COMPARING CLASSROOM SPELLING LISTS AND SOUND-SPECIFIC DIGITAL FLASHCARDS AS THERAPY MATERIALS FOR FIRST GRADERS WITH SPEECH SOUND DISORDERS

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DEDICATION

For my husband, Vince Bradburn, and our girls, Isabella and Abigail, thank you for your love, support, patience, and encouragement.

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ABSTRACT

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COMPARING CLASSROOM SPELLING LISTS AND SOUND-SPECIFIC DIGITAL FLASHCARDS AS THERAPY MATERIALS FOR FIRST GRADERS WITH SPEECH SOUND DISORDERS

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School-based speech-language pathologists (SLPs) are charged with minimizing the negative educational impact of their students' speech sound disorders (SSDs; Ehren, 2000; Wallach, 2014). Current studies on SSDs in children are rich with discussions of therapy-and child-level contributions to gains in speech sound production (Byers et al., 2021; Farquharson et al., 2020; Jesus et al., 2019; Namasivayam et al., 2019; Preston et al., 2019; Rehfeld & Sulak, 2021). However, while many studies have supported using curricular content during language interventions (Ehren, 2009; Wallach, 2014; Wallach et al., 2009), there is little theoretical and no empirical evidence to demonstrate that using academically integrated therapy materials (AITM) during intervention provides a positive educational impact for students with SSDs. The purpose of this study was to determine if the materials used during school-based speech therapy could impact spelling performance in the classroom. In addition, the study sought to determine if there were differences noted in speech sound production performance when AITM vs. CATM (commercially available therapy materials) were utilized in business-as-usual therapy. Five first grade students with moderate to severe SSDs participated in this study. A single participant, alternating treatment design was used to compare the effectiveness of using AITM and CATM during intervention for SSDs. For spelling performance, results from quantitative and qualitative measures (visual inspection of the data, calculation of a d-statistic, percentage of nonoverlapping data [PND], a pre- and post-test spelling assessment, and teacher/student social validity

questionnaires) were varied with four out of five participants demonstrating gains in spelling on at least one measure. When comparing the relative effects of the two therapy materials on speech sound production in the classroom, quantitative and qualitative data indicated that speech sound production was better for four out of five participants when AITM were used during intervention. This early feasibility study sought to examine data on the potential academic impact of materials used during speech intervention. Results indicated that further study is warranted on the use of AITM during intervention with speech sound disorders, specifically the impact on interprofessional practices and the workloads of school-based SLPs.

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CHAPTER I

INTRODUCTION

Theoretical Framework

School-based speech-language pathologists (SLPs) are charged with minimizing the negative educational impact of their students' speech and language disorders (Ehren, 2000; Wallach, 2014). Students with speech sound disorders (SSDs) represent a large portion of a school-based SLP's workload. According to the National Institute on Deafness and Other Communication Disorders (NIDCD), 8-9% of young children (around 4.1 million) in the United States have an SSD, with 5% of students (around 2.6 million) demonstrating a noticeable speech impairment by the first grade (NIDCD, 2016). Along with diminishing daily communication abilities due to limited intelligibility, SSDs have been found to have a negative impact on educational performance in the areas of reading, writing, and socialization (Farquharson, 2015; Farquharson & Boldini, 2018; Hitchcock et al., 2015; Tambyraja et al., 2020). Considering the prevalence of SSDs and the documented negative educational impact they impose, school-based speech therapy services that support academic gains are crucial to student success.

In her conceptual framework for speech intervention for school-age children, Wallach (2014) noted that when making intervention choices for students with SSDs from a clinical perspective, traditional decision-making techniques often do not consider the increasing demands of the curriculum, nor do they support collaborative efforts between teachers and SLPs. Wallach (2014) went on to question why such a gap exists between what we know works for students with speech and language delays at school (i.e., integrating students' background knowledge into therapy, focusing on the interaction of SSDs and the demands of curriculum, and helping students understand the benefits of speech therapy on their school performance) and the current

practices of school-based SLPs (i.e., employing pull-out services using materials that are not easily transferable to supporting access to the curriculum and that do not explicitly target the stated goals). If SLPs are making decisions about speech therapy for SSDs in a school setting without considering the curriculum, their choice of materials, or the possible positive contributions of classroom teachers, they are not completing all of the unique workload duties of a school-based SLP (American Speech-Language-Hearing Association [ASHA], 2022). These duties include: identifying delays in speech and language, determining the negative educational impact of those delays, and providing research-based interventions that lessen that negative educational impact.

McLeod and Baker (2014) identified one possible solution to closing the gap between what SLPs know about research-based practices and how they provide interventions in a school setting, which was to ensure that SLPs "identify and adopt implementation strategies that better translate empirical knowledge into action" (p. 526). One of these implementation strategies could be to carefully consider which materials school-based SLPs use during intervention that could lessen the negative educational impact of SSDs. There is a need to identify the best mix of materials, instruction, and personnel to effectively and efficiently meet student speech sound production objectives (Cirrin et al., 2010) while also impacting educational outcomes (Ehren, 2000; Wallach, 2014).

Commercially available therapy materials (CATM) like speech therapy-specific games, flashcards, and digital applications have been used successfully in school speech therapy rooms for decades; however, the positive impact of CATM is likely limited to improvement in speech sound production (Wallach, 2014). Theoretically, using curricular materials as therapy materials could hasten achievement of the expected level of classroom performance in conjunction with

targeting correct speech sound production. Using academically integrated therapy materials (AITM) or, in other words, the materials students are encountering in the classroom, could support the provision of high quality intervention that improves speech sound production while increasing the likelihood of transferring newly learned skills gained in therapy to the classroom. This simple change in materials used in therapy sessions (Farquharson et al., 2020) could be of benefit to students who are receiving school-based speech therapy based on the documented negative educational impact of their speech sound disorders.

While many studies have supported using curriculum content during language interventions (Ehren, 2009; Wallach, 2014; Wallach et al., 2009), there is little theoretical and no empirical evidence to demonstrate that using AITM in therapy provides a positive educational impact for students with SSDs. Additionally, considering the current focus on recouping learning loss attributed to educational interruptions caused by the COVID-19 pandemic (Khan & Ahmed, 2021; Robinson, 2022; Sanderson et al., 2021), SLPs need new strategies to ensure they use materials and service delivery models that limit the negative educational impact of communication disorders for their students with SSDs while targeting correct speech sound production.

Project Significance

Previous practices using isolated pockets of intervention (e.g., pull-out speech services using traditional speech therapy materials) will not work in a post-pandemic world as schools are scrambling to recoup lost academic skills (Khan & Anderson, 2021; Robinson, 2022; Sanderson et al., 2021). Since school-based SLPs must strive for improved speech sound production as well as positive educational outcomes from services (Every Student Succeeds Act [ESSA], 2015; Individuals With Disabilities Education Act [IDEA], 2004), using AITM could support SLPs

who want to employ service delivery models that target both. If SLPs transition to using AITM, they could not only monitor progress and performance from data collected during direct speech intervention as in clinic-based settings, but they could also use students' grades in the classroom as data points to support favorable influences of speech therapy on academic skills. If SLPs specifically support classroom performance when using curricular materials, their services could have an immediate impact on educational outcomes (Wallach, 2014). Students may benefit academically when SLPs can shift their focus and time from preparing CATM that are not related to the curriculum to using their research-based treatment strategies including: modeling, prompting, guided responding, chaining, shaping, time delay strategies, guided repetition, and home programming with adapted AITM.

Study Purpose

The purpose of this study was to determine if materials used during speech therapy could impact spelling performance in the classroom. The study compared the relative effects of two types of therapy materials (i.e., spelling lists/AITM and the digital, app-based flash cards/CATM) alternately used in intervention with five first graders with SSDs, on spelling grades in the classroom and speech sound production performance. Specifically, two research questions were addressed:

1. Does the use of academically integrated materials during speech therapy for students with speech sound disorders improve the educational impact of services, namely spelling performance, more than commercially available speech therapy products?
2. Are there comparative differences noted in speech sound production performance when AITM vs. CATM are utilized in therapy?

