Concordia University St. Paul

DigitalCommons@CSP

Graduate Teacher Education

6-30-2022

Improving the Implementation of the Science of Reading in Primary Classrooms

Molly Lout
loutm@csp.edu

Improving the Implementation of the Science of Reading in Primary Classrooms

Molly L. Lout

Concordia University, St. Paul

Master of Arts in Education – Differentiated Instruction

ED 590: Research & Complete Capstone, Cohort 092

Professor Brian Boothe Ed.D.

Second Reader: Elisabeth Amirahmadi

June 18, 2022

Dedication

To my husband: I could not have done this without your love and support! I am so glad you convinced me to finally go back to school to complete my master's degree. Thank you for keeping me on track and encouraging me along the way.

To my son: I hope you can forgive me for all the times I had to "do homework" instead of playing one more game, coloring one more picture, or going to another park together. Seeing your excitement on my graduation day was exactly what I needed to know this journey was worth the time, stress, and struggle.

To my students: Your hard work and dedication to learning to read inspired me to pursue this capstone topic. Thank you for always bringing your best each day even when it was hard. You have taught me a lot about myself as an educator and to remember what is most important in life.

Acknowledgements

I would like to start by giving thanks to everyone in Cohort 092. I would not have made it through this program without your support and encouragement. I love how we became invested in one another's success in this program, professionally, and in our personal lives. While we have only connected online for the past two years, I feel like I have known all of you for much longer. Thank you for being vulnerable, honest, and inspiring throughout this entire journey.

I would like to extend my sincere appreciation to the professors who helped me grow professionally and personally throughout this program. I will never forget the advice, encouragement, and wisdom they shared. A special thank you to Professor Boothe whose flexibility, realistic expectations, and reassurances helped me complete my capstone. I cannot thank you enough!

Table of Contents

Abstract

Becoming a proficient reader is critical if one wants to have a successful future. Unfortunately, students in the United States continue to fall well-below basic reading levels. Although a plethora of research on the science of reading exists, many educators have not implemented science-based instructional practices in primary classrooms. A total of 17 peer-reviewed articles were synthesized to show teacher education programs, phonological awareness, decoding skills, and specific interventions played a critical role in students' acquisition of reading skills. The analysis discovered the science of reading has not been implemented adequately in primary classrooms or teacher education programs. However, the studies provided teaching strategies focused on phonological awareness to aid in students' future reading skills. Additionally, studies offered guidance on instructional methods shown to help students decode words more consistently and accurately. It was determined that the education system needed to make drastic changes so all students could become proficient readers.

Keywords: decoding, phonemic awareness, phonological awareness, science of reading, systematic phonics

Improving the Implementation of the Science of Reading in Primary Classrooms

Chapter One: Introduction

"Unless students learn to read by the end of first grade, they are highly likely to remain poor readers and suffer academic difficulties across all subjects" (Juel et al., 1986; Olson et al., 2014; Sparks et al., 2014, as cited in Moats & Tolman, 2019, p. 4). Research showed how critical it was for students to read proficiently by the end of first grade, yet many students across the United States have failed to become proficient readers. Science-based instructional practices have been available for decades, so why have so many students struggled to read in third grade and beyond? Unintentionally, educators have been using methods not aligned with the science available. While not entirely their fault, teachers have entered their classrooms unprepared to provide quality reading instruction. Teacher education programs have not adequately taught future educators the science behind how students acquire reading skills.

In the 1990s, a significant debate about the proper way to teach students to read, later known as the "reading wars," began. As Shanahan and the North Central Regional Educational Lab (2005) described, one side of educators fought for whole-language instruction, and the other argued for explicit instruction in the skills needed to read. People were losing confidence in public education as the debate intensified, so President Bill Clinton and the United States Congress formed the National Reading Panel (NRP). The NRP consisted of "scientists, teachers, administrators, and teacher educators [to] determine what research had to say about reading" (Shanahan & North Central Regional Educational Lab, 2005, p. 1). The panel's role was to look at the research available, not to determine how educators should implement their findings. The NRP's report created different perspectives on the science of reading and how it should affect classroom reading instruction. While some districts chose curriculum programs aligned with

scientific research, many schools chose programs with components of the NRP's findings but may not have been systematic or explicit enough.

Research and literacy experts shared their views on the NRP's report and the discussions that followed its release. Shanahan (2020) wrote, the term 'science of reading' has most often been associated with the research on how to decode and pronounce words. Meanwhile, Moats described the science of reading as a collaborative work from multiple disciplines and a plethora of studies (Stuart & Fugnitto, 2020). Moats also said, "These studies have revealed a great deal about how we learn to read, what goes wrong when students don't learn, and what kind of instruction is most likely to work the best for most students" (Stuart & Fugnitto, 2020, para. 3). Furthermore, Ehri (2020) shared results from her research that showed systematic phonics instruction, along with meaning-based instruction, could be matched to students' instructional needs. Ehri's (2020) development theory could be seen as a possible compromise or resolution to the reading wars debate. Moats shared that the NRP's report provided a succinct and thorough evaluation of the available research at that time, and it gave educators a chance to understand which skills were most necessary in teaching students to read. However, even with that information, data showed students in the United States continued to struggle to become proficient readers.

Importance of the Topic

The data and perspectives shared by various sources revealed the dire need for a change in reading instruction across the United States. The 2019 National Assessment of Educational Progress (NAEP) Reading assessment showed 34% of the nation's fourth graders performed below the NAEP basic level (White et al., 2021) and only 35% read at or above the proficient level (Hindman et al., 2020). Alarmingly, reading scores across the nation have increased only

slightly since 1992 (State Collaborative on Reforming Education, 2020). The National Reading

Panel report was published in the year 2000 (*Eunice Kennedy Shriver* National Institute of Child

Health and Human Development et al.), so why were students still struggling to be proficient

readers by fourth grade?

As Seidenberg (2013) wrote, the reading research has not impacted classroom instruction

because there was no connection to pedagogy when the NRP report was published. Educators

were not given direction on what to do with the newly published information, but instead they

were given statements on the most important components of reading instruction. Another

possible reason the reading research has not made its way into classrooms was because change is

hard, especially with conflicting interests and so many stakeholders involved (Seidenberg et al.,

2020). Moats shared her perspective in saying the research on teaching children to read has been

known since the early 1990s, and "…yet today a majority of teachers still haven't been given the

knowledge or instruction to effectively teach children to read" (Stuart & Fugnitto, 2020, para. 7).

The research had not been shared with those who needed it most.

The education system needed to find a way to bring the science of reading research to

educators. Duke and Cartwright (2021) wrote, "There is no shame in the need for revision; in

fact, it is a sign of embracing science over ideology, progress over nostalgia" (p. S39). The

research clearly provided data-informed teaching strategies and insight into how children learn to

read. The research showed the need to reform teacher preparation programs and inform current

educators and school districts with evidence-based reading practices.

Scope of Research

As discussed, an abundance of research existed on the science of reading and how

children learn to read. In fact, there was too much research to share in the scope of this literature

review. The studies shared investigated how teacher preparation programs prepared educators for teaching beginning readers. The impact of phonological awareness on students' future reading skills, as well as more accurate ways to measure phonological awareness for students with speech and/or language impairments were examined. Studies also explored the best instructional strategies for teaching students how to decode words. Additionally, the research looked at the impact specific types of reading instruction had on students' acquisition of reading skills.

It is important to note the research analysis only looked at studies with students in preschool through second grade because those are the critical years in mastering foundational literacy skills. The goal of this research was to discover which components of reading instruction needed to be implemented in those grade levels. The scope of the analysis did not include studies with participants in third grade or higher because students of that age should already have a solid foundation in phonological awareness and decoding skills. Additionally, only studies from teacher preparation programs in English-speaking countries were examined. This was due to the complex nature of the English language and because the information learned from non-English speaking programs would not have the same transferability.

Research Question

The purpose of this research analysis and literature review aimed to answer the question: In light of what is known about differentiated instruction, how can the science of reading research be more effectively and efficiently implemented in primary classrooms, so students learn to read? With a surplus of relevant research available, the literature review shared specific research-based instructional practices shown to teach all students to become proficient readers. Additionally, empirical studies on teacher preparedness to teach beginning literacy skills was shared. This specific research question aligned with Concordia University-St. Paul's program

essential question: In light of what is known about differentiated instruction, how shall professional educators effectively teach every student? Both questions were answered through the literature review in chapter two and the insights and applications shared in chapter three.

