature has shown strong evidence in the benefits of using computers and online learning programs to support both reading and math growth in early elementary school children. In many cases, students who had access to these computer programs, even for short periods of time, showed significant growth in various phonological awareness and early literacy skills as compared to their traditionally-instructed peers. This was shown to be especially true for students who were English Language Learners or were struggling in their early literacy development. These findings were important because it provided schools with another option to support the students who needed it most.

However, in many of these studies, students using these computer programs were being compared to students who were getting no exposure whatsoever to explicit phonemic awareness instruction. In the last few years, many schools have acknowledged the importance of this explicit phonemic awareness instruction, and are ensuring that all students are being exposed to it in their early elementary years (kindergarten through second grade). Also, many of the studies relied on the computers being used in a small-group or one-on-one situation which allowed for heavy adult support during the treatment sessions.

My research examines phonemic awareness growth and achievement in kindergarten students in an urban public charter school. The control group of students in the study received only the general classroom phonemic awareness (PA) instruction, whereas the experimental group of students not only received that same explicit PA instruction, but also received

additional Tier II support via an online learning program, *Lexia*. As mentioned previously in the chapter, *Lexia* exposes children to different activities depending on the child's specific academic level. Therefore, children use this program completely independent from classroom instruction. The following chapters will describe the study's procedures, the results of the intervention, and the implications for future instruction.

CHAPTER THREE: PROCEDURES

As detailed in the previous chapter, there has been much research done that suggests that online programs are effective supplements to teacher-led classroom instruction, especially in the areas of literacy and reading development. Most studies have focused mainly on the general classroom population and whether online learning programs have a positive effect on the class as a whole. At our school, all students are exposed to online learning programs daily, regardless of academic level. In this study, however, I was interested in whether or not a specific online learning program, *Lexia*, would be beneficial as a Tier 2 remediation technique for a small group of my lowest, most struggling readers. Thus, while the general class population used their online time on a math program, students in the experimental group used the reading program instead. This was in addition to our general classroom curriculum and scaffolding techniques. Their progress over the course of the study was measured by their success on a phonemic awareness assessment. The procedures for the study are outlined below.

Population

All ten students who participated in this study were kindergarteners attending a public charter elementary school in an urban school district. The demographic breakdown of the group was as follows: seven Hispanic boys, two Hispanic girls, and one Native American girl. Of these ten students, seven of them attended K4 (pre-Kindergarten) at the school; the other three were attending school for the first time this year. Six of the ten students were English Language Learners (ELL), with Spanish as their first language. Two of the students were on medication (sometimes inconsistently) for Attention Deficit Hyperactivity Disorder (ADHD), but

none of the students had identified Individualized Education Programs (IEPs) at the time of the study.

Reading achievement at the school was measured by the Measures of Academic Progress (MAP) test, the Phonemic Awareness Inventory (created by the school's charter network), and the Strategic Teaching and Evaluation of Progress (STEP) test. These students were chosen for the study because, by the start of the third trimester, they were the lowest-performing five students in each of my two classes in the area of phonemic awareness and reading development. All but one of them scored in the <25 percentile on the Reading MAP test. None of the the students had passed the first level of the Phonemic Awareness Inventory (PAI) except for two. The end-of-year goal for K5 on the PAI is a Level 4. On the STEP reading assessment, two had passed STEP 1, four had passed Pre-Reading, and the other two had not passed the Pre-Reading level, which is the most basic level of the assessment. The end-of-year goal for K5 on the STEP test is Level 3, and Pre-Reading was the goal for K4. Among the students in the group, the average number of letters they knew at the start of the third trimester was thirty, and the average number of letter sounds was ten. They also knew, on average, six sight words. The class average at that point was 63 words and the end-of-year goal is 100 words.

Many of the students in this group were distracted easily in class. Therefore, they learned best in small group settings. This was also a time when they were able to do more manipulative and kinesthetic tasks, and they seemed to enjoy these. Also, since six of the ten students in this group were ELLs, they were much more successful when there were pictures or kinesthetic motions attached to different processes or vocabulary terms.