The principal investigator (PI) hypothesized that the use of spelling lists (AITM) during speech intervention would positively impact the students' academic performance through improved spelling grades. Gains in speech sound production were predicted to be similar using either type of material, but the added positive educational impact of improved performance in spelling could support the use of curricular materials during speech therapy.

Current studies on SSD in children are rich with discussions of therapy-level and child-level contributions to gains in speech sound production (Byers et al., 2021; Farquharson et al., 2020; Jesus et al., 2019; Namasivayam et al., 2019; Preston et al., 2019; Rehfeld & Sulak, 2021). However, no studies have focused specifically on the materials used during speech intervention for SSDs in schools, nor have any compared the use of AITM to CATM to determine effectiveness on classroom performance and speech sound production. Studies that illuminate the need for careful consideration of materials choice and demonstrate successful alternatives to current intervention materials could guide SLPs through the complicated process of ensuring positive educational impact of speech intervention for speech sound disorders. The current study could support the need for further research in materials choice for school-based speech therapy and could better inform the use of service delivery models that integrate speech sound disorder interventions into classrooms and curriculum.

Methodology Overview

Participants

Five first graders diagnosed with moderate to severe SSDs took part in the study.

Setting

This study was completed at a public elementary school in a suburban area in the Midwestern United States. The study took place at a small table in the hallway right outside of

the first-grade classrooms during speech sound disorders intervention. Intervention consisted of five-minute individual articulation drill sessions two to three times per week with frequency of services based on the students' individualized education programs (IEPs).

Materials

Spelling Lists (AITM)

Words from the weekly spelling lists from the school's first-grade curriculum were used as the AITM and served as the target words during one of the alternating phases of the study.

Digital Flashcards (CATM)

The CATM were digital flashcards from the Little Bee Articulation Station application (http://littlebeespeech.com/articulation_station.php) during one of the alternating phases of the study.

Word Lists

During the baseline phase and final data probe administration, word lists with 10 untreated words that contained the participant's target sound were used to obtain the percentage of correct productions in the absence of direct therapy, similar to progress monitoring assessments within therapy as usual (TAU) conditions. TAU conditions were considered intervention or progress monitoring completed without the specified AITM or CATM from the study.

Dependent Variables

One dependent variable was the weekly average of percentage correct scores on spelling tests and graded classroom spelling activities calculated during the baseline phase as well as when using spelling lists (AITM) versus digital flashcards (CATM) during speech intervention. Another dependent variable was the percentage of total consonants correct (PTCC)

from students' production of target words during the baseline phase as well as when using spelling lists (AITM) versus digital flashcards (CATM) during speech intervention.

Experimental Design

A single participant, alternating treatment design was used to compare the effectiveness of using curricular materials versus sound-specific digital flashcards during intervention for students with SSD.

Data Collection Procedures

Percentage of Targeted Consonants Correct

Each participant had a Quick Response (QR) code that, when scanned, linked to a Google Form. The Google Form tracked the PTCC during baseline, alternating treatments phases (spelling lists and flashcards), and the final data probe.

Spelling Grades

The QR code and Google Form were also used to record the spelling grades (on tests and classroom activities) for students during each phase of the study. Once a week, the SLP checked the real-time averages of all spelling grades (spelling test and three graded classroom assignments in which they practiced spelling words) for the week and added them to the Google Form.

Inter-Observer Reliability

The PI listened to recorded therapy sessions and marked target consonant production as correct (+) or incorrect (-) and then calculated PTCC. A mean agreement of 90% between the SLP and the PI was the mastery criterion.

Procedural Integrity

In order to ensure procedural fidelity of the study, the PI listened to recordings of the SLP providing therapy during 30% of the total number of sessions in all phases of the study and completed a checklist to ensure that: the only materials used were those assigned to each student; the servicing SLP provided the interventions as listed in each students' IEP regardless of the materials used; and the servicing SLP used the same reinforcement strategies for both types of materials with a similar number of responses in each session regardless of material type.

Procedures

Baseline

Baseline data on spelling grade averages and PTCC was collected for three sessions to determine stable performance prior to beginning intervention. In addition, a standardized assessment of spelling performance was individually administered pre- and post-study to compare the standard scores and examine overlap of confidence intervals.

Intervention

Students received speech therapy using CATM for 2 weeks and then AITM for 2 weeks with documentation of a PTCC and an average of all spelling grades recorded at the end of each week. Students then rotated through CATM and AITM again for 2 weeks each with data points recorded for speech sound production and spelling performance for a total of 8 weeks of intervention and four data points per materials type to use for comparison.

Post-Treatment Data

Final Treatment Probe. After 8 weeks of intervention, the SLP stopped using the spelling lists and the digital flashcards during intervention and replaced them with a therapist-created card matching game to use in TAU conditions during which intervention was provided

without the specified AITM or CATM from the study for 1 week. At the end of the week, a final data point was taken for PTCC and the average classroom spelling grade.

Post-Test. The spelling subtest of the Kaufman Test of Educational Achievement: 3rd Edition (KTEA:3, 2014) was re-administered to obtain a standard score for spelling to compare to the pretest score.

Data Analysis

Visual Analysis

Visual inspection of the data was used to examine individual trends/changes in speech sound production and classroom spelling performance between phases and over time when using AITM and CATM during intervention

Effect Size

A d-statistic was used to examine the magnitude of the difference in spelling performance and speech sound production between the alternating materials (spelling lists and digital flashcards).

Percentage of Nonoverlapping Data

A percentage of nonoverlapping data (PND) was used to assess the relative effectiveness of each material type (AITM or CATM) to determine if variations existed across conditions.

Pre- and Post-Test Evaluation of Spelling

The spelling section of the KTEA:3 (2014) was individually administered pre- and post-study to compare the standard scores. Confidence intervals for the pre- and post-test standard scores were also compared for overlap. For those confidence intervals that did not overlap, this could indicate clinically significant improvement in spelling (Cumming & Finch, 2005).

Social Validity

Student Questionnaire. A questionnaire was given to the first-grade students after each 2-weeks segment of using AITM or CATM during speech therapy that asked age-appropriate yes/no questions regarding their experiences during the study.

Teacher Questionnaire. A questionnaire was given to the two teachers at the beginning and end of the study to measure their perception of the students' speech sound production and spelling performance during the study.

Summary

School-based SLPs are charged with ensuring educational relevance and impact of their speech therapy services (Ehren, 2000; Wallach, 2014). SSDs have been found to have a negative impact on reading, writing, and socialization skills (Farquharson, 2015; Farquharson & Boldini, 2018; Hitchcock et al., 2015; Tambyraja et al., 2020). However, no studies have focused on the materials SLPs should use during intervention in order to ensure positive educational impact of their efforts. This study compared CATM and AITM during speech therapy to determine if using AITM could have a positive impact on spelling performance in the classroom. Additionally, many SLPs have been using the same or similar pull-out service delivery models with CATM for decades (Brandel, 2020; Brumbaugh & Smit, 2013). Chapter 2 will present a review of the literature supporting the need for a paradigm shift in school-based speech therapy, including using a variety of service delivery models and how using AITM could support implementation of new models.

CHAPTER II

LITERATURE REVIEW

Early Speech Therapy in Schools

The development of the practice of speech language pathology to treat speech sound disorders in schools is a difficult path to find and follow. The SLPs of today's public schools still resemble some of the early practitioners who sought to correct speech sound disorders. Early elocutionists are thought to be pioneers of the profession during the progressive era from around 1870-1920s (O'Connell, 1990). Samuel Potter wrote one of the first books on the topic of speech correction (Potter, 1882) in which he defined speech disorders and suggested treatments. Of note in Potter's (1882) work is the purely physical component of speech correction without mention of the much later theorized phonological basis of SSDs (Brosseau-Lapré & Rvachew, 2017). Several of Potter's (1882) suggestions for treatment continue to influence school-based therapy today including the ideas that each case should be treated individually and "The patient should be regularly exercised on the offending sounds by reading aloud, repeating the alphabet, or other exercises in pronunciation" (p. 35-36).