Definition of Terms

The definitions shared provide insight and additional information for those who may be unfamiliar with specific terminology associated with beginning reading instruction. Additionally, the terms shared provide background knowledge about the science of reading which will aid in better understanding of the research presented.

Decoding is "the ability to apply your knowledge of letter-sound relationships, including knowledge of letter patterns, to correctly pronounce written words" (Reading Rockets, 2020b, para. 1). Another view of decoding is "a means of getting spellings of words into memory so they can be read by sight" (Ehri, 2020, p. S57). The ability to decode is critical in the beginning stages of learning to read as that eventually transfers to automatic word recognition.

Phonemic awareness is "the specific ability to focus on and manipulate individual sounds (phonemes) in spoken words" (Reading Rockets, 2022a, para. 2).

Phonological awareness "is a broad skill that includes identifying and manipulating units of oral language – parts such as words, syllables, and onsets and rimes" (Reading Rockets, 2022a, para. 1). Research has shown this area to be a key component of becoming a proficient reader (Ehri, 2020; Moats & Tolman, 2019; Shanahan, 2020)

Science of reading is "a term that has been used for more than 200 years. Throughout this history, it has been used most frequently to refer to the pronunciation and decoding of words" (Shanahan, 2020, p. 1). However, the definition of the science of reading can change based on a person's viewpoint. Moats said the science of reading is a compilation of thousands

of studies that disclosed how people learn to read, "what goes wrong when students don't learn,

and what kind of instruction is most likely to work the best for the most students" (Stuart &

Fugnitto, 2020, para. 3). Moats also pointed out the science of reading "is not an ideology, a

philosophy, a political agenda, a one-size-fits-all approach, a program of instruction, nor a

specific component of instruction" (Stuart & Fugnitto, 2020, para. 2).

Systematic phonics "provides the foundational knowledge that launches students'

development as alphabetic readers and enables them to move through the phases. Scope and

sequence charts specify the major grapheme-phoneme relations that must be mastered and their

order of presentation" (Ehri, 2020, p. S55). Through years of research, Ehri (2020) has shown

this type of phonics instruction to be most beneficial for all students.

Summary

The goal of this paper is to discover why primary educators have been unable to

effectively teach children how to read and to share research-based teaching practices that follow

the science of reading. While such research has been around for decades, most primary educators

are unaware of how students learn to read in the beginning grades. These educators are following

state standards and curriculum programs and implementing what they were taught in

undergraduate programs and by district mentors. However, those practices have been shown to

be ineffective for many learners based on the most recent reading assessment data (Hindman et

al., 2020). Educators are better equipped to successfully teach all students to read by third grade

when they understand the science behind how children learn to read.

The literature reviews provided in chapter two focused on why the science of reading

research has not been utilized by many primary teachers. As established in empirical qualitative

and quantitative studies, effective instructional practices will be shared to improve the

implementation of the science of reading in primary classrooms. A major theme discovered in

the research was the lack of science-based instruction within preservice education programs. It is

important for all educators, but especially new educators, to understand how children learn to

read. Educators cannot do better for their students if they do not realize their instruction is part of

the problem. Furthermore, educators need to understand, and know how to effectively teach, the

foundational skills children must know to become proficient readers. Data and research on how

students master those foundational skills, such as phonological awareness and alphabetic

principles, will guide primary teachers to implementing best practices. The ultimate goal is to

provide practical, relevant, and current information on the science of reading and how primary

educators can help all students learn to read through its implementation.

Chapter Two: Literature Review

There is a plethora of research on the science of reading and which instructional practices

are most effective. However, most of the research has not impacted reading scores in the United

States or how educators are trained to teach reading. It appears many educators are unaware of

the foundational skills students need to become proficient readers. How does that happen?

Research has shown which evidence-based teaching practices help students learn to read, yet

primary educators continue to implement ineffective reading instruction. The literature review

explored answers to those problems.

A major theme in this research was educators' preparedness to teach beginning readers.

While there were many meta-analyses and literature reviews on the topic, only primary studies

were reviewed. The first section of the literature review aimed to discover why education

programs at colleges and universities inadequately prepare future teachers of reading. Research

by McMahan et al. (2019), Hurford et al. (2016), Ehri and Flugman (2018), Meeks et al. (2020),

and Washburn et al. (2016) revealed the need to drastically improve preservice teacher

preparation programs. As the research showed, future educators were graduating with limited

knowledge of phonological awareness, phonics, and morphology, and they were unprepared to

provide effective reading instruction to early learners. The research highlighted the need for

change to teacher preparation programs, as could be seen within the first theme of teachers'

preparedness.

A second theme from the literature was the critical importance of building a strong

foundation in phonological awareness (Burns et al., 2018; Skibbe et al., 2020; Brown et al.,

2021). Although there was enough research to prove this fact, educators continued to give

inadequate attention to phonological awareness (PA) in their instruction. The studies reviewed

focused on how much instructional time was devoted to PA and its most important components.

Knowing phonemic awareness has been a determining factor for future reading ability, Skibbe et

al. (2020) reviewed an assessment tool that could provide educators with more accurate data for

students with speech and/or language impairments.

The third section focused on instructional practices specific to decoding skills and

alphabetic knowledge. Research conducted by Roberts et al. (2019), Pullen and Lane (2014),

Wolf (2016), Gonzalez-Frey and Ehri (2021), and Sargiani et al. (2021) provided evidence to

show the positive impact different decoding strategies had on beginning readers. The theme of

decoding skills and their connection to alphabetic knowledge gave insight to effective strategies

educators could use with beginning readers. Since decoding is how students apply their letter-

sound knowledge to reading print, that particular section would help educators improve the

implementation of science of reading practices in their classrooms.

A fourth theme included in the review focused on the impact additional interventions and instructional practices had on students' reading skills. The interventions discussed did not fall under the previous themes of phonological awareness or decoding skills, so the final section included implementation of integrated spelling, writing, and comparing different types of reading instruction (McGeown & Medford, 2014; Moller et al., 2022; Ray et al., 2021; Vollebregt et al., 2021). These studies aimed to provide evidence-based instruction practices focused on early literacy skills teachers may not have used before.

Teacher Preparedness

A common theme found in the research was that educators are entering classrooms without the scientific knowledge of how to effectively teach students to read. McMahan et al. (2019) conducted a quantitative study to discover the relationship between teachers' knowledge of the English language and various stages of training that met the objectives of the International Dyslexia Association (IDA). There were 347 licensed teachers from several southern states in the United States who participated. Those teachers were also involved in either a two-year course for systematic literacy instruction or a one-day workshop on literacy and reading disabilities (McMahan et al., 2019). The researchers created two 50-item tests that assessed the following: phonological sensitivity, phonemic awareness, decoding, encoding, and morphology (McMahan et al., 2019). The results showed no statistically significant difference in knowledge of the five domains for teachers without specific training, whether they held a bachelor's degree or a master's degree (McMahan et al., 2019). Additionally, as the authors hypothesized, educators enrolled in an accredited training course had higher levels of knowledge overall (McMahan et al., 2019). Results also showed the weakest areas of knowledge were encoding and morphology,

and those without training knew very little about morphology at all (McMahan et al., 2019). The

authors suggested teachers should receive more training in both areas, encoding and morphology.

The data from the McMahan et al. (2019) study suggested the accredited training

provided participants with increased knowledge and skills in literacy, which was to be expected.

However, the teacher preparation programs could teach more specifics about the English

language, specifically phonological awareness, phonemic awareness, decoding, encoding, and

morphology. While there was no student data in this study to measure the impact of teacher

knowledge and skills on students' reading outcomes, the data showed the importance of having

knowledgeable educators teaching students to read (McMahan et al., 2019). Furthermore,

McMahan et al. (2019) showed the value in providing educators with accredited training that

would help them effectively teach students to read, especially those with dyslexia.

Similarly, Hurford et al. (2016) used a mixed-methods study to discover if preservice

teachers were lacking in knowledge of phonological processing skills and whether they could

demonstrate those skills themselves. For the study conducted by Hurford et al. (2016), the

participants all came from a public, midwestern university and included 85 preservice teachers

and 79 non-education majors. The Comprehensive Test of Phonological Processing (CTOPP;

Wagner, Torgesen, & Rashotte, 1999, as cited in Hurford et al., 2016, p. 894) was used to assess

phonological processing. The authors analyzed the results and provided conclusions to how the

data could be used for future studies and bring change to preservice teacher preparation programs

(Hurford et al., 2016). As the data showed, preservice teachers had similar phonological

processing skills as non-education majors, which led to the conclusion that preservice teachers

are capable of phonological processing. However, preservice teachers were still unprepared for

how to teach phonological awareness to beginning readers (Hurford et al., 2016).