In general, these students were pretty attentive to whole-group instruction, but hesitant to participate because of the difficulty level of many of the lessons. A few of them had a difficult time staying on task during independent work, even if it was at their level. Two of the students had fairly extreme, but sporadic behavior problems. Another two of the students had a difficult time exhibiting pro-social behaviors when they were not on their medications.

Because these students were far behind the rest of the class academically, and because of the mentioned behavioral difficulties, I met with them every day for small group instruction to attempt to catch them up on some of those foundational reading skills. Most of them were extremely interested and participatory in small-group instruction. However, they were still not responding adequately to this small-group intervention which is why they were chosen to participate in the current study whose procedures are detailed in the following section.

Procedures

Every kindergarten student at the school attends a computer class, "Learning Lab", for forty-five minutes each day. They spend the entirety of this class on one of two programs, *Dreambox Learning* for math, or *Lexia* for reading. This class is taught by a trained computer lab teacher, and she is the one who generally makes the choice of which program the class will use during a particular week. For the purposes of this study, however, I was the one to dictate which program they would go on, but she was still the one to oversee the class. Therefore, during the study, all kindergarten students at the school used *Dreambox* during Learning Lab, for the entirety of the forty-five minutes. The five students in my intervention group instead used *Lexia* for the first half of their Learning Lab block, and then switched over to *Dreambox*. This meant that they would have the opportunity to be on *Lexia* for approximately twenty

minutes per day, five days per week, as compared to the control group, who would be on *Dreambox* for forty-five minutes per day and not use *Lexia* at all. As mentioned above, students were selected as participants based on their lack of progress in their phonemic awareness and reading achievement with the general reading curriculum of the class as demonstrated by their STEP, Phonemic Awareness Inventory, and sight word recognition achievement/level.

Each intervention session occurred in the afternoon in the same Learning Lab classroom. The Lab had a class set of Google Chromebooks, and students logged on to their Chromebooks using their own usernames and passwords. They would then complete an activity on *Lexia*, depending on their unique academic level. All students start at the same level at the beginning of the year in Kindergarten, and then progress through the levels based on their mastery of the previous skill. Therefore, what students work on in *Lexia* is independent of what they are learning in class because the program meets them at their own level.

The *Lexia* program includes activities that address five different strands of literacy instruction: phonological awareness, phonics, automaticity/fluency, vocabulary, and comprehension. Once students reach a 2nd grade reading level, the structural analysis strand is added to their activities. At this point, the phonological awareness and phonics strands are eliminated. The activities that students complete are Common Core aligned within those strands, and offer corrective feedback to the students throughout their session. Along with offering students activities that are at their specific academic level, the program also scaffolds within each lesson/activity. Students are celebrated in the program when they pass levels, and they are also able to keep track of their own progress.

When students were not in Learning Lab on their respective online learning programs (depending if they were in the treatment or control groups), they were in the general classroom. At this school, students have two different teachers for literacy and for math. I taught literacy to the treatment group in the morning, and taught the control group in the afternoon. The 3-hour literacy block consisted of a morning meeting, shared reading, phonics/phonemic awareness instruction, a read aloud, guided reading, literacy centers, and writer's workshop. All students participated in every portion of this literacy block, regardless of which experimental group they were in. When they were not in my literacy class or Learning Lab, they were in math or specials with a different teacher.

Even though I did not oversee their time in the Learning Lab, I received weekly reports from the *Lexia* program through email that summarized my students' progress in the program. Mainly, I used this information to keep track of how much time they were actively completing activities in the program. I used different progress monitoring tools to track their academic progress through the course of the study, as detailed below.