In the late 1800s, elocutionists like John Thelwall built upon Potter's work and created conceptual frameworks that again mimic the constructs of modern school-based speech therapy (Duchan, 2006, 2010a). In her writings on Thelwall, Duchan (2006, 2010a) sought to demonstrate that his conceptual framework created an argument to separate elocution work from the field of medicine and establish its own field of study and practice in educational settings. This separate study and practice is illustrated in Duchan's (2010a) list of Thelwall's therapeutic strategies and interestingly coincides with many of the more modern practices in school-based settings. Just as school-based practitioners of today, Thelwall posited that clinicians must first

"presume confidence," or in other words, give a positive prognosis of improved speech sound production based on the skillset of the clinician. Next, in Thelwell's words, clinicians must "experiment" or what is now called "provide therapy" that matches the individual needs of the speaker. Duchan (2010a) went on to describe Thelwall's preference to not rely solely on medical interventions (e.g., surgery) but instead to continually intervene and assess progress which aligns with the practices of school-based SLPs who must ensure educational relevance of therapy even if parents choose not to seek any recommended medical interventions. The final pieces of Thelwall's conceptual framework parallel present-day school-based SLPs' focus on "persevering," or continuing services until goals are reached. Thelwall's conceptual frameworks of the 1800s parallel modern-day school-based speech therapy practices and were the foundation of some of the present-day roles and responsibilities of school-based SLPs.

Speech-Language Pathologists' Roles and Responsibilities

Just as in the early days of the profession, in the dynamic culture of public schools, SLPs are often at the center of ongoing debates regarding best practices when providing services to students with speech and language impairments (SLIs). The types and severity of SLIs treated by SLPs in school settings are vast, with over 90% of SLPs working with students with language, speech sound, and autism spectrum disorders. In addition, more and more caseloads now include students with reading and writing difficulties (ASHA, 2022). SLPs are considered a vital service element for a large portion of students in schools with IEPs (Powell, 2018; Rehfeld & Sulak, 2021).

SLPs and Speech Sound Disorders

Students with SSDs represent a large portion of a school-based SLPs' caseloads. According to the NIDCD, 8-9% (around 4.1 million) of young children in the United States have

a speech sound disorder, with 5% (2.6 million) of students demonstrating a noticeable speech impairment by the first grade (NIDCD, 2016). Given these percentages, it is not surprising that students with SSDs are estimated to make up a range between 36% and 90% of an SLP's yearly caseload (ASHA, 2022, Jesus et al., 2019; Oliveira et al., 2015). Over 90% of school-based SLPs work with students with SSDs (ASHA, 2022). Along with diminishing daily communication abilities due to limited intelligibility, SSDs have been found to have a negative impact on educational performance in the areas of reading, writing, and socialization (Farquharson, 2015; Farquharson & Boldini, 2018; Hayiou-Thomas et al., 2017; Hitchcock et al., 2015; McCormack et al., 2009; Tambyraja et al., 2020). Considering the prevalence of SSDs and the documented negative educational impact they impose, high-quality, school-based speech therapy services are crucial to student success.

School districts have adopted an "all hands on deck" mentality to improve students' access to instruction and intervention (Powell, 2018). One set of necessary hands is the highly specialized skill sets of SLPs (Rehfeld & Sulak, 2021), specifically their extensive experience in limiting the negative educational impact of speech sound disorders (Farquharson, 2015; Farquharson & Boldini, 2018; Hitchcock et al., 2015; McKean et al., 2017; Tambyraja et al., 2020). McCabe and Nye-Lengerman (2021) went as far as to say that "Since much of a student's academic success is rooted in strong speech, language, and communication skills, school-based SLPs play an important role in helping students achieve educational success" (p**.** 950).

As the caseloads, and thus, workloads of school-based SLPs have soared, along with the charge to support learning, SLPs must strive to maximize every moment spent (directly and indirectly) providing services to students with SSDs. These service responsibilities include establishing eligibility for special education services, providing evidence-based interventions

using a wide variety of service delivery models, completing workload duties unique to school-based SLPs (i.e., participating in multi-tiered systems of support (MTSS) plans, billing third-party providers like Medicaid for school services, completing evaluations and case conferences within strict timelines, and progress monitoring goals and objectives), and collaborating with teachers and other school staff.

Establishing Eligibility For School Based Services

When establishing eligibility for school-based therapy to target speech sound disorders, SLPs must first be aware of the mandates set forth in the IDEA (2004) that include the IEP team's determination that the student meets the three prongs of eligibility. For example, SLPs must be able to first demonstrate that the student has an impairment in speech sound production (prong 1). That impairment must also have a negative educational impact (prong 2). Finally, the impairment and negative educational impact must require specially designed instruction using the highly-specific skill-set of an SLP (prong 3). In addition to the three-prongs of eligibility listed in the IDEA (2004), school-based SLPs should consider employing criterion-based assessments along with standardized assessments when determining eligibility for services to remediate SSDs in order to avoid "diagnostic pitfalls" such as over-identification of bilingual students (Fabiano-Smith, 2019).

School-Based Vs. Clinic-Based Eligibility

As Ireland and Conrad (2016) indicated, the eligibility requirements set forth in the IDEA (2004) are dramatically different from the procedures used when determining the need for clinical-based (e.g., private practice or university settings) interventions for SSDs. Clinical-based SLPs (e.g., private practitioners, university-based clinicians) need only to determine delays in speech and language in order to recommend and provide services and, if necessary, they can rely

on clinical judgment when determining the need for services. The IDEA (2004), along with state and local school district mandates, require that school-based SLPs diagnose these same delays, but they also must determine the educational impact of the delay along with the need for specially designed instruction to target the speech or language impairment. In Furlong et al.'s (2018) inductive thematic analysis of individual interviews with SLPs who work in clinic-based settings, decision-making for qualification and prognosis for successful therapy included the individuality of the child in regard to how their personality, temperament, and executive function skills would impact speech sound correction. Parental involvement was also perceived as crucial in clinic-based decision-making (Furlong et al., 2018). In contrast, successful speech therapy in schools is determined by improved access to the curriculum through lessening the negative impact of the SSD, not necessarily perfecting the child's speech sound production (ASHA, 2010; Powell, 2018). As for parental involvement, although it is required by federal law (IDEA, 2014) during the initial determination of eligibility and creation of the IEP in school settings, school-based services do not typically depend on or anticipate parental involvement when making decisions regarding eligibility for services.

In addition to these differences in clinic versus school-based decision-making, McLeod and Threats (2008) noted the importance of the impact of SSDs on daily-living activities and participation in social settings (e.g., parks, birthday parties) when making clinic-based decisions for eligibility and services. This is in contrast to the need to determine the educational impact of SSDs necessary for school-based eligibility (Ehren, 2000; Farquharson, 2015; Farquharson & Boldini, 2018; Hayiou-Thomas et al., 2017; Hitchcock et al., 2015; Tambyraja et al, 2020; Wallach, 2014). Clinic-based SLPs interviewed in Furlong et al.'s (2018) study also focused on goals important to the family and the client, pulling from the evidence demonstrated in Baker

and McLeod (2011). In contrast, school-based SLPs must focus on goals that support educational success (Farquharson et al., 2014; IDEA, 2004). These differences are at the center of one of the core struggles of school-based SLPs. SLPs in schools must adapt their more clinical university training into services in a school setting (including classrooms) while maintaining a therapeutic focus (Ehren, 2000). Traditional service delivery models that mimic clinic-based services including seeing students two times a week for 30-minutes in separate spaces (Brandel, 2020; Brumbaugh & Smit, 2013) may only perpetuate this struggle. Thus, using a wider variety of service delivery options may support the transition of clinically-trained SLPs into school-based settings (Brandel, 2020; Wallach, 2014).

Service Delivery in the Public Schools

In their systematic review of the effects of different service delivery models on the outcomes of speech and language interventions for elementary students, Cirrin et al. (2010) reviewed the effectiveness of pullout, classroom-based, and indirect-consultative service delivery models. At the end of their review, they called for more studies as a result of limited data concerning the effectiveness of different service delivery models. With the scarcity of evidence when choosing service delivery models, SLPs often have to rely on their own data and logic when making decisions as to when, how, and where to provide services to students (Cirrin et al., 2010). Both the former No Child Left Behind Act (NCLB, 2002) and the more recent ESSA (2015) indicated that curriculum and classroom performance should be at the forefront of decision-making criteria when choosing service delivery models (McCabe & Nye-Lengerman, 2021; Means, 2006; Powell, 2018). Rehfeld and Sulak (2021) recommended further investigation of service delivery models in schools that would best incorporate curriculum, while also suggesting that students could benefit from a variety of models. The authors go on to theorize

that an increased awareness of the many options for service delivery would improve both the effectiveness and the efficiency of services for students with SSDs while ensuring continued access to curriculum therefore meeting the federal mandates set forth in IDEA (2004), NCLB (2002), and ESSA (2015).