The study by Hurford et al. (2016) showed teachers graduated from their preparation programs with phonological processing skills but not knowing how to teach those same processing skills to their students. As Hurford et al. (2016) wrote, "Reading courses must be developed or revamped to include the science of reading" (p. 900) and change should also include appropriate coursework to teach elements of the science of reading. Research by Ehri and Flugman (2018) could help bridge the gap between teachers' personal knowledge of foundational literacy skills and their preparedness to teach those skills to early learners.

Ehri and Flugman (2018) wanted to discover how a year-long mentoring program impacted teachers' knowledge and ability to effectively teach phonics. Additionally, they looked at the impact it had on students' reading and spelling outcomes. The mixed-methods study by Ehri and Flugman (2018) was funded partially by the Reading Reform Foundation (RRF). Participants were 69 K-3 teachers and their students from 23 urban public elementary schools in the greater New York City region (Ehri & Flugman, 2018). Across the schools, a range of 43 to 98% of students were on free and reduced lunch. Principals nominated teachers to take part in the year-long study and those teachers received training in either the Orton-Gillingham (OG) or the Spalding program (Ehri & Flugman, 2018). Teacher questionnaires, teachers' views about reading and spelling (TVRS), and monthly observation notes from the mentors were used qualitatively. Ehri and Flugman (2018) also used quantitative research to analyze the data for teacher responses and student assessments. Throughout the year, a mentor worked with an individual teacher twice a week, for 30 weeks, in implementing one of the two systematic phonics programs.

As expected, the mentorship program provided positive results for teachers' knowledge, effectiveness in teaching phonics, and students' reading and spelling skills. While only two

phonics programs were used in the study, their specific effectiveness was not the focus, rather

the effectiveness of the mentoring program and how that could be applied to any high-quality

systematic phonics program was the main focus (Ehri & Flugman, 2018). The results showed

students' reading and spelling scores across all grades increased from fall to spring; however,

students in kindergarten and first grade showed more growth than students in second and third

grade (Ehri & Flugman, 2018). The authors noted the differences in student growth may have

been due to teachers' mindset, whether they taught the phonics program with fidelity, or because

students in K-1 benefitted more from the phonics instruction than in later grades (Ehri &

Flugman, 2018). Additional research would help explore those differences further.

A qualitative study by Meeks et al. (2020) aimed to discover how prepared new

education graduates felt about teaching reading to early learners. Meeks et al. (2020) conducted

telephone interviews with 11 recent graduates in Australia. Participants were asked open-ended

questions about their experiences in practicums and literacy courses, their preparedness to teach

"beginning reading and perceived ability to teach phonological awareness skills and phonics

skills to Kindergarten-Year 2 students," as well as their personal knowledge of early reading

instruction (Meeks et al., 2020, p. 165).

Results showed seven out of eleven participants did not feel adequately prepared to teach

beginning readers (Meeks et al., 2020). Surprisingly, two participants rated themselves as

proficiently able to teach early literacy skills, when they actually "demonstrated inadequate

knowledge of phonological awareness and phonics" (Meeks et al., 2020, p. 168). A common

concern shared by most participants was they were not shown how to teach specific skills to

beginning readers (Meeks et al., 2020). While only 11 new teachers were interviewed for the

qualitative study, the results raised concerns for how well universities prepare educators to teach

students how to read (Meeks et al., 2020). As Meeks et al. (2020) noted in their article, teacher

educators should be teaching their preservice teachers with the same methods that would be used

while teaching beginning readers. The authors also stated, "preservice teachers need to be given

explicit and systematic instruction in the foundational skills necessary for beginning reading

instruction *and* allocated practicum placements with expert and competent teachers" (Meeks et

al., 2020, p. 178). As their research (Meeks et al., 2020) showed, most new teachers graduating

from education programs were unprepared to effectively teach students how to read. Similarly,

Washburn et al. (2016) examined preservice teachers' knowledge of the English language and

how to teach early literacy skills to their students.

   The purpose of the 2016 study by Washburn et al. was to assess preservice teachers'

(PSTs) knowledge of basic reading skills and their views on teaching those skills. For the mixed-

methods study, 279 PSTs from four different university-based teacher preparation programs in

Canada, England, New Zealand, or the USA participated (Washburn et al., 2016). Each of the

universities involved had different requirements for their teacher preparation programs. For

example, PSTs in Canada were required to take a half-year literacy course on teaching word

identification in grades K-2 and another half-year focused on teaching comprehension skills in

grades 3-6. Meanwhile, during the first two years of the program for PSTs in England, students

learned subject knowledge and the skills needed to teach reading using "a systematic, synthetic

phonic approach and how to use children's literature in the classroom" (Washburn et al., 2016, p.

14).

   Washburn et al. (2016) used the *Survey of Basic Language Constructs* to measure PSTs

content knowledge and ability to teach phonology, phonics, and morphology. The survey

contained 46 items, where 38 measured content knowledge and ability and the last 8 were self-

perception items but were not included in the data analysis. Results showed all groups had a mean percent of correct scores below 70% and ranged between 49 and 67% (Washburn et al., 2016), which the authors considered failing. PSTs from Canada had the highest mean score, PSTs from England had the lowest, and PSTs from the USA and New Zealand were between the two. More specifically, participants may have scored lower on the morphology section than other items because that skill was not emphasized as much in beginning reading instruction, but it still played a role in word level reading down the road (Washburn et al., 2016). Results from the study, although limited by the small number of participants, showed PSTs who participated in a program "in which there was an explicit emphasis on teaching phonological and phonemic awareness instruction" scored higher in those areas than other PSTs (Washburn et al., 2016, p. 21). While the studies already shared focused on teachers' lack of preparedness to teach beginning reading skills, the next section of the literature review shifts to instructional practices teachers should be using in their classrooms.

Phonological Awareness

Phonological awareness is an overarching umbrella term for the ability to identify and manipulate parts of spoken language, such as syllables, words, phonemes, and onsets and rimes (Reading Rockets, 2022a). This foundational skill is necessary to become a proficient reader; however, many students in third grade and beyond struggle due to their lack of phonological awareness. One way to alleviate the problem is for primary educators to devote more time to phonological awareness instruction. The studies shared in this section take a closer look at how well educators teach phonological awareness and what practices they should be implementing.

A qualitative case study by Brown et al. (2021) examined the most widely used core literacy programs in Utah school districts during the 2019-2020 school year. The most widely

used core literacy program included five minutes of daily instruction at the phoneme level and

five minutes twice a week with larger units (i.e., syllables). Brown et al. (2021) looked

specifically at kindergarten teachers' use of the core program and any additional supplemental

programs they used. They found neither the core nor the supplemental programs used by

kindergarten teachers were consistent with the science of reading research in phonemic

awareness tasks, such as manipulating letters or focusing on one or two phonemic awareness

tasks (Brown et al., 2021). The programs used by Utah kindergarten teachers asked students to

complete phonemic awareness tasks developmentally inappropriate for their age and time of the

year. Additionally, the programs required students to focus on three or more phonemic

awareness tasks within the same lesson, and oftentimes, included tasks that were too rigorous

(Brown et al., 2021).

From their own research and information, Brown et al. (2021) determined phonemic

awareness instruction should match students' orthographic development and progress from easier

to more difficult tasks. Moreover, the results from Brown et al. (2021) aligned with a report from

the National Institute of Child Health and Human Development (NICHD) released in 2000, when

it was said, "manipulating letters during phonemic awareness instruction is much more powerful

for improving reading outcomes than instruction that is strictly oral" (p. S257). Additionally, the

NICHD stated focusing instruction on one or two phonemic awareness tasks is "superior to

instruction that uses three or more" (NICHD, 2000, as cited in Brown et al., 2021, p. S257). The

results from their study (Brown et al., 2021) showed value in having students write the sounds

they hear in words and produce those sounds orally as well. The authors also recommended

using consonants at the beginning of words that have continuous sounds (m, s, f, l, r, n, v, z) and

consonants at the end of words (t, p, g, d, k, b) to guide students' phonemic awareness knowledge.