Data Collection

One assessment was used to track and measure student growth across the study's timeframe. This was the Phonemic Awareness Inventory (PAI) assessment which was created by the school's charter network. The PAI is divided into five "Levels". Each level contains two to three different skills, and each skill is tested with ten questions. In order to "master" a skill, the student needed to get eight out of ten questions correct. In order to pass a Level, the student had to master every skill that fell under that level. The following phonological awareness skills were tested in each level:

-Level 1: whole word discrimination, rhyming recognition, and rhyming application
-Level 2: beginning sound recognition, syllable blending, and phoneme blending
-Level 3: ending sound recognition and middle sound recognition
-Level 4: syllable counting and phoneme segmentation
-Level 5: phoneme substitution, phoneme addition, and phoneme deletion

Examples of the types of questions on each Level were as follows:

-Level 1: "How many words are in the sentence, 'That dog is big'?"; "Do the following words rhyme: happy/sappy?"; "Give me a word that rhymes with 'old'."
-Level 2: "What is the beginning sound of 'pail'?"; "I am going to tell you parts of word. Please tell me what complete word it makes. 'bas-ket'"; "I am going to tell you the sounds in the word. Please tell me what complete word it makes. '/d/ /o/ g/'"
-Level 3: "What is the ending sound in the word 'water'?"; "What is the middle sound in the word 'hat'?"
-Level 4: "How many syllables are in the word 'butterfly'?"; "Please give me the sounds in the word 'spike'."

Students were tested at the onset of the study as a pre-test measure, and then re-tested at the end of the 6-week period as a post-test. The assessment was given to each student one-on-one, and took fifteen minutes to complete. Students were assessed on each question and level until they did not pass a level. If they reached a point where they did not pass a Level, I stopped the assessment. Their score was recorded as the highest level on which they passed every question. Scores were then compared on both assessments to measure growth in the control versus treatment groups. I was interested in using statistical analysis, as will be explained in the following chapter, to determine whether or not the treatment group had significantly higher results on the assessment than students in the control group. This would suggest that using the *Lexia* program for twenty minutes per day served as an effective Tier 2 remediation technique for struggling readers in my kindergarten class.

CHAPTER FOUR: RESULTS

The previous chapter outlined the procedures and described the sample used for this study. This chapter will describe the effects of the online learning intervention on phonemic awareness development, as measured by students' scores on the Phonemic Awareness Inventory (PAI) assessment. Scores will be compared across the treatment and control groups, but will also be compared within the assessment itself in order to analyze the effects the treatment had on different strands of phonemic awareness.

As described in chapter three, the PAI is divided into five levels. The skills tested on each level were as follows:

-Level 1: whole word discrimination, rhyming recognition, and rhyming application
-Level 2: beginning sound recognition, syllable blending, and phoneme blending
-Level 3: ending sound recognition and middle sound recognition
-Level 4: syllable counting and phoneme segmentation
-Level 5: phoneme substitution, phoneme addition, and phoneme deletion

Each of these skills is tested with ten questions. In order to pass a skill, i.e. whole word discrimination, the student has to get eight out of the ten questions correct. To pass the level, the student must pass every skill tested at that level. For example, in order to pass Level 1, a student must get an eight out of then on whole word discrimination, rhyming recognition, and rhyming application. At our school, the goal is that K4 (pre-K) students end their school year having passed Levels 1 and 2. The goal for K5 (kindergarten) is Level 4.

The PAI was administered to each student in both groups at the onset of the study in order to obtain a baseline phonemic awareness level for the students. Tables 1 and 2 show the score breakdown for students in the experimental and control groups, respectively, on this baseline administration of the PAI.

Table 1. PAI: BASELINE (Experimental Group)

GROUP: Exp	Level Achieved (Overall)	LEVEL 1			LEVEL 2			LEVEL 3		LEVEL 4		LEVEL 5		
NAME		Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q1	Q2	Q1	Q2	Q3
RR	2	8	8	10	9	10	8	8	0	n/a	n/a	n/a	n/a	n/a
JL	0	**6**	7	**2**	4	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
GM	0	**5**	8	**0**	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
OV	0	10	**1**	**0**	7	3	3	n/a	n/a	n/a	n/a	n/a	n/a	n/a
AM	0	8	**5**	**5**	9	10	**6**	n/a	n/a	n/a	n/a	n/a	n/a	n/a
GROUP AVERAGE	0.4	7.4	5.8	3.4	5.8	4.6	3.4							

Table 2. PAI: BASELINE (Control Group)