Service delivery model options for SSDs are vast and can include differences in location, length, and group size. For example, school-based SLPs can provide services in the classroom, in a therapy room, or in a wide variety of school environments (i.e., the library, the cafeteria, the art room). SLPs can also choose between short bursts of 5-minute speech sound drills several times per week, longer 30-minute sessions once per week, or any length and dose combination in between (Brosseau-Lapré & Greenwell, 2019). Group size options can also range from individual to a whole class. The optimal service delivery model for treating SSDs in schools should be both effective (i.e., improving speech sound production and decreasing negative educational impact) and efficient (i.e., using the least amount of time and resources possible) (Baker, 2012; Cirrin et al., 2010). Finding this balance between service effectiveness and efficiency is of significant concern for school-based SLPs (Baker, 2012; Brosseau-Lapré & Greenwell, 2019; Cirrin et al., 2010). Before choosing from the range of service delivery models that best support and incorporate the curriculum while also improving speech sound production, SLPs may need to first establish a theoretical framework for making service delivery decisions when treating SSDs in schools.

Dose and Frequency Considerations for Service Delivery

When establishing a theoretical framework for many of the service delivery models used to target SSDs in schools, it may be beneficial to first consider the cognitive theories of massed practice versus distributed practice for interventions. In Donovan and Radosevich's (1999) meta-

analytic review of the distribution of practice effect, they found that individuals participating in spaced (or distributed) practice conditions performed better than those participating in massed practice. Their study provided a definition of massed practice and "spaced" or distributed practice. Massed practice was defined as conditions in which there is no rest for individuals while practicing a task continually until the task is completed. Distributed practice was defined as giving individuals rest intervals within each practice session (Donovan & Radosevich, 1999). While the purpose of their study was to structure business management training programs for optimal outcomes, they noted that much of the research they analyzed came from educational and classroom settings. SLPs could benefit from determining the best service delivery model for speech sound remediation that also takes into consideration factors like students' school schedules and missed class time.

In their systematic review of treatment intensity in speech disorders, Kaipa and Peterson (2016) found that more randomized-controlled design studies were needed to best determine the optimal treatment for speech sound disorders. Their results showed that intensity effectiveness often depended on the individual client as well as the type of speech sound disorder being treated. Results of their systematic review did find that in several studies, higher dose (the number of practice trials during a session) and dose frequency (how often therapy takes place in a set unit of time) were more effective over lower dose and dose frequency for treating SSDs. Other studies (Edeal & Gildersleeve-Neumann, 2011; Maas et al., 2008) have found that children with CAS benefit from shorter, more frequent sessions.

When comparing the findings of Mass et al. (2008) and Edeal and Gildersleeve-Neumann (2011) to the theories of massed vs distributed practice, massed practice with high numbers of repetitions within longer sessions were optimal service delivery models for motor

speech disorders (e.g., apraxia of speech). Namasivayam et al. (2015) also found that children with childhood apraxia of speech (CAS) benefit from higher intensity treatments (more sessions per week with more trials per session). However, longer, more frequent sessions outside of the classroom do not always pair well with ensuring continued access to curriculum in order to meet the federal mandates set forth in IDEA (2004) and ESSA (2015). This again emphasizes the professional struggle for SLPs who want to provide clinically-sound, research-based interventions schedules for SSDs while also ensuring positive educational outcomes of services. School-based SLPs need to find a balance between effective services that remediate SSDs and efficient services that ensure consistent access to the curriculum (less missed class time). Since most school-based SLPs continue to use pull-out, high intensity, massed practice (20-30 minutes sessions twice a week) in groups (Brandel, 2020; Brumbaugh & Smit, 2013), the next consideration to ensure the effectiveness and efficiency of school-based services may be group size during sessions.

Group Vs. Individual Service Delivery

Group sessions of 20-30 minutes are more common than shorter, individualized sessions in school-based settings (Byers et al., 2021). When providing services to a group of students with SSDs, several factors like severity of the disorder, age, behaviors, and attention to tasks could impact the intensity of services. When comparing intervention intensity and service delivery models for children with SSDs, Farquharson et al. (2020) and Skelton and Richard (2016) suggested that longer group therapy sessions were superior to shorter individual therapy sessions, while Byer et al.'s (2021) study found that both types of sessions improved speech sound production. Namasivayam et al. (2019) and Rehfeld and Sulak (2021) also suggested that children with SSDs could make progress in either group or individual settings. While both group

and individualized therapy were theorized to be effective in remediating SSDs, the efficiency of the shorter (5 minute), individual sessions minimized the time students missed out on classroom instruction, allowed for more flexibility in making up missed sessions (since it is easier to schedule one student for a make-up session versus four or five), and provided more time for other SLP workload duties (Byers et al., 2021). Using service delivery models that incorporate shorter, individualized sessions could therefore support SLPs who are striving to provide effective direct services while also completing the long list of workload duties necessary in schools (Brosseau-Lapré & Greenwell, 2019).

Workload Duties

Modern-day school-based SLPs' workload duties are vast. Without federal special education laws that regulated eligibility and service provision and national associations like ASHA that delineated the roles and responsibilities of SLPs, the early conceptual frameworks of John Thelwall and Samuel Potter focused only on the remediation of what we now call speech sound disorders (Duchan, 2010a; Duchan, 2010b, Potter, 1882). ASHA's most recent survey of workload characteristics painted a very different picture of the daily work life of school-based SLPs from that of the early elocutionists of the 19th century who worked in schools. The 2022 ASHA survey results showed that school-based SLPs spent a majority of their average of 37.3 hours a week on direct services (22.2 hours). The remaining hours were split between workload duties including documentation (5.8 hours), diagnostics (3.6 hours), consultation (1.9 hours), technical support (1.0 hours), supervision (.8 hours) and other duties as assigned (2.1 hours; ASHA, 2022).

The amount of workload duties beyond direct intervention often requires SLPs to complete these tasks outside of work hours. Dowden et al. (2006) surveyed 421 Washington

State SLPs and found that 85% typically worked approximately 6 hours before or after weekly contracted work hours on tasks such as completing paperwork or holding parent meetings. Working hours past contracted times in order to complete all of the duties of a school-based SLP supports the need for more efficient use of resources through use of a wider variety of service delivery models beyond the most often used two times per week for 30 minutes in group settings (Brandel, 2020; Brosseau-Lapré & Greenwell, 2019; Brumbaugh & Smit, 2013). One avenue that can support SLPs who seek to find the balance between providing speech services that positively impact academic outcomes and making efficient use of resources is the use of the MTSS framework (Brosseau-Lapré & Greenwell, 2019; Meaux et al., 2020).

Multi-Tiered Systems of Support and Workload

In ASHA's (2010) position statement, *Roles and Responsibilities of Speech-Language Pathologists in Schools*, one of the six critical roles for SLPs was to strive to make unique contributions to the curriculum. In order to make these unique contributions, ASHA suggested several actions for SLPs working in schools including the previously mentioned use of a variety of service delivery models. In addition, they recommended participation in Response to Intervention(RtI)/MTSS teams (including for students with noted speech sound errors). MTSS is a framework that helps educators identify strengths and areas of need in academic, behavioral, and social-emotional realms and then plan for and provide individualized support based on the students' needs (Sailor et al., 2018).