Similarly, Burns et al. (2018) studied the connection between components of phonemic awareness and letter-sound knowledge in kindergarten students from high-poverty backgrounds. Participants in the study included 192 kindergarten students from one of three high-poverty urban elementary schools in the upper Midwest, and a majority of the participants were African American (Burns et al., 2018). It is important to note the study was conducted as part of a three-year research project called Path to Reading Excellence in School Sites (PRESS). Also, the PRESS research project provided the Quick Phonemic Awareness Assessment to measure students' development in phonemic awareness in the study (Burns et al., 2018). The assessment looked specifically at rhyming, initial sound isolation, blending, and segmenting tasks.

Researchers (Burns et al., 2018) analyzed the data from students' letter-sound fluency assessment from the Fall compared to their scores in the Winter, in addition to the scores from the Quick Phonemic Awareness Assessment. Results from the study showed initial sound isolation, blending, and segmenting contributed to letter-sound fluency but not rhyming (Burns et al., 2018). While rhyming has been shown to predict later reading skills, much of the research has been conducted with middle-class white children, not students form high-poverty backgrounds, which was the aim of the Burns et al. (2018) study. The authors discovered, "for students from high-poverty backgrounds, rhyming may not be a useful measure for predicting early literacy skills above and beyond these other phonemic awareness tasks" (Burns et al., 2018, p. 416). The results showed teachers should not rely on rhyming to determine future reading skills for students in high-poverty backgrounds. While Burns et al. (2018) explored the connection between phonemic awareness and letter-sound knowledge, Skibbe et al. (2020)

studied the use of a new system to measure students' phonological awareness, which could also

guide teachers' instruction.

Skibbe et al. (2020) noted that current phonological awareness assessments do not

consider the needs of students with speech and/or language impairment. This is important for

students and teachers because students with speech and/or language impairments cannot help it

when they are unable to succinctly pronounce or enunciate sounds during phonological

awareness tasks. Skibbe et al. (2020) described the Access to Literacy Assessment System—

Phonological Awareness (ATLAS-PA) as a new way to measure phonological awareness, on a

web-browser, tailored specifically for students with speech and/or language impairments because

it uses nonverbal response options. Essentially, students listen to the word or sounds, just as they

would with a teacher, but instead of giving a verbal response, students choose a picture or icon

they think is the correct response.

For their quantitative study, Skibbe et al. (2020) were able to create two groups of

participants: the first group had 938 students of typical development and did not have an

Individualized Education Program (IEP) for speech and/or language impairments, and the second

group had 227 students who had a reported speech and/or language impairment. Students came

from 57 different schools in the Midwest of varying socioeconomic backgrounds and ethnicities.

The authors wanted to determine if the ATLAS-PA would be a reliable way to measure

phonological awareness in students with and without speech and/or language impairment. Using

a Rasch measurement approach, which analyzed responses for validity, the results showed it was

reliable (Skibbe et al., 2020). It is important for educators to use an assessment that does not

skew students' scores because of their speech or language needs. Skibbe et al. (2020) may have

found a more inclusive way to measure students' phonological awareness without wondering if

their speech skills impacted their score. While focused phonological awareness instruction is
important, so too are students' decoding skills.

Decoding Skills and Alphabetic Knowledge

Decoding is the ability to use one's letter-sound knowledge to read words. While the act
of decoding is not new, educators and curriculum programs often have not taught students to
decode words in the same ways. Gonzalez-Frey and Ehri (2021) used an experimental design in
their quantitative study where the independent variable was the type of decoding training:
segmented phonation versus connected phonation. Participants took pretests to determine if they
knew enough letter sounds for the decoding training to have value but also could not yet decode
nonwords (Gonzalez-Frey & Ehri, 2021). Three different studies took place at different times,
places, and elementary schools in the northeastern United States with kindergartners. Study 1
had 18 participants, Study 2 had 16 participants, and Study 3 had 38 kindergartners from an
urban charter school. Gonzalez-Frey and Ehri (2021) wanted to see if students could decode
nonwords more successfully after segmented phonation training or connected phonation training.

The segmented phonation training required students to break up the "speech stream"
between each phoneme (Gonzalez-Frey & Ehri, 2021, p. 277). For example, if the word was *maf*,
the student would say each sound separately, 'mmmm – aaaa – ffff' and then blend all sounds to
say 'maf.' In contrast, the connected phonation training required students to sound out
consonant-vowel-consonant (CVC) nonwords without putting space between each phoneme.
Using the same word, *maf*, the student would say mmmmaaaaffff and slide their finger under the
letters as they stretched the sound of each letter and pronounced the word regularly, 'maf.'
(Gonzalez-Frey & Ehri, 2021). Results showed most students in the connected training found it
easier to learn to decode compared to those in the segmented training. The final assessment,

including CVC nonwords with stop consonants, showed the connected phonation group in all three studies to have better success than students in the segmented phonation group (Gonzalez-Frey & Ehri, 2021). Data showed that 90% of the connected group read more than the combined mean score, 14.6 nonwords correct out of 20, while only 32% in the segmented group had scores higher than 14.6 (Gonzalez-Frey & Ehri, 2021).

Gonzalez-Frey and Ehri (2021) speculated that participants in the connected phonation groups in Studies 1 and 2 required more training because they had already been taught to say phonemes separately and then blend during their classroom instruction. This was a difficult habit to break, so those students needed more frequent corrective feedback, which delayed their learning (Gonzalez-Frey & Ehri, 2021). Their analysis also concluded the segmented phonation group made more errors in decoding because when they paused between phonemes, they added a schwa sound, which means they added /uh/ after other sounds, and because of that, students had a harder time remembering all the sounds they needed to blend together (Gonzalez-Frey & Ehri, 2021). An important note about the Gonzalez-Frey and Ehri (2021) study was how they addressed limitations from Studies 1 and 2 by implementing Study 3 with an increased sample size, analysis of errors, and the researchers gave a delayed posttest to see if the decoding skill lasted beyond the training session.

Similarly, Sargiani et al. (2021) tried to find the most effective instruction for decoding skills. Sargiani et al. (2021) conducted a quantitative study to compare grapheme-phoneme decoding (GPD) to whole-syllable decoding (WSD) instruction. Graphemes are the written form of sounds, or phonemes, so a letter or cluster of letters is used to represent the sounds heard in a word (Ehri, 2020). 60 Brazilian Portuguese-speaking first graders, 30 boys and 30 girls, who knew letter names but could not read or write words participated. All students came from the

same public elementary school in Sao Paulo, Brazil and were from middle- to lower-class families. Authors randomly assigned students into three different conditions: the GPD group was taught to decode 40 consonant-vowel (CV) syllables through sounding out and blending, the WSD group was taught to decode the same 40 CV syllables but as a whole unit, or the Individual Grapheme-Phoneme (IGP) group who was taught 15 graphemes as single units, but no decoding was taught (Sargiani et al., 2021). Each student was given seven different pretests, received several days of instruction based on their group placement, and then had two days of posttests to determine the effectiveness of the instruction they received.

While being limited to only three weeks of time from pretests to posttests, Sargiani et al. (2021) were able to analyze results to show the grapheme-phoneme decoding instruction was more effective than the whole-syllable decoding instruction. The data also showed students in the whole-syllable decoding group took longer overall to master the skills assessed. This showed it is more effective to teach students to decode in smaller units than in larger syllabic units (Sargiani et al., 2021). The authors (Sargiani et al., 2021) pointed out how the study was completed with Portuguese-speakers, and the syllable structure of Portuguese is simpler than English syllables, which may cause limitations to the generalization of the study for students speaking a language other than Portuguese. Future studies with English-speakers may help contribute to more generalized results. Sargiani et al. (2021) wrote their "results support theories that reading instruction is most effective when it begins by teaching students to decode with small grapheme-phoneme units rather than with larger syllabic units" (p. 629). Their statement was connected to studies by Roberts et al. (2019) and Pullen and Lane (2014).

Participants of the Roberts et al. (2019) quantitative study included 127 preschoolers who attended five different elementary schools in a suburban district in the western United States.

The preschoolers were placed into 34 small groups for the instruction. Roberts et al. (2019)

aimed to discover if contextualized instruction, where letter instruction is rooted within

meaningful activities and words, or decontextualized instruction, where attention is given to

individual letters and the name or sound it represents, was more effective in teaching letter

names to preschool students. For their study, Roberts et al. (2019) chose 10 letters (T, A, D, M,

S, H, B I, F, and K) based on letter features, placement in the alphabet, well-known and less

known, and ease of articulation. They did this to avoid confusion with similar-looking letters and

for letters students had not heard as frequently.