GROUP: Control	Level Achieved (Overall)	LEVEL 1			LEVEL 2			LEVEL 3		LEVEL 4		LEVEL 5		
NAME		Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q1	Q2	Q1	Q2	Q3
LB	1	9	9	9	**3**	4	**0**	n/a	n/a	n/a	n/a	n/a	n/a	n/a
LR	0	10	**7**	**0**	10	10	**4**	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NM	0	**0**	**7**	**0**	8	**2**	**0**	n/a	n/a	n/a	n/a	n/a	n/a	n/a
JA	0	**6**	10	8	**0**	4	6	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BS	0	9	**7**	**0**	**7**	8	**5**	n/a	n/a	n/a	n/a	n/a	n/a	n/a
GROUP AVERAGE	0.2	6.8	8	3.4	5.6	5.6	3							

The bolded scores are the ones that kept the student from passing that particular level, in other words, any score of 7 or less. Usually, teachers only test students on the next level if they pass the previous one. However, for the purposes of being able to have enough information to compare at the end of the study, I tested students on both Levels 1 and 2 at the baseline, even if they did not pass Level 1. As shown on the tables, eight of the ten students had not passed Level 1. One student in the experimental group had passed level 2, and one student from the control group had passed Level 1. Since no student passed higher than level 2, I used averages only from Levels 1 and 2 to compare the groups. The p-value for the averages of each group's score on the PAI at the baseline was 0.75. This is greater than 0.5, which means that there were no significant differences between the experimental and control groups, in terms of phonemic awareness level, at the onset of the study.

After the intervention was complete, the PAI was administered to every student for a second time. Again, even if a student did not pass the first level, both Levels 1 and 2 were administered for comparison's sake. Tables 3 and 4 show the breakdown of scores at the end of the study on the final administration of the PAI.

'Table'3.'PAI:'Final'(Experimental'Group)

GROUP:' Exp	Level' Achieved' (Overall)	LEVEL'1			LEVEL'2			LEVEL'3		LEVEL'4		LEVEL'5		
NAME		Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q1	Q2	Q1	Q2	Q3
RR	2	10	10	10	9	10	9	7	6	n/a	n/a	n/a	n/a	n/a
JL	0	9	9	1	9	8	7	n/a	n/a	n/a	n/a	n/a	n/a	n/a
GM	1	9	8	8	10	7	6	n/a	n/a	n/a	n/a	n/a	n/a	n/a
OV	2	10	8	9	10	10	10	3	0	n/a	n/a	n/a	n/a	n/a
AM	2	9	9	9	10	10	8	2	7	n/a	n/a	n/a	n/a	n/a
GROUP' AVERAGE	1.4	9.4	8.8	7.4	9.6	9	8							

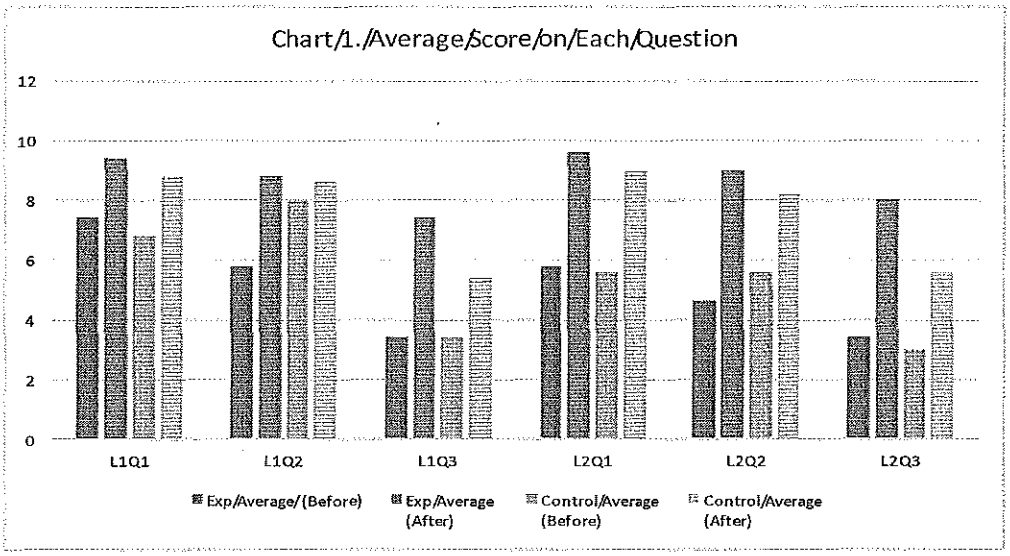
'Table'4.'PAI:'Final'(Control'Group)