In the federal ESSA (2015), SLPs were encouraged to participate more in the development and implementation of MTSS programming in schools. School-based SLPs' expertise in speech sound development and disorders and their impact on reading, spelling and overall literacy development could be beneficial to development of early intervention

programming through MTSS (ASHA 2010; Snyder, 2016; Suleman et al., 2014). The ESSA contains provisions that promote employing school-based SLPs not just to correct speech sound production, but to help schools set and attain educational standards (ASHA, 2016). Along with supporting high educational standards, the ESSA (2015) recognizes SLPs' contributions to literacy instruction and promotes their involvement on interdisciplinary teams like MTSS. Considering Ehren's (2000) notion that SLPs have specialized skill sets including; a deep knowledge base for language development, the ability to sequence activities based on individual needs and extensive practice in using "on-the-spot error analysis" to guide intervention, it is not surprising that the ESSA also encourages employing SLPs to participate on MTSS teams in order to support struggling students through early intervention. Since MTSS is focused on providing early intervention with fidelity to struggling students and thus decreasing the likelihood that general education students will later need an IEP, SLPs' participation in MTSS could help decrease SLPs' workloads (ASHA, 2016).

As SLPs move toward working more in the areas of literacy and curriculum, collaboration with other staff (e.g, classroom teachers, reading specialists, special education teachers, school psychologists, school administrators) is crucial to successful implementation of MTSS that can target both improved speech sound production and academic gains (ASHA, 2010). Considering the already vast workload duties of a school-based SLP along with the increased focus on partnerships with classroom teachers through MTSS (ESSA, 2015: Suleman et al., 2014), an increased focus on successful collaboration among SLPs and school staff is critical.

Collaboration

ASHA's (2010) *Roles and Responsibilities of School-based SLPs* position statement lists collaboration with classroom teachers as one of the critical responsibilities of SLPs. Suleman et al. (2014) described several forms of collaboration between classroom teachers and SLPs that move from the least integrative models used outside the classroom (e.g., consultation) to the most integrative models that are classroom-based (e.g., parallel and/or team teaching). Use of any of these types of collaboration could be of benefit to both students' education and the large workloads of SLPs by decreasing the missed class time from pull-out sessions while supporting generalization and maintenance of speech sound production goals (Farber & Klein, 1999; Heisler & Thousand, 2021). When using any type of collaborative model, SLPs play a critical role in educating teachers and other service providers on the negative impact of SSDs on students' ability to access their education (McCabe & Nye-Lengerman, 2021). However, SLPs face several challenges when seeking to collaborate with teachers in and out of the classroom.

Large caseload sizes, scheduling difficulties, limited administrative support, and insufficient teacher buy-in and thus, limited collaboration are often cited as barriers to interprofessional collaborative practice (ASHA, 2022; Edgar & Rosa-Lugo, 2007; Green et al., 2019; Pfeiffer et al., 2019). The repercussions of these challenges are illustrated in the national survey results from Pfeiffer et al. (2019), in which only 14% of SLPs participated in interprofessional collaborative practices during intervention sessions. In addition to these barriers to collaborative practices, SLPs could find themselves serving as a paraprofessional and not maximizing their skillset in the classroom (Ehren, 2000). Several provisions of the ESSA (2015) could help SLPs maintain a therapeutic focus when collaborating in the classroom, thus maintaining their defined roles and responsibilities while ensuring full access to the curriculum

(Heisler & Thousand, 2021; McCabe & Nye-Lengerman, 2021). Both successful collaborative practices and decreased workload duties can make the way for more effective school-based intervention for students with speech sound disorders.

Intervention

Barriers to Evidence-Based Intervention

In ASHA's 2010 *Roles and Responsibilities of School-Based SLPs* position statement, SLPs are encouraged to promote and use evidence-based assessment and intervention practices. School-based SLPs who strive to provide evidence-based interventions for SSDs confront several potential barriers. The gap between research and practice is wide (Fulcher-Rood et al., 2020; Meline & Paradiso, 2003; Morris et al., 2019; O'Connor & Pettigrew, 2009). Oftentimes, school-based SLPs struggle to implement intervention strategies with fidelity based on the methodologies of published research (Morris et al., 2019; O'Connor & Pettigrew, 2009). For example, SLPs are charged with ensuring the same dose, frequency, and service delivery guidelines when implementing interventions as they are described in published intervention research (Kaderavek & Justice, 2010). Unfortunately, there are often major differences between the children recruited to participate in research in clinical settings and the very dynamic caseloads of school-based SLPs (Morris et al., 2019; O'Connor & Pettigrew, 2009; Rehfeld & Sulak, 2021). This discrepancy impedes how, when, and where services are provided, therefore skewing the fidelity of the implementation. For example, Baker and McLeod (2011) found that most intervention research published between 1979 and 2009 was conducted in a one-on-one setting between the client and the SLP in a university clinic while many school-based SLPs continue to provide services 20-30 minutes sessions twice a week in group settings (Brandel, 2020; Brumbaugh & Smit, 2013). The concept of implementation science may be a bridge

between the strictly mandated parameters of clinical research and the real-life practices of school-based SLPs working with students with SSDs.

Implementation Science

Implementation science is defined as “the study of variables and conditions required to promote the systematic uptake, sustainability and effective use of evidence based programs and practices in typical service and social settings" (Boothroyd, 2014). In a recent study on service delivery schedule effects on speech sound production outcomes, Rehfeld and Sulak (2021) discussed future directions for research that may help construct a bridge between research and practice in schools. They outlined the need to investigate service delivery models that meet the need for flexibility in implementation for school-based SLPs while still maintaining treatment fidelity. They also recommended that researchers account for SLPs who serve students in multiple locations when recommending the dose and frequency of interventions (SLPs may not be able to implement treatment 4 days a week like the research design mandates if they are only at a school 2 days a week). Finally they recommended that researchers carefully consider the severity of the SSDs and any comorbid diagnoses of study participants. Without these considerations and possible recommendations for implementation for a variety of severity levels, school-based SLPs could be asked to implement treatment methodologies in settings where most of their caseload would not meet the eligibility criteria of the published research. These recommendations from Rehfeld and Sulak (2021) support the concept of implementation-focused research that will help SLPs choose interventions that will best support students with SSDs in school-settings. Meline and Paradiso (2003) wrote “Research is the foundation for the science in communication disorders, and the science is paramount to good practice” (p. 273). If SLPs felt more empowered to make intervention decisions from research that considered implementation

in school settings, they could be confident that their intervention choices would provide maximum benefits to the students they serve.

Choosing Interventions

Not surprisingly, given the negative educational impact of SSDs, the time and effort SLPs devote to students with SSDs in schools, and the call to provide services tied to research, there has been an increased interest in the types of interventions provided to improve speech sound production and intelligibility (Dodd et al., 2018). In their survey study of SLP practices, McLeod and Baker (2014) indicated that the breadth of choices for management of SSDs often makes clinical decision-making in school settings complicated. SLPs have a wide variety of intervention choices when planning treatment for SSDs (McLeod & Baker, 2014) with several factors impacting those decisions. For example, when choosing interventions, SLPs must consider the individual needs of students, how much carry-over support the student will receive from school staff in the classroom, and if an SLP will even be available to provide the intervention with fidelity based on the number of schools and students that must be served. Choosing from the wide variety of interventions using a research-based perspective requires that SLPs go beyond just using past clinical experience and their university education when choosing how to treat SSDs (Ratner, 2006). Evidence-based practices require that SLPs consult current scientific literature and consider the unique characteristics of the students they are treating.

Unfortunately, school-based SLPs have attempted to simplify this complicated process of choosing interventions for students with SSDs in several non-scientific ways (Kahmi, 1999). Diepeveen et al. (2020) found that most SLPs base intervention decisions on the student's age, diagnosis, and what is most appealing to the student (e.g., using high-interest technology-based

materials with a group of three 5-year old kindergarten students who delete final consonants). Since SLPs often do not use an intervention technique with a body of evidence in isolation, but instead use a combination of pieces of traditional intervention strategies (e.g., auditory bombardment, auditory discrimination, minimal pairs; McLeod & Baker, 2014), making intervention research attempts within school settings becomes even more complex. In their qualitative study of clinical decision making, McCurtin and Carter (2014) found that SLPs often take a "less than scientific" (p. 1148) approach by only using clinical experience to inform most intervention decisions. These findings support those of Kahmi (1999) who found that SLPs choose interventions based on their own familiarity or previous success with an intervention technique. McCurtin and Carter (2014) went on to question the traditional therapeutic choices of SLPs including the continued use of older approaches (i.e., traditional articulation therapy or cued articulation) when evidence was clearly stronger for more recent intervention types (i.e., cycles, multiple oppositions, and metaphonological interventions). Referencing SLP intervention choices, Ratner (2006) went as far to say that "getting the ineffective approaches out of the system seems perversely difficult" (p. 261). SLPs working in schools need to ensure they seek out the best available evidence for intervention choices so that they are not only using current effective practices with students, but can also support their choices with research when collaborating with parents and teachers. Adding to the complicated decision-making process of choosing research-based interventions to fit the needs of students, SLPs are also charged with ensuring the positive educational impact of those interventions (Ehren, 2000; Farquharson, 2015; Farquharson & Boldini, 2018; Hayiou-Thomas et al., 2017; Hitchcock et al., 2015; Tambyraja et al, 2020; Wallach, 2014).