Students were randomly assigned to either the contextualized or decontextualized

instruction groups. As described by Roberts et al. (2019), the decontextualized instruction had

the teacher show a letter card, told the students the name and sound of the letter, and asked the

students to repeat. This occurred daily with a review of previously taught letters and new letters

introduced. Also, students matched a letter card to the picture of an animal that started with a

new target letter and practiced saying the name and sound of each letter in a booklet. In contrast,

the contextualized instruction used letter cards that included an animal starting with the letter and

the name of the animal below the picture (i.e., B, Bear). The teacher pointed to the letter, said the

name and sound, and had the students repeat (Roberts et al., 2019). Another difference was the

use of a storybook to introduce each new letter and having the teacher point out pictures that

matched words in the book.

Roberts et al. (2019) analyzed the results of the posttest-assessments and found students

in both conditions had made gains. However, students in decontextualized instruction groups

made more gains in letter-sound identification of letters in isolation and phonemic awareness

(Roberts et al., 2019). The posttest consisted of students naming as many letter names or sounds

as possible in 30 seconds. The students were also shown four-letter words with one of the taught letters underlined within the word to see if they could recognize letters there as well (Roberts et al., 2019). This study connected to Pullen and Lane's 2014 study as they too compared decontextualized instruction but with decoding skills in first graders.

Pullen and Lane (2014) conducted a quantitative study to compare the effects of two approaches to decoding for struggling first-grade students: decontextualized, where the teacher directed the practice using manipulative letters, versus embedded, incidental coding practice. The 98 first-grade students at-risk for reading disability, who participated in the study, were from nine different elementary schools and were randomly assigned to one of three groups: treatment, comparison, or control (Pullen & Lane, 2014). The treatment group received 30 sessions of small-group instruction using manipulative letters to practice decoding skills in a four-step intervention. During the instruction, the teacher introduced a book, read the book, guided students through alphabetic word work with letter tiles, and then reread the book with students (Pullen & Lane, 2014). The comparison group received the same small group reading instruction but without the additional decoding practice with letter tiles. The control group did not receive any additional small group instruction, rather, they received their normal reading instruction from the classroom teacher (Pullen & Lane, 2014).

Analyses showed students with additional decoding practice with manipulative letters scored "significantly better on phonological awareness, decoding, and word recognition skills than students who received incidental decoding practice" (Pullen & Lane, 2014, p. 1). The authors mentioned the extra word work with letter tiles added only nine minutes to the intervention but helped increase students' decoding skills (Pullen & Lane, 2014), which seemed worth the additional time.

Wolf (2016) also looked at the impact of explicitly teaching letters and sounds. In fact, the study in 2016 built on a quantitative descriptive study by Wolf in 2014, "which showed children who could letter-sound read were the better CVC word decoders when compared to children who had a low or no letter-sound reading abilities" (Wolf, 2016, p. 12). Wolf (2016) wanted to take it a step further to uncover what instructional strategies aided in better letter-sound reading. For the quantitative study, 41 preschoolers from one of four rural preschools participated, and they were assigned to either the control group or the intervention group (Wolf, 2016). During the intervention, the instructor asked if the student could pronounce a letter's most common sound, point to a letter read by the instructor, and if the student could say a letter read aloud. The control group continued to receive their regular instruction in the preschool classroom.

Wolf (2016) noted the study used "a moments of measure data collection procedure" (p. 13), which meant the researcher documented the participants' accuracy in decoding and the speed of word decoding. With the data collected, the number of letter sounds read was higher for the intervention group than the control group, and those students increased their letter-sound reading at a faster rate than the control group as well (Wolf, 2016). However, Wolf (2016) pointed to the fact that after 8 weeks of intervention, there were still not enough children who learned to decode CVC words for analysis to occur. The results showed preschool teachers may not need to wait until students seemed ready for letter instruction; rather, simple exposure through repeated reading could have beneficial effects early on (Wolf, 2016).

Effective Interventions and Instructional Practices

The fourth theme from the literature was implementing effective interventions and instructional practices shown to help students learn to read. McGeown and Medford (2014)

designed a quantitative study to find how the method of instruction impacted the skills students

used while learning to read. There were 85 students, all English-speaking and no special

education needs, who participated in the study and were from the same school in a low

socioeconomic area. Participants were assessed during the second week of school, six months

later, and one year later. During those times, the researchers assessed: letter-sound knowledge,

rhyme awareness, phoneme analysis, phoneme synthesis, vocabulary, short-term memory, visual

discrimination, and word ability with regular and irregular words (McGeown & Medford, 2014).

An interactive computer program called 'Fast Phonics First' (Watson & Johnston, 2007, as cited

in McGeown & Medford, 2014) was used with the whole class to deliver 40 minutes of synthetic

phonics instruction each day and phonemic awareness instruction which always involved letters.

Analysis of the results showed letter-sound knowledge and short-term memory span were the

strongest and most consistent predictors of early word reading in the participants (McGeown &

Medford, 2014). Phonemic awareness was also a strong predictor for early word reading.

    While there was no control group involved, participants showed growth in their reading

skills, and the data supported a systematic synthetic phonics approach. The data also provided

insight into how a synthetic phonics approach could be used to teach students how to read.

Knowing which skills were stronger predictors for early word reading provided data educators

could use to determine which skills to focus on during their instruction (McGeown & Medford,

2014). Beyond a synthetic phonics approach, researchers (Vollebregt et al., 2021) explored the

impact of code- and knowledge-focused reading instruction on students' reading skills.

    Vollebregt et al. (2021) conducted a quantitative study in three different schools in the

Greater Toronto Area (GTA, Canada) with students in first grade. The study compared the

results of the intervention Reading for All (RfA), a code-based and knowledge-based skills

program, to the Dialogic Reading intervention, a program that tried to develop knowledge-rich

vocabulary (Vollebregt et al., 2021). Both interventions were given twice a week in 50-minute

sessions to the whole class, with 30 minutes of that time being active instruction. Also, the

Reading for All intervention included small-group practice in addition to the 30 minutes of

instruction (Vollebregt et al., 2021). While the Reading for All intervention focused on nine

language and literacy goals, the goal of the Dialogic Reading intervention was to "develop

vocabulary and oral language by encouraging child participation in the reading experience,

adding information to responses using rephrasing and expansion techniques" (Vollebregt et al.,

2021, p. 308). Essentially, should teachers focus more on code-based skills such as phonics,

decoding, and phonological awareness, or should they focus on helping build students'

vocabulary and language skills?

Data showed participants in the Reading for All program achieved significant

improvements in phonological awareness, non-word decoding, letter and word recognition,

reading comprehension, and written expression; more specifically, the scores for phonological

awareness, non-word decoding, and written expression were significantly higher than the

Dialogic Reading group (Vollebregt et al., 2021). The authors pointed out the Dialogic Reading

group increased their scores in Receptive Vocabulary at the schools with average or lower

household incomes, which may have to do with the oral language skills students' families use at

home. Vollebregt et al. (2021) provided an important limitation to their study, stating potential

bias with the Reading for All program because the designers of the program were also the ones

who completed the assessments in the study. They also co-instructed the Reading for All

intervention with the classroom teachers (Vollebregt et al., 2021). Nonetheless, this study

provided evidence to show the need for "a comprehensive approach to provide both a solid

foundation in phonics, and the oral language skills and strategies to become an expert reader"

(Castle et al., 2018, as cited in Vollebregt et al., 2021, p. 317).

Similarly, Moller et al. (2022) explored the effects of integrated spelling-reading

instruction with two trained control conditions and to an untrained "business-as-usual" condition

(p. 70). This quantitative study included 65 kindergartners from six schools in the Copenhagen,

Denmark area, and participants were chosen based on their narrow knowledge of letters and

phonemic awareness, and unable to read words (Moller et al., 2022). All three trained control

groups used the same systematic phonics approach where teachers taught students letter-sound

correspondences and read with students one-on-one. The experimental spelling-reading condition

replaced some of the letter-sound training with spelling practice, which occurred in the two

trained controlled conditions.