GROUP:' Control	Level' Achieved' (Overall)	LEVEL'1			LEVEL'2			LEVEL'3		LEVEL'4		LEVEL'5		
NAME		Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q1	Q2	Q1	Q2	Q3
LB	1	10	9	8	8	10	5	n/a	n/a	n/a	n/a	n/a	n/a	n/a
LR	0	10	8	0	10	10	8	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NM	0	7	8	1	9	7	2	n/a	n/a	n/a	n/a	n/a	n/a	n/a
JA	1	8	10	10	8	6	6	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BS	1	9	8	8	10	8	7	n/a	n/a	n/a	n/a	n/a	n/a	n/a
GROUP' AVERAGE	0.6	8.8	8.6	5.4	9	8.2	5.6							

At this PAI administration, all but one of the students in the experimental group had passed Level 1. Of those four students, three of them passed Level 2 as well. The student who was at Level 0 was actually able to pass Level 2, but was not considered as passing Level 1 because he did master the rhyming application skill. The average overall PAI level of the group grew from 0.4 at the baseline to 1.4 at the end of the study. The control group had three students who passed Level 1, and two students who stayed at Level 0. One of these students at level 0 similarly was able to pass Level 2 but did not pass Level 1 because of the rhyming application

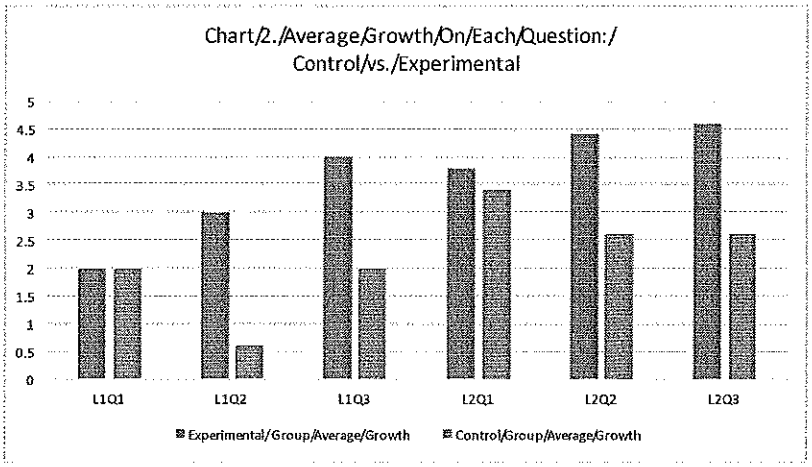
question. The average overall level of this group grew from 0.2 at the baseline to 0.6 at the end of the study.

The p-value for the average PAI level at the end of the study also showed no significant differences between the experimental and control groups (p=0.18). However, because the sample was so small and because the range of levels was so limited, I also compared the growth of scores on individual questions from the baseline to the end of the study between the two groups. Chart 1 shows the average growth on each question for both groups before and after the intervention.



Both groups made significant growth on their scores on the PAI assessment. However, the experimental group made significantly more growth than the control group across all the questions (p=0.01). On average, the experimental group showed 1.4 points more growth on a particular question than the control group.

The amount of growth in specific skills was different depending on which group students were in, as shown in Chart 2.



For students in the experimental group, the most growth was shown in phoneme blending (4.6 points), followed by syllable blending (4.4 points) and rhyme application (4 points). For students in the control group, the most growth was shown in beginning sound recognition (3.4 points), followed by syllable blending and phoneme blending (both 2.6 points). Across both groups, the two questions that showed the least growth were whole word discrimination and rhyme recognition. However, these were also the skills with the highest baseline scores. Since the maximum a student could get on a question was 10, the amount of growth that could have been shown in those two areas was limited.