Choosing Interventions in Schools

In her conceptual framework for intervention with school-age children, Wallach (2014) noted that making intervention choices for students with SSDs from a clinic-based mindset does not take into account the increasing demands of the curriculum or support collaborative efforts between teachers and SLPs. Wallach (2014) went on to question why such a gap exists between what we know works for students with speech and language delays at school (i.e., integrating students' background knowledge into therapy, focusing on the interaction of SSDs and the demands of curriculum and helping students understand the benefits of speech therapy on their school performance) and the current practices of school-based SLPs (i.e., employing pull-out services using materials that are not easily transferable to supporting access to the curriculum and that do not explicitly target the stated goals). These current practices prevent many school-based SLPs from using research-based intervention that both consider the curriculum and foster collaborative efforts. If SLPs are making decisions about speech therapy for SSDs in a school setting without considering the curriculum, their choice of materials, or the possible positive contributions of classroom teachers, they are not completing all of the unique workload duties of a school-based SLP (ASHA, 2022). Along with the theoretical considerations relative to the curriculum, materials, and classroom teachers' contributions when choosing interventions, school-based SLPs have the additional responsibility of considering the costs of their intervention choices.

Funding and Interventions

When making intervention decisions, SLPs often rely on logistical considerations like available funding for training or materials/equipment. They also need to consider whether staff is available to implement evidence-based treatment that requires more sessions, more time, or

smaller groups with fidelity (McCurtin & Clifford, 2015). One of the causes of the gap between the implementation of research-based interventions and traditional school-based practices could be the lack of funding for special education. Since the passage of the IDEA (2004) in 1975 and its reauthorization in 2004, special education and related services have been underfunded (Katsiyannis et al., 2001). Although Part B of IDEA authorized Congress to fund 40% of the costs associated with IDEA (otherwise known as "IDEA full funding") by 1982, as of 2018, funding had only reached 13% (National Council on Disability, 2018). Since speech and language services in schools are paid for out of the same limited funding as other special education services, ASHA (2021) pinpointed increased workloads and the need to change service delivery models as consequences of stretched budgets on practices of school-based SLPs. With less money to fund employment of SLPs, group sizes become larger and collaboration and co-teaching becomes more difficult (ASHA, 2022; Edgar & Rosa-Lugo, 2007; Green et al., 2019). Lack of funds also has a trickle-down effect and may limit the amount of continuing education an SLP can obtain in order to stay on top of the current research for therapeutic approaches. Considering that Wallach (2014) identified that a common erroneous practice of SLPs was to continue using the treatment approaches they were taught during their pre-service university courses, continuing education on newly researched therapy approaches is crucial to ensuring use of research-based interventions in school settings.

Funding and Therapy Materials

Additionally, underfunded budgets may limit the materials that an SLP can purchase to provide individualized, evidence-based services for students. Potentially, then SLPs may continue to use traditional interventions that no longer have current scientific support since there is no money to purchase new commercially-produced therapy materials to employ cutting-edge

approaches. McLeod and Baker (2014) identified one possible solution to closing the gap between what SLPs know about research-based interventions and what they do at school is to ensure that SLPs "identify and adopt implementation strategies that better translate empirical knowledge into action" (p. 526). One of these implementation strategies may be to carefully consider the materials SLPs use when treating students with SSDs in schools.

Farquharson et al. (2020) noted that SLPs had control over many therapy factors in school settings such as composition of groups as well as the location, frequency, and duration of services. This environmental control allowed SLPs to tailor interventions in ways that consider the child and therapy-level factors that the researchers found to impact gains in speech sound production. Thus, the materials (including activities, manipulables, worksheets, data sheets, and games) SLPs use during direct services with children may be one of the many environmental variables that can contribute to improved speech sound production. SLPs need to identify the best mix of materials, instruction, and personnel to effectively and efficiently meet student objectives (Cirrin et al., 2010). It is difficult to identify the best mix of materials, instruction, and personnel with no studies specific to materials used during treatment of SSDs in schools. In order to improve effectiveness and efficiency of services as noted in Cirrin et al. (2010), SLPs need more evidence to aid them when they are choosing between CATM that require significant funding and AITM that are already available in the classroom, require none of the limited SLP budget, and could more likely support positive educational impacts of speech therapy.

Commercially Available Therapy Materials

CATM can be defined as the thousands of materials SLPs or school districts purchase from websites, catalogs, or vendors that are specifically designed and marketed to support improved speech sound production. These materials can include: worksheets, games, flashcards,

digital applications, and books. Most of the materials for traditional intervention approaches for students with SSDs (that may no longer be backed by current evidence) include objects, pictures, and board games that are specifically designed for speech sound production drill/improvement (Jesus et al., 2019; Justice, 2006). However, CATM often requires students to complete a variety of tasks beyond speech sound production including: learning how to play a game, reading directions and completing worksheets, and learning new vocabulary. Following their study on computerized interventions for students with social communication disorders, Murphy et al. (2014) indicated that packaged training materials have several advantages including availability of "ready to use" supplies. However, the researchers also posited that packaged CATM may not allow for consideration of student-specific benefits of the materials that would allow for individualization of interventions that would most directly benefit students in the classroom.

Packaged CATM come "ready-to-use" for the deliberate practice that is necessary in order to improve speech production skills and to ensure that the intervention drills are implemented with fidelity (Preston et al., 2019; Rehfeld & Sulak, 2021; Skelton & Richard, 2016). However, if the skillset of the SLP (e.g., training in speech sound development and how to best intervene when development is delayed or disordered) is considered a more essential element in the fidelity of the intervention than the materials themselves; the prescribed practice could theoretically be provided without CATM. Interestingly, in a recent tutorial on motor-based treatment strategies for improved /r/ production, Preston et al. (2020) cautioned practitioners that "many popular or commercially promoted approaches may lack an empirical or theoretical basis and, thus, are not recommended practices" (p. 976). Without an empirical or theoretical basis for commercially marketed approaches and the materials that accompany them, it may be more

difficult to support their use, especially when it is more difficult to transition CATM into classroom settings.

CATM in the Classroom

CATM that are specific to speech sound drills and include sets of random words/pictures that do not align with the curriculum or learning and are not easily transferred into the students' "classroom world." Digital applications on tablets (e.g., articulation applications with pictures containing specific speech sounds on an iPad) that allow the SLP to conduct drill-based practice and never leave the therapy room do not translate back to the classroom curriculum. In fact, when challenging the traditionalism in speech and language intervention, Wallach (2014) considered the journey of "going to speech in the speech room" for intervention that did not match the students goals to classroom contexts a practice that created a barrier to meeting students' speech and language needs in a manner that would support their academic success. CATM have been used successfully to correct speech sound errors in school speech therapy rooms for decades; however, the positive impact of packaged materials is limited to improvement in communication skills and often does little to hasten achievement of the expected level of performance on academic tasks in the classroom (Wallach, 2014). Practitioners have traditionally chosen CATMs for speech interventions in schools and yet CATMs do not easily support both maintenance of a therapeutic focus or contribute to success in the classroom. A more thorough review of alternative materials choice needs to be explored.