Participants in all conditions were taught individually by trained instructors in four 20-

minute sessions, while the participants in the business-as-usual condition stayed in their

classrooms and received their usual instruction (Moller et al., 2022). Students in each control

group were taught nine letters and corresponding sounds gradually, using letter cards with letters

embedded in pictured objects. The second part was different for each condition: the integrated

spelling condition segmented and spelled four to five words as many times possible in the time

given; the second group practiced saying letter sounds with the cards used in part one numerous

times; and the third group required the student to point to a letter after the instructor said the

sound (Moller et al., 2022). The third part was the same for all conditions, where students were

asked to read 17 different words formed with letter cards by the instructor.

While limited by the small number of letters included in the training and having students

from the same area, the study by Moller et al. (2022) showed promise for students' reading skills

with the integrated spelling-reading instruction. All three conditions made significantly more progress than untrained controls, and participants in the integrated spelling condition made considerably higher gains than the business-as-usual group on all measures (Moller et al., 2022). In fact, the authors noted the integrated spelling caused students to use their phonemic awareness skills while segmenting words because they had to connect sounds with the written letters (Moller et al., 2022). An instructional practice that required students to actively engage their phonological awareness in multiple ways improved students' reading skills. Even with the limitation of one-on-one instruction in this study (Moller et al., 2022), educators could implement this type of instruction in their classrooms.

The final study reviewed was conducted by Ray et al. (2021) and investigated the effect of a handwriting intervention, Write Start-K, on kindergartners' reading skills compared to the standard way of teaching reading and writing. The Write Start-K intervention provided "explicit instruction and practice of letter formation both in isolation and in words and sentences, through a combination of whole-class instruction and themed, station-based activities" (Ray et al., 2021, p. S195). The quantitative study included students in two schools in New South Wales, Australia, in communities with lower socioeconomic status. The school that received the intervention had 29 kindergarten participants, and the control school had 41 kindergarten participants. Ray et al. (2021) explained the Write Start-K intervention included two 45-minute sessions per week for a period of eight weeks. The lesson was given to the whole class, and it focused on letter formation and using that particular letter in words and sentences within the station-based activities. The first session focused on fine-motor, visuomotor, and cognitive aspects of the handwriting task, such as writing letters in Play-Doh with a pencil or drawing a mirror image, while the second session used crafts and writing tasks to create authentic writing opportunities (Ray et al., 2021).

The control school used their usual handwriting instruction and tasks such as cutting, sorting words, worksheets, tracing, and copying, but it did not focus as much on letter-formations through the multisensory and fine-motor activities as the intervention did (Ray et al., 2021). Ray et al. (2021) analyzed the data with linear mixed models to discover each students' growth for each measure and to determine if there was a difference between the two groups in terms of individual growth.

As expected, the Write Start-K program "had a statistically significant impact on two of the literacy measures, word reading and letter name knowledge" (p. S202) and had nearly the same impact on letter-sound knowledge and nonsense word reading. Authors correlated the positive results to how the Write Start-K intervention "emphasize[d] four aspects of fluency: recall of the letter form, retrieval of the motor pattern, reproduction of the retrieved form through handwriting, and sufficient repetition" (Ray et al., 2021, p. S203). Limitations should be mentioned though. First, there were limited randomizations because the intervention was meant to be used in a whole class setting. Additional studies that included more classrooms could help with generalizing the results of this study (Ray et al., 2021). Secondly, the co-teaching model used in the Write Start-K intervention may not be possible for all classrooms, so the results with smaller groups may not be seen with a regular-size classroom with one teacher (Ray et al., 2021). Again, further research into such limitations would help solidify these results.

Review of the Proposed Problem

As previously stated, the purpose of this research was to answer the question: In light of what is known about differentiated instruction, how can the science of reading research be more effectively and efficiently implemented in primary classrooms, so students learn to read? It is critical for teachers to have a solid understanding of the foundational skills necessary to become

proficient readers and know the most effective ways to teach those foundational skills. The

science of reading research has been around since the 1990s, but educators continue to use

ineffective methods for teaching beginning readers. It is imperative to find a solution to this

problem.

Review of the Importance of the Topic

With everything known about how children learn to read, there is no reason students are

not reading proficiently by third grade. Unfortunately, our education system has failed both

students and teachers. Educators are graduating from colleges and universities ill-equipped to

effectively teach young learners how to read. Meanwhile, students have no control over the

instruction they receive, so it is up to teachers and the education system to have a better

understanding of the science of reading research and how to implement it in their classrooms.

Students will continue to fail at reading if something is not done right away.

Summary of Findings

The literature review focused on four themes related to the reading crisis in schools. The

first theme looked at teachers' preparedness to effectively teach young learners how to read. As

was shared in section one, many teacher preparation programs in the United States and other

English-speaking countries were not adequately preparing new teachers with the skills necessary

to teach beginning readers (Meeks et al., 2020; Washburn et al., 2016). While some new teachers

possessed knowledge of the basic foundational skills to read, they did not know how to teach

those skills to their students (Hurford et al., 2016; Washburn et al., 2016). Researchers shared

evidence on different trainings and programs to help fill the gap for teachers' knowledge in the

foundational skills of reading (McMahan et al., 2019; Ehri & Flugman, 2018). Overall,

researchers showed new teachers, and veteran teachers, have been unprepared to effectively

teach beginning readers.

The research also gave a glimpse into the importance of phonological awareness in

students' ability to learn to read. Teachers need to give more instructional time devoted to

phonological awareness tasks, while maintaining caution to not include too many components at

once (Brown et al., 2021). Additionally, scholars reviewed a new, adaptive system to measure

students' phonological awareness skills, regardless of their speech or language deficits (Skibbe et

al., 2020). Lastly, the research shed light on the most important subunits of phonological

awareness and the impact they have on students' reading skills (Burns et al., 2018).

Continuing with reading skills, research focused on decoding skills and their relation to

alphabet knowledge. Two studies examined the type of instruction that was most effective in

teaching students to decode. Connected phonation instruction was found to be the best way to

teach students how to sound out words in the study by Gonzalez-Frey and Ehri (2021). The study

by Sargiani et al. (2021) provided evidence to show using smaller word parts and units of sound

were more conducive to learning to decode than with whole syllables. Scholars also found

students learned letter-sound correspondences more consistently when they were taught directly

and connected with the letter in print (Roberts et al., 2019; Pullen & Lane, 2014; Wolf, 2016).

Finally, the last section focused on additional interventions and instructional practices

shown to be effective in teaching students to read. McGeown and Medford (2014) found a

synthetic phonics approach provided positive results in students' word reading skills and

phonological awareness. Other authors compared reading, spelling, and writing interventions to

discover they each had a greater impact on students' skills than the typical instruction they

received (Vollebregt et al., 2021; Moller et al., 2022; Ray et al., 2021). Those researchers

provided data to show there are ways educators can implement science of reading research into their daily instruction.

Conclusion

While there was more research than could be included in this literature review, the fact remained, primary educators have not been implementing the science of reading research effectively in their classrooms. Nonetheless, this review aimed to share the most common themes that came from the research on the science of reading. Research showed reformation of preservice teacher education programs is necessary to adequately teach future educators the instructional practices needed to teach students to read. Additionally, the research provided evidence into effective and efficient practices teachers could use for phonological awareness and decoding skills. The additional interventions and instructional practices shared could also make an impact on teachers' implementation of the science of reading in their classrooms. The next chapter looks closer at how the research shared effects primary classroom teachers and what studies may need to take place in the future.

Chapter Three: Discussion and Application

Reading is a lifelong skill that impacts many different aspects of one's life. This chapter dives deeper into the insights gained from the research provided, including the quality of teacher preparation programs, the important foundational skills needed for learning to read, and how the types of reading instruction impact students' acquisition of reading skills. In addition, ways in which primary educators can implement those insights effectively and efficiently into their classrooms will be discussed. The suggested practices are practical, efficient, and follow the science of reading research. Future studies will also be suggested in order to gather additional data on how the science of reading practices can be better implemented in classrooms.

Insights Gained from the Research

As previously mentioned, there is more research on the science of reading than can be analyzed in the scope of this paper, but many insights were gained from the studies analyzed. First, most teacher preparation programs do not adequately prepare primary educators how to teach beginning readers (McMahan et al., 2019; Meeks et al., 2020; Washburn et al., 2016). Possessing the knowledge of basic literacy skills is not enough to effectively instruct young students (Hurford et al., 2016: Ehri & Flugman, 2018; Meeks et al., 2020; Washburn et al., 2016). While students learn in their own way, they still need explicit and systematic instruction, and that type of instruction needs to be included in teacher preparation programs (Ehri & Flugman, 2018). A second insight gained is that phonological awareness does not receive enough instructional time in many primary classrooms (Brown et al., 2021). Additionally, classroom teachers, and oftentimes reading programs, ask students to engage in too many phonemic awareness tasks at one time. The research showed focusing on one or two tasks at a time is more beneficial than three or more tasks at time. Furthermore, some reading programs implement phonemic awareness tasks that are too rigorous for students' ability levels.