The tables and charts provided in this chapter show a few different results. All students, regardless of their group, made at least some growth in their phonological awareness as shown by their PAI scores before and after the study. However, students in the experimental group showed more growth than their control group peers on all sub-skills of the PAI, except for whole word discrimination. This difference in growth was most pronounced in the rhyme recognition, rhyme application, and phoneme blending. Students in the experimental group also averaged a higher overall PAI score than students in the control group. The following

chapter will provide a discussion of these results and describe the strengths and limitations of this study, as well as make recommendations for further research on the topic.

CHAPTER FIVE: DISCUSSION

The purpose of this study was to test the efficacy of *Lexia*, a literacy-focused online learning program, as a Tier II intervention for struggling readers in kindergarten. As mentioned in previous chapters, phonemic awareness mastery in early elementary years is critical to success in reading later in life. Therefore, this study was aimed at finding an effective means to remediate these early literacy skills in students who were progressing inadequately in these areas. This chapter will start with an explanation of how this study relates to previous research done in the areas of phonemic awareness and online learning programs. It will draw conclusions from the results of the study detailed in chapter two, and list some strengths and limitations of the study's design. It will end with recommendations for further instruction for the students in the study and also ideas for further research on the topic.

Connections to Existing Research

As detailed in chapter two, there has been much research done in the areas of both phonemic awareness development and online learning program usage for elementary-aged students. The studies varied in the types of computer programs that were used, ranging from computerized versions of traditionally teacher-led activities (Dubois 2014; Hitchcock 2000) to an array of educational online games and activities (Segers 2005; Macaruso 2008). Although the magnitude of the effects of online learning has varied across studies, most of this previous research has found positive effects of online learning programs on phonemic awareness development in kindergarten and first grade students.

Furthermore, other studies have shown that a Tier II intervention approach is extremely effective for students struggling with various literacy skills. With a decrease in resources

available in many schools, there has been a search for efficient and effective ways to provide academic support for the students who need it the most. Koutosftas (2009) showed that a focused skill-based intervention can lead to great gains in phonemic awareness for struggling students in preschool and kindergarten. Mioduser (2000) was similarly interested in Tier II interventions for phonemic awareness remediation, but used computerized intervention materials. He found significantly higher gains amongst students in the computer intervention group than the traditional teacher-led one in six of the eleven tested measures.

My research was inspired by the Koutosftas and Mioduser's focus on the struggling learners in the class, and was modeled closely after Macaruso's 2008 study that also tested the effects of *Lexia* as an intervention for kindergarten students. In his study, the students used *Lexia* for 15-20 minutes a few times per week, and it was found that it had the greatest positive effective on phoneme segmentation (over letter naming fluency). In this study, as in mine, students in both groups were exposed to an explicit and systematic phonics and phonemic awareness instruction program in the classroom as well. However, my study differed from Macaruso's in that my intervention was focused on struggling readers needing Tier II assistance, as opposed to the general population of the class.

Explanation of Results

Phonological awareness consists of various different skills that must be tested separately and on a mostly one-on-one basis because it is tested orally. The assessment chosen for this study was the Phonemic Awareness Inventory (explained in detail in chapter three), which assessed whole word discrimination, rhyme knowledge, onset fluency, and syllable and phoneme blending, along with other more difficult skills assessed at later levels of the

assessment. This section will detail the progress that students in the experimental and control groups made on this assessment across the course of the study.

All students in the study, in both the experimental and control groups, made growth in their phonemic awareness mastery, as measured by the Phonemic Awareness Inventory (PAI) assessment. Students in the experimental group showed more growth than the control group on the raw score of every question except one. There were no significant differences between the groups on their final overall PAI level. Also, the differences in the averages on question growth between the two groups was generally within one or two points. Thus, the overall difference in results was not as great as past research would have suggested. However, this could have been due, in part, to the small sample size and the small range of possible scores on each question.