Academically Integrated Therapy Materials

AITM can be defined as materials that are part of students' daily, grade-level reading, writing, and math curriculums. These materials can include worksheets, books, manipulatives, and digital applications. In theory, using and adapting AITM during direct speech services

allows SLPs to expand their repertoire of materials to include those that can remain in the classroom with students while still improving speech sound production accuracy through intervention. Using AITM could also support integrated services in the classroom. This approach to materials selection supports Ehren's (2000) call to maintain a therapeutic focus when providing integrated speech-language services in classrooms. As noted previously, SLPs in schools are tasked with ensuring that SSDs do not have a negative impact on students' abilities to access their curriculum (Ehren, 2000; Wallach, 2014). Given this charge, weaving speech sound production intervention into tasks like learning vocabulary lists from classroom novels, answering questions about reading passages, reading story problems aloud in math class, or using spelling lists for speech sound drill could benefit the cross-over between the classroom and speech therapy rooms through AITM (McNeill et al., 2017). Spelling lists, in particular, are available, easy to access, and easy to adapt to therapy plans for SSDs for most grade levels in schools. Weekly spelling lists could be both easy to implement in speech therapy and support carry-over of correct speech sound production to the classroom. When making the change from using CATM to adapting AITM to use in speech therapy, spelling lists may be a good first choice.

AITM and Spelling

Since children with SSD often exhibit lower spelling scores than their age-matched peers (Apel & Lawrence, 2011; McNeill et al., 2017; Peterson et al., 2009), using spelling lists during intervention for speech sound disorders could provide additional educational support (e.g., extra exposure to the words, using the words in different contexts, receiving explicit, individualized instruction from a skilled interventionist) to students while maintaining the therapeutic focus of targeting gains in speech sound production. Fallon and Katz (2011) noted that SLPs are among

the “critical personnel” who need to be addressing the written language needs of students (including spelling). This material choice could, in theory, save SLPs time and create more effective and efficient school-based services by eliminating the need to find and prepare materials while supporting a connection between speech therapy and what Wallach (2014) described as the “outside world of curricular and classroom contexts” (p.132). With the extra exposure to and experiences with the spelling words during speech intervention, students could potentially improve their classroom spelling performance. For example, if students receive better grades on spelling tests or win classroom spelling bees and subsequently recognize the connection between speech intervention and this success in the classroom, using AITM during intervention could also positively impact the social emotional well-being of students.

AITM and Social-Emotional Well-Being

In addition to negatively impacting literacy acquisition, SSDs also have the potential to impact a students’ social-emotional well-being (Farquharson & Boldini, 2020; Hitchcock et al., 2015; McCormack et al., 2009; Overby et al., 2007). In a systematic review of 57 papers on the topic of limitations in life participation caused by SSDs, McCormack et al. (2009) found limitations in the following social-emotional areas that could relate to educational impact: self-care, relating to persons in authority, and informal relationships with friends/peers. Overby et al. (2007) took “relating to persons in authority” a step further by investigating teachers’ perceptions of students with SSDs. They found speech intelligibility appeared to influence teachers’ perceptions of students’ academic, social and behavioral abilities. This supports the need for SLPs to prioritize improved classroom performance during intervention for SSDs through use of AITM that would translate back to the classroom. Considering the social impact of SSDs in classroom settings (Farquharson & Boldini, 2020; Hitchcock et al., 2015;

McCormack et al., 2009; Overby et al., 2007), using spelling lists or other AITM during speech therapy could potentially have a positive impact on several social-emotional areas. Students may be more willing to participate in class since they have been exposed to and engaged with the curricular content in an intervention capacity and are more confident with the materials. This increased participation could have a positive impact on teachers' perceptions of students' overall social-emotional abilities despite the SSD. In addition, witnessing this increased participation could enhance teacher's perceptions of SLPs' potential contributions to their classrooms. If teachers see SLPs as an important factor in student success in the classroom, collaborative efforts and interprofessional practices could also improve.

AITM and Collaboration

If SLPs become more proficient using AITM in therapy and then communicate student successes in speech therapy with teachers using their increased knowledge of the curriculum, collaborative efforts could naturally improve. Given the charge to ensure positive educational impact of speech services in schools (Ehren, 2000; ESSA, 2015; IDEA, 2004; Wallach, 2014), the use of AITM could support continuity of services since students can continually reference the same materials targeted in therapy once they return to the classroom. This allows the student, classroom teacher, and SLP to all utilize the same materials, supporting a cross-over between therapeutic interventions and classroom instruction. Effective collaboration requires SLPs and teachers to go beyond just "working together" and instead engage in team-minded planning and implementation of strategies with common goals in mind (Pampoulou, 2016; Suleman et al., 2014). Adapting materials from the classroom could support these next steps for collaboration beyond just working together in the same room. In addition to having common goals and using collaborative planning, Lindsay and Dockrell's (2002) position that effective collaboration

requires that professionals share responsibilities, have similar knowledge bases, and limit autonomy (e.g., eliminating a teacher's perception that "spelling is my job and speech intervention is your job") also supports using AITM during speech therapy. If SLPs used spelling lists (AITM) during speech therapy, they could increase their knowledge of the curriculum, limit their autonomy by shifting away from CATM that are specific to their field, and ultimately share responsibility with the teacher for students' spelling success.

When SLPs use AITM in therapy, this could not only set the student up for successful transfer of knowledge to the classroom, but it could support development of a common "language" between SLPs and the classroom teachers as well as other support staff (Ehren, 2000). The common vocabulary that emerges when school professionals use the same AITM could help alleviate one of the communication roadblocks (Pfeiffer et al., 2019) that may prevent SLPs from successfully consulting and planning with school staff. For example, it would be much easier for an SLP to model how to elicit correct speech sound production of a specific speech sound during class using a target word from a readily-available spelling list instead of using a word from the SLPs iPad application that the teacher cannot easily access.

Since SLPs should also consult with classroom teachers regarding functional goals and service delivery while delegating tasks (e.g., articulation drill practice, auditory discrimination) to other qualified staff like speech language pathology assistants (SLPAs) or paraprofessionals (McNeilly, 2018), AITM could support this practice. For example, while the SLP models how to elicit the /s/ sound that is present in 10 of the spelling words that week for a teacher, the support staff/paraprofessional could be making the flashcards for therapy that contain the 10 spelling words. Sharing resources is essential when consulting and collaborating with school staff (Friend & Cook, 2017) and using AITM supports this defining characteristic of collaboration by

simplifying the pursuit of common goals, shared language and quality co-planning time. Sharing resources with classroom teachers could also support more authentic data collection that supports the positive educational impact of speech services for students with SSDs.

If SLPs transition to using AITM, they could not only monitor progress and performance from data collected during direct speech intervention as in clinical settings, but they could also use students' grades in the classroom as data points to support favorable influences of intervention on academic skills. If SLPs are specifically supporting classroom performance when using classroom materials, their services could have an immediate impact on educational outcomes. For example, if a student shows an improvement on his spelling test grades on the weeks that the SLP used those lists in therapy, this could be documentation of the direct educational impact of speech therapy services. This positive impact on performance is an important responsibility of SLPs who choose to practice in a school setting (ASHA, 2010). Students may benefit academically when SLPs can shift their focus and time from preparing CATM that are not related to the curriculum to using research-based treatment strategies including: modeling, prompting, guided responding, chaining, shaping, time delay strategies, guided repetition, and home programming while using AITM.

CATM vs. AITM

Interestingly, although the list of possible material types for both CATM and AITM are very similar, the main difference between the two is that CATM are designed specifically for students with speech impairments without consideration of the academic portions of the school day, while AITM are already aligned to the students' grade level academic standards. SLPs could modify and adapt academically-relevant AITM to each students' unique speech needs instead of using CATM that were created for general speech and language skill development

without a focus on age, developmental, or cognitive levels, all of which could impact their effectiveness for individual students.