Researchers showed combining phonological awareness tasks with printed letters aided in better long-term memory storage (Roberts et al., 2019). Similarly, studies showed referring to the correct spellings of words during reading instruction was more beneficial to students than simply saying the word aloud (Pullen & Lane, 2014). When considering decoding skills, research showed connected phonation instruction to be a more effective teaching strategy than segmented phonation instruction, partly because students did not have to pause between sounds and remember each sound when blending the word back together (Gonzalez-Frey & Ehri, 2021).

An additional insight gained was how teaching proper letter formations through multisensory and fine-motor activities had long-term benefits compared to typical handwriting instruction (Ray et al., 2021). Primary teachers may not have considered the impact explicit handwriting instruction could have on students' letter-sound knowledge and reading skills. Finally, studies showed how systematic phonics instruction could elevate students' acquisition of reading skills (McGeown & Medford, 2014; Vollebregt et al., 2021). These insights are notable, but they are worth nothing if they are not applied in the classroom.

Application for Professional Practice

As was shown in the literature review, teacher preparation programs need to be reformed in order to adequately prepare educators to teach beginning readers. The teacher education programs at colleges and universities must include courses focused on foundational reading skills, such as phonological awareness, why phonological awareness is important, and the best practices to teach those early skills. Preservice teachers would also benefit from opportunities to observe and co-teach science of reading practices with a quality primary classroom teacher. Oftentimes, preservice teachers have not had the opportunity to learn from quality reading teachers prior to graduating from their programs.

While time is hard to come by for anyone, it is especially scarce for teachers. However, any primary classroom teacher unsure of the science of reading practices and how the brain learns to read would bode well to take the time to learn about said practices. Additionally, although it is difficult for any professional to hear that their methods are ineffective, it is critical for teachers to implement the science of reading as soon as possible. Some primary teachers may already be implementing instruction practices that follow the science of reading, but if not, they should delegate time to start the process. Educators should not feel pressured to do a complete

overhaul of their reading instruction immediately, rather, they should give themselves grace in knowing it is not completely their fault and are taking the right steps to doing better for their students.

Additional applications for professional practice incorporate classroom instruction. The research implores that science-based reading programs be implemented in schools and teacher preparation programs at colleges and universities. When educators are following directives from administration to teach the curriculum as written, there is little room for professional judgement to include science of reading practices. The research also calls for more focus on phonological awareness tasks for preschool through second grade students. It is imperative for students to have a solid foundation in phonological awareness before moving into more complex literacy skills in third grade. Also, teachers should combine letters with the phonological awareness activities to help students retain the skills more efficiently.

Future Studies

In the literature review, some studies had limitations with numbers of participants, narrow geographic location, or parameters of the study which may not generalize to typical classrooms. This section suggests different studies that could provide further answers to how the science of reading can be more effectively and efficiently implemented in primary classrooms. After recognizing the dire situation teacher preparation programs are in, one recommended study would compare the foundational skill knowledge of current teacher graduates with teacher graduates from ten years ago. This would help determine if changes have already been made to teacher preparation programs and whether or not the changes have had an impact on teacher preparedness. The study would include survey questions for recent teacher graduates now and those who graduated roughly ten years ago. The participants could provide open-ended responses

to be analyzed, as well as provide ratings on their personal knowledge of foundational skills and their ability to teach those skills.

An additional future study would expand on the qualitative study conducted by Meeks et al. (2020) where they interviewed recent graduates from education programs in Australia. A new study could use the same format of open-ended questions to learn the preservice teachers' thoughts on their literacy courses, practicum experiences, and preparedness to teach beginning readers. However, the new study would focus on graduates from education programs across the United States, attempting to gather participants from a variety of colleges and universities. Also, because the Meeks et al. (2020) study was limited to only 11 participants, the new study would need to include a larger number of participants to aid in generalization of the results.

A third future study would build on that of Gonzalez-Frey and Ehri (2021) comparing types of decoding instruction. The Gonzalez-Frey and Ehri (2021) study had some limitations with students who had already received segmented phonation instruction, which may have caused delays in students' ability to learn a new way of decoding. A new study would include kindergartners from multiple schools across the United States at the beginning of the school year. Participants would be assigned to either segmented phonation instruction or connected phonation instruction. Even though this is what Gonzalez-Frey and Ehri (2021) already examined, additional data would help solidify their findings. An additional component of the study, or possibly an entirely different study, could explore the time of year students receive their assigned instruction. For example, do students acquire decoding skills at a faster rate if they receive instruction early in the year, or later in the year once they have solidified more letters and sounds? The quantitative data would be analyzed for rate of learning and which type of decoding instruction caused higher word-reading scores.

Another future study would compare the impact of phonological awareness tasks given orally versus the same tasks paired with printed letters. This could be conducted in primary classrooms in multiple locations with students of various socioeconomic statuses. The control group would receive phonological awareness instruction with only oral directions and responses. In contrast, the treatment group would receive the same phonological awareness instruction, except they would also manipulate letters during their tasks. Students' phonological awareness would be assessed before the study, mid-year, and at the end of the school year to determine rate of learning for each group and how many phonological awareness skills students mastered.

As previously stated in chapter two, the study by Sargiani et al. (2021) would benefit from additional research because their study was conducted with Portuguese-speaking students. Their study (Sargiani et al., 2021) could be replicated with English-speaking students to see if the grapheme-phoneme decoding instruction was still more beneficial in students' nonword reading skills than the whole-syllable decoding instruction. As mentioned earlier, the English language is more complex than other languages in its structure and written representation of sounds, so modifications may need to be made if the original Sargiani et al. (2021) study could not be replicated exactly.

Conclusion

Numerous studies have been conducted with the hopes of impacting the reading instruction primary educators provide their students. However, those studies have yet to make a real difference in the instructional practices implemented in primary classrooms across the United States. Part of this may be due to insufficient research conducted in classrooms with typical, realistic scenarios (e.g., whole-class instruction, instruction that can be implemented by one classroom teacher, students of all abilities). As Shanahan (2020) wrote, "the only way to

know if any instructional approach is effective is to try it out in classrooms and to measure its

impact on student learning" (p. 8). The studies shared in the literature review included such

measurements with students in situations that could be implemented in most classrooms.

This literature review aimed to answer the question: In light of what is known about

differentiation, how can the science of reading research be more effectively and efficiently

implemented in primary classrooms, so students learn to read? The research showed

phonological awareness to be a key factor in students' ability to become a proficient reader in the

future; however, many primary educators do not focus enough time on this essential skill.

Additionally, students would benefit from having printed letters paired with phonological

awareness tasks to solidify the content in their long-term memory. Finally, major reforms must

be made to most teacher preparation programs to better prepare future primary educators

responsible for teaching young learners how to read. As discussed in the beginning, if students

cannot read by the end of first grade, "they are highly likely to remain poor readers and suffer

academic difficulties across all subjects" (Juel et al., 1986; Olson et al., 2014; Sparks et al., 2014,

as cited in Moats & Tolman, 2019, p. 4). If educators want all students to read by the end of first

grade, and have the opportunity for a better future, it is imperative to act now and implement the

science of reading practices shared in the research.

References

Brown, K. J., Patrick, K. C., Fields, M. K., & Craig, G. T. (2021). Phonological awareness

    materials in Utah kindergartens: A case study in the science of reading. *Reading*

    Research Quarterly, 56(S1), S249-S272. https://doi.org/10.1002.rrq.386

Burns, M. K., Maki, K. E., Helman, L., McComas, J. J., & Young, H. (2018). Contributions of

    the components of phonemic awareness to letter-sound knowledge with kindergarten

    students in high-poverty urban elementary schools. *Reading & Writing Quarterly, 34*(5),

    409-418. https://doi.org/10.1080/10573569.2018.1468835

Duke, N. K., & Cartwright, K. B. (2021). The science of reading progresses: Communicating

    advances beyond the simple view of reading. *Reading Research Quarterly, 56*(S1), S25-

    S44. https://doi.org/10.1002/rrq.411

Ehri, L.C. (2020). The science of learning to read words: A case for systematic phonics

    instruction. *Reading Research Quarterly, 55*(S1), S45-S60.

    https://doi.org/10.1002/rrq.334

Ehri, L. C., & Flugman, B. (2018). Mentoring teachers in systematic phonics instruction:

    Effectiveness of an intensive year-long program for kindergarten through 3rd grade

    teachers and their students. *Reading and Writing, 31*(2), 425-456.

    https://doi.org/10.1007/s11145-017-9792-7

Eunice Kennedy Shriver National Institute of Child Health and Human Development, NIH,

    DHHS. (2000). *Report of the National Reading Panel: Teaching Children to Read:*

    Reports of the Subgroups. https://www.nichd.nih.gov/publications/product/247

Gonzalez-Frey, S. M., & Ehri, L. C. (2021). Connected phonation is more effective than

    segmented phonation for teaching beginning readers to decode unfamiliar words.