Aside from the raw scores on the assessment, there were some qualitative observations that also suggested a positive effect of the intervention. It seemed that even when students got the answers wrong at the final administration of the PAI, their attempts were becoming more logical. For example, for the rhyme production question, some students initially gave association responses (i.e. "What rhymes with house?" "chair"). Then, at the final testing window, they would instead give a word with the same beginning sound, or another skill. Although this meant they still were lacking the ability to produce rhymes, it also showed that they were internalizing some other phonemic awareness skills that they had not mastered previously. Similarly, there were other cases where students had initially completely refused to respond to a question, and at the end of the study were at least drawing on some knowledge to

produce an answer. Although these changes were not reflected in the assessment scores, they still show a certain level of growth in the students' confidence and knowledge of the material.

The effect of the intervention also seemed to differ based on the particular phonemic awareness skill. As mentioned in chapter one, the skills practiced in this study reflect seven different Common Core Standards, as follows:

- CCSS.ELA.RF.K.2.A Recognize and produce rhyming words.
- CCSS.ELA.RF.K.2.B Count, pronounce, blend, and segment syllables in spoken words.
- CCSS.ELA.RF.K.2.C Blend and segment onsets and rimes of single-syllable spoken words.
- CCSS.ELA.RF.K.2.D Isolate and pronounce the initial, medial vowel, and final sounds (phonemes) in three-phoneme (consonant-vowel-consonant, or CVC) words.
- CCSS.ELA.RF.K.2.E Add or substitute individual sounds (phonemes) in simple, one-syllable words to make new words.
- CCSS.ELA.RF.K.3.A Demonstrate basic knowledge of one-to-one letter-sound correspondences by producing the primary sound or many of the most frequent sounds for each consonant.
- CCSS.ELA.RF.K.3.D Distinguish between similarly spelled words by identifying the sounds of the letters that differ.

The standards that benefited most from the intervention were RF.K.2.B and RF.K.2.C, the two standards that encompass the skills of syllable and phoneme blending. Those two questions were the ones that had the highest average growth in the intervention group (4.6 and 4.4 points, respectively). The standard that was least affected by the intervention was RF.K.2.A, which encompassed recognizing and producing rhyming words. More specifically, at the end of the study, students were still struggling with producing rhyming words, especially ones with less common endings. Overall, the study showed mild positive effects of the computer program on phonemic awareness mastery.

Strengths and Limitations

As with all research, this study had a number of strengths and limitations. One strength of this study was that it was a realistic representation of an average classroom teacher's actual ability (time-wise) and availability to monitor extra interventions for their students. Past studies on online learning program interventions, including many of the studies described in chapter two, relied on graduate student or teaching assistant monitoring of the computer time one-on-one or in a small group. In other studies, the adult monitoring the intervention even had to be the one manipulating the program for each student. While that would obviously be an ideal scenario for these interventions, those extra human capital resources are luxuries that are not available in many urban, under-resourced schools. In my research, the intervention was being implemented with the exact resources that are always available to every teacher in the building. This makes it a more accurate representation of what interventions could actually be implemented in the future.

Another strength of the research was the differentiation in phonemic awareness instruction that was provided to all students in the study. The structure of literacy instruction in my classroom was centered around small group instruction for all students. Students were homogeneously organized into these small groups, which meant that they were in groups with other students of approximately their same reading and phonological awareness level. This allowed me to address each group's specific literacy needs, instead of attempting to generalize my instruction to fit the whole class. Therefore, students in the control group were getting this scaffolded small group instruction, even though they were not getting the time to work on *Lexia*. Students in the experimental group were receiving this small group time in addition to the even more individualized literacy skill practice provided by the *Lexia* program. This means

that regardless of the group they were in, all students were receiving high-quality, explicit phonemic awareness instruction which, as shown by studies detailed in chapter two, has huge implications for literacy development.