Scientific Studies of Reading, 25(3), 272-285.

https://doi.org/10.1080/10888438.2020.1776290

Hindman, A. H., Morrison, F. J., Connor, C. M., & Connor, J. A. (2020). Bringing the science of

reading to preservice elementary teachers: Tools that bridge research and practice.

Reading Research Quarterly, 55(S1), S197-S206. https://doi.org/10.1002/rrq.345

Hurford, D. P., Fender, A. C., Swigart, C. C., Hurford, T. E., Hoover, B. B., Butts, S. R., Cullers,

K. R., Boux, J. L., Wehner, S. J., Hevel, J. K., Renner, L. P., Overton, K. B., Dumler, J.

D., & Wilber, L. M. (2016). Pre-service teachers are competent in phonological

processing skills: How to teach the science of reading. *Reading Psychology, 37*(6), 885-

916. https://doi.org/10.1080/02702711.2015.1133464

McGeown, S. P., & Medford, E. (2014). Using method of instruction to predict the skills

supporting initial reading development: Insight from a synthetic phonics approach.

Reading and Writing, 27(3), 591-608. https://doi.org/10.1007/s11145-013-9460-5

McMahan, K. M., Oslund, E. L., & Odegard, T. N. (2019). Characterizing the knowledge of

educators receiving training in systematic literacy instruction. *Annals of Dyslexia, 69*(1),

21-33. https://doi.org/10.1007/s11881-018-00174-2

Meeks, L., Madelaine, A., & Stephenson, J. (2020). New teachers talk about their preparation to

teach early literacy. *Australian Journal of Learning Difficulties, 25*(2), 161-181.

https://doi.org/20.2080/29404258.2020.1792520

Moats, L.C., & Tolman, C. A. (2019). *LETRS* (3rd ed.). Voyager Sopris Learning.

Moller, H. L., Mortensen, J. O., & Elbro, C. (2022). Effects of integrated spelling in phonics

instruction for at-risk children in kindergarten. *Reading & Writing Quarterly, 38*(1), 67-

82. https://doi.org/10.1080/10573569.2021.1907638

Pullen, P. C., & Lane, H. B. (2014). Teacher-directed decoding practice with manipulative letters and word reading skill development of struggling first grade students. *Exceptionality, 22*(1), 1-16. https://doi.org/10.1080/09362835.2014.865952

Ray, K., Dally, K., Colyvas, K., & Lane, A. E. (2021). The effects of a whole-class kindergarten handwriting intervention on early reading skills. *Reading Research Quarterly, 56*(S1), S193-S207. https://doi.org/10.1002/rrq.395

Roberts, T. A., Vadasy, P. F., & Sanders, E. A. (2019). Preschool instruction in letter names and sounds: Does contextualized or decontextualized instruction matter? *Reading Research Quarterly, 55*(4), 573-600. https://doi.org/10.1002/rrq.284

Reading Rockets. (2022a). *Phonological and phonemic awareness.* https://www.readingrockets.org/helping/target/phonologicalphonemic

Reading Rockets. (2022b). *Word decoding and phonics.* https://www.readingrockets.org/helping/target/phonics

Sargiani, R. D. A., Ehri, L. C., & Maluf, M. R. (2021). Teaching beginners to decode consonant-vowel syllables using grapheme-phoneme subunits facilitates reading and spelling as compared with teaching whole-syllable decoding. *Reading Research Quarterly, 57*(2), 629-648. https://doi.org/10.1002/rrq.432

Seidenberg, M. S. (2013). The science of reading and its educational implications. *Language Learning and Development, 9*(4), 331-360. https://doi.org/10.1080/15475441.2013.812017

Seidenberg, M. S., Borkenhagen, M. C., & Kearns, D. M. (2020). Lost in translation? Challenges in connecting reading science and educational practice. *Reading Research Quarterly, 55*(S1), S119-S130. https://doi.org/10.1002/rrq.341

Shanahan, T. (2020). What constitutes a science of reading instruction? *Reading Research*

      Quarterly, 55(S1), S235-S247. https://doi.org/10.1002/rrq.349

Shanahan, T., & North Central Regional Educational Lab. (2005). The national reading panel

      report: Practical advice for teachers. *Learning Point Associates/North Central Regional*

      Educational Laboratory (NCREL), p. 1-44.

Skibbe, L. E., Bowles, R. P., Goodwin, S., Troia, G. A., & Konishi, H. (2020). The access to

      literacy assessment system for phonological awareness: An adaptive measure of

      phonological awareness appropriate for children with speech and/or language

      impairment. *Language, Speech, and Hearing Services in Schools, 51*(4), 1124-1138.

      https://doi.org/10.1044/2020_LSHSS-19-00006

State Collaborative on Reforming Education. (2020). *The science of reading.*

      https://tnscore.org/wp-content/uploads/2020/01/Science-of-Reading-2020.pdf

Stuart, K., & Fugnitto, G. (2020, March 3). A conversation about the science of reading and

      early reading instruction with Dr. Louisa Moats. *Collaborative Classroom.*

      https://www.collaborativeclassroom.org/blog/a-conversation-about-the-sceince-of-

      reading-with-dr-louisa-moats/

Vollebregt, M., Leggett, J., Raffalovitch, S., King, C., Friesen, D., & MD Archibald, L. (2021).

      Evidence for complementary effects of code- and knowledge-focused reading instruction.

      Child Language Teaching and Therapy, 37(3), 300-320.

      https://doi.org/10.1177/0265659021101426

Washburn, E. K., Binks-Cantrell, E. S., Joshi, R. M., Martin-Chang, S., & Arrow, A. (2016).

      Preservice teacher knowledge of basic language constructs in Canada, England, New

Zealand, and the USA. *Annals of Dyslexia, 66*, 7-26. https://doi.org/10.1007/s11881-015-0115-x

White, T. G., Sabatini, J. P., & White, S. (2021). What does "below basic" mean on NAEP reading? *Educational Researcher, 50*(8), 570-573. https://doi.org/10.3102/001389X211044144

Wolf, G. M. (2016). Letter-sound reading: Teaching preschool children print-to-sound processing. *Early Childhood Educ J, 44*, 11-19. https://doi.org/10.1007/s10643-014-0685-y

Appendix

Article Tracking Matrix

Articles: Author(s) name and year of publication	Method: Qualitative/ Quantitative/ Meta-Analysis/ Mixed-Methods	Theme 1: Teacher Preparedness	Theme 2: Phonological Awareness	Theme 3: Decoding Skills and Alphabetic Knowledge	Theme 4: Effective Interventions and Instructional Practices	Outlier
Brown et al., (2021)	Qualitative		X			
Burns et al., (2018)	Quantitative		X			
Ehri, L. C., & Flugman, B. (2018)	Mixed-Methods	X				
Gonzalez-Frey, S. M., & Ehri, L. C. (2021)	Quantitative			X		
Hurford et al., (2016)	Mixed-Methods	X				
McGeown, S. P., & Medford, E. (2014)	Quantitative				X	
McMahan et al., (2019)	Quantitative	X				
Meeks et al., (2020)	Qualitative	X				
Moller et al., (2022)	Quantitative				X	
Pullen, P. C., & Lane, H. B. (2014)	Quantitative			X		
Ray et al., (2021)	Quantitative				X	
Roberts et al., (2019)	Quantitative			X		
Sargiani et al., (2021)	Quantitative			X		

Skibbe et al., (2020)	Quantitative		X			
Vollebregt et al., (2021)	Quantitative				X	
Washburn, et al., (2016)	Mixed-Methods	X				
Wolf, G. M. (2016)	Quantitative			X		