One limitation of the research was the environment in which the intervention took place. Students completed all their *Lexia* time in the Learning Lab, the computer lab at our school. Although this was a quiet environment, and one in which they were used to being on the computer, they were surrounded by classmates who were completing a different program. Most students in the class preferred *Dreambox* (the math online program) to *Lexia*, so students in the study were sometimes distracted by the students on *Dreambox* around them. It might have been better if the students on *Lexia* sat in a different part of the room so they would be less distracted.

Another limitation was that there was no system in place to incentivize or motivate activity completion on the computer program. Although students were generally excited by the chance to use the computers, they were sometimes easily distracted or unmotivated to complete the different activities and challenges on *Lexia*. This could have been for a variety of reasons, but could have been lessened if they felt there was some sort of tangible benefit for doing so. I had originally decided against having an incentive because I thought it would be unfair for the other students, since they were all expected to be on the computer anyway. However, it is possible the effects of the program could have been enhanced with an increase in motivation on the part of the students.

Recommendations for the Classroom and Further Research

Analysis of the results of this study led me to a few conclusions regarding next-steps for both the students in this group and my teaching in general. First, I noticed the students in this study still struggled with rhyme awareness, even if they had mastered other phonemic awareness skills that were considered more difficult. This suggests that students struggling with phonemic awareness development need repeated exposure to rhyme recognition and application practice, in various modalities. Second, since many of the students in this study were English Language Learners, I found they could have benefited from explicit vocabulary development. I found that sometimes, they knew how to apply a skill in one context, but struggled if the question was worded a different way. Similarly, they were sometimes distracted if they did not understand the meaning of the example, even if understanding the meaning was unnecessary to answer the question. For example, in order to blend the /sh/-/i/-/p/ sounds, they did not necessarily need to know what a ship was. Therefore, this study showed the importance of providing frequent opportunities for ELL (and all) students to develop their general vocabulary in order to help them grasp more straightforward early literacy skills.

Lastly, this study reinforced my necessity as a teacher to ensure that I am being intentional about all the instructional techniques and interventions I am exposing my students to in order to maximize their impact. It is not merely enough to give my students time on the computer programs, or have them participate in small-group lessons. I must utilize frequent progress monitoring and informal observations to stay informed on my student's most up-to-date instructional gaps and needs. This way, students will be able to develop both skills they may be lacking and expand upon skills they have already mastered.

While this study helped to inform my own future instruction, it also flagged areas upon which more research could and should be done in the future. Although research on different aspects of online program usage for elementary school students has become quite ubiquitous, there are a few areas that could be more critically analyzed. First, I think it would be beneficial to compare the effects of computer use on the students who are above grade level and those who are below grade level. I chose my most struggling readers for my study because of how important phonological awareness is for reading success later in life, and I think it is critical to find ways to remediate their gaps in literacy development. However, after observing all the students in my class, I repeatedly saw a pattern of the more advanced students in my class being more motivated by computer time (even though they were using *Dreambox*) and making the most progress with the program. It would be interesting to do a controlled study of this in order to ensure that different groups within the class are having their needs met in the most effective and efficient way possible.

It would also be beneficial to have a study whose purpose it was to find the most effective frequency and duration of online program usage. Most of the previous studies described in chapter two only had students using the online program for 15-20 minutes per week. My research had students on the computer for 15-20 minutes per day. I think my students might have been more engaged in the program, when expected to complete it independently as was the case in this study, if they were not using it so frequently. This is probably also dependent on both the academic level of the student and the features of the specific program being used. However, research in this area would add to the goal of maximizing efficiency and effectiveness of literacy interventions.

Conclusion

The purpose of this thesis was to study the effects of a literacy-focused online learning program as a Tier II intervention for phonemic awareness remediation in kindergarten students. The results of the study showed that although use of the *Lexia* program did increase the amount of growth shown by students in their phonemic awareness skills, the overall results on phonemic awareness mastery were not particularly extreme. Furthermore, the program was shown to provide greater benefits for some phonemic skills over others. Although teacher-led small group instruction was shown to be almost as effective as mixture of computer and small-group exposure, the computer program, if tied to classroom instruction, could still serve as a beneficial supplement to the general curriculum of the class.

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