Theory of Competing Resources

When comparing the choice of CATM and AITM in school settings, SLPs should consider Lahey and Bloom's (1994) theory of competing resources in which the researchers theorized how to best create mental models of language. A simple explanation of their theory is that learning anything is more difficult when students have to navigate two hard or unfamiliar concepts at the same time and therefore practitioners should seek to reduce these competing resources. They suggested that SLPs must consider the factors that compete for a share of students' language processing abilities when planning interventions. If their theory is applied to speech sound production and therapy, new materials that students have not already seen in the classroom could add elements that compete for their resources (e.g., attention, interest, motivation) and do not allow for focus on correcting speech sound production (Lahey & Bloom, 1994). Students may expend all of their energy, attention, or cognitive ability to simply interact with the unfamiliar materials (e.g., learn/play the game, read the directions on the worksheet, read new vocabulary), leaving little for them to focus on the actual purpose of the therapy—correct speech sound production. This could indicate that AITM may be a better material choice for intervention with students who may already be at a disadvantage academically, cognitively, or socially. If SLPs exercise their environmental control over therapy-level factors like therapy materials (Farquharson et al., 2020) and modify AITM that are readily available and familiar to students, teachers, and therapists in many school settings, they could quickly diminish the number of competing resources for their students.

Parental Involvement and Materials

When choosing between AITM and CATM, parental involvement is another variable to consider. Regular homework along with parent motivation are important factors when considering the success of therapeutic intervention (Günther & Hautvast, 2010). If materials for speech therapy homework and classroom homework are the same, this could positively impact parental involvement and motivation to regularly target speech goals at home since "speech therapy homework" would not require additional work. For example, if spelling lists are marked with speech therapy goals and suggestions from the SLP, the student and parent could focus on both at the same time at home while studying for the weekly spelling test. This added convenience and efficiency could increase parental participation (Sugden et al., 2019) in speech sound correction and increase the effectiveness of speech services through a simple change in materials choice (Lahey & Bloom, 1994; Piper et al., 2011).

Further Study

Studies on SSD in children are rich with discussions of therapy-level and child-level contributions to gains in speech sound production. Many evidence-based therapy approaches include implementation instructions and even data collection form samples, but few include examples or even mention the daily therapy materials that would be best suited to the approach (McDaniel & Schuele, 2021; Preston et al., 2020; Preston et al., 2019; Skelton & Richard, 2016). This is in direct contrast to the findings of Gierut (1998) that indicated that stimuli presentation during intervention is one factor that determines the effectiveness of interventions. An analysis of the materials used during intervention for SSDs in school-based settings is needed. No studies have focused specifically on the materials used during speech intervention in schools. Studies that illuminate the need for careful consideration of material choice and demonstrate successful

alternatives to current intervention materials could provide SLPs with the guidance needed to tailor every part of school-based interventions to their students' speech needs while also supporting students' academic efforts. Specifically, studies that compare CATM and AITM are needed to help school-based SLPs meet the challenges of targeting SSDs using interventions tailored to the individual needs of students while also effectively collaborating with school staff and parents. Considering the potential educational (academic and social) impact of SSDs, SLPs should carefully consider all aspects of intervention and service delivery including the materials they use. Previous practices using isolated pockets of intervention and speech-sound specific materials in the speech room may no longer be enough in a post-pandemic world (Khan & Ahmed, 2021; Robinson, 2022; Sanderson et al., 2021).

CHAPTER III

METHODOLOGY

Study Method

Participants

Five students met the following inclusion criteria: (a) diagnosed with an SSD in the moderate to severe range with initial assessment scores 1.5 to 2 standard deviations below the mean standard score on the *Goldman Fristoe Test of Articulation: 3rd Edition* (Goldman & Fristoe, 2015), (b) received no other special education services other than speech therapy, (c) passed a hearing screening at 20dB for 1000, 2000, 4000 Hz during the current school year, (d) least restrictive environment (LRE) placement in a general education first-grade classroom, and (e) documentation of parental consent and student assent (appropriate to age) to participate for this study.

The PI first met with the school's SLP (who was also conducting the study intervention), first-grade teachers, and administrators to identify first-grade students with SSD that met the inclusion criteria. Recruitment letters that explained the study were sent home to obtain parental consent. Upon receipt of this consent, students' IEPs and evaluation reports were reviewed for eligibility for the study. The PI then met with each student in order to obtain student assent for the study. The student assent form was read aloud to each student and verbal responses were recorded. Each student wrote their name at the bottom of the assent sheet to indicate that they agreed to participate and that they knew they could stop participating at any time. The two first-grade teachers from the participants' classrooms participated in the study and signed consent forms before responding to questionnaires.

Of those who met the criteria, four were male and one was female, and all were between the ages of 6 and 7 at the time of the study. Participant numbers 1-5 were used to identify the students during all phases of the study. Participants 1 and 2 were in the same classroom and Participants 3, 4, and 5 were in a different classroom together. Each participant was initially evaluated for an SSD in preschool or kindergarten and each had received speech therapy the school year prior from the SLP conducting the study intervention. Participants 1 and 2 were parent referrals and were initially evaluated at 4 years of age. Participants 3, 4, and 5 were teacher referrals in kindergarten and were initially evaluated at 5 years of age. There was no attrition during this study. One participant had an illness that prevented him from taking three of the weekly spelling tests at the same time as the other participants, but his overall classroom spelling grades reflect the same number of data points as the other participants with tests made up upon his return.

Table 1

Participant Demographics

Participant #	Gender	Race	Age	Standard Score On GFTA:3
1	M	white	7	42
2	M	white	6	55
3	F	white	6	71
4	M	white	6	<40
5	M	white	6	74

Setting

This study was completed at a public elementary school in a suburban area in the Midwestern United States. The Indiana Department of Education INVIEW database (2020) indicated that the school had 665 students enrolled in kindergarten through fifth grade. The percentage of students who received free or reduced lunch (indicative of economic disadvantage) was 50%. The ethnic diversity of the school was 82% White, 11% Hispanic, 1% Black, 1% Asian, and 5% more than one race. The study intervention took place at a small table in the hallway right outside of the first-grade classrooms during SSDs intervention. The hallways were busy at times with students transitioning to other areas of the school. Intervention in the hallway was standard practice prior to the study for students receiving interventions. Intervention consisted of 5-minute individual articulation drill sessions two to three times per week with frequency of services based on the students' IEPs. The SLP sat across from the student at the table with the materials between them.

Materials

Spelling Lists (AITM)

Words from the weekly spelling lists from the school's first-grade curriculum were used as the AITM and served as the target words during the intervention phase of the study. The weekly spelling lists were made up of 10 words. The spelling lists used during intervention were the same lists that all first-grade students were using that week in the classroom.

Digital Flashcards (CATM)

The CATM were digital flashcards from the Little Bee Articulation Station application (http://littlebeespeech.com/articulation_station.php). The digital flashcards were made up of

photographs and words containing the student's target sound and the application included voice output that modeled the word if the SLP tapped the pictures.

Word Lists

During the baseline phase and final data probe, word lists with 10 unreated words that contained the participant's target sound were used to obtain the baseline PTCC during TAU conditions which consisted of the same 5-minute individual intervention or progress monitoring with no explicit instruction, in the same location, but without the required alternating materials (CATM/AITM). Baseline percentages were based on the present levels of production complexity for each students' IEP goal (e.g., some students imitated the words, some produced the word without a model, some used the words spontaneously in sentences).

Dependent Variables

One dependent variable was the weekly average of percentage correct scores on spelling tests and graded classroom spelling activities calculated during the baseline phase as well as when using spelling lists (AITM) versus digital flashcards (CATM) during speech intervention. The second dependent variable was the PTCC from students' production of target words during the baseline phase as well as when using spelling lists (AITM) versus digital flashcards (CATM) during speech intervention.

Experimental Design

A single participant, alternating treatment design was used to compare the effectiveness of using curricular materials versus sound-specific digital flashcards during intervention for students with SSD. This study consisted of three phases: (a) baseline, (b) alternating use of spelling lists and flashcards during 5-minute articulation drill sessions, and (c) final treatment probe administration.

Data Collection Procedures

Percentage of Targeted Consonants Correct

The SLP had a dedicated iPad to use for audio recording each session and to scan QR codes for data collection. Each participant had a QR code that, when scanned, linked to a Google Form. The Google Form tracked the PTCC during baseline, alternating treatments (spelling lists and digital flashcards), and the final data probe administration. The SLP scanned the QR code at the beginning of each session of each phase (e.g., baseline, intervention phase, or the final data probe administration). If the student produced the sound correctly, a "+" was noted on a paper data sheet and if the sound was not produced correctly "-" was noted on the data sheet. To calculate PTCC, the total number of correctly produced target consonants during the session was divided by the total number of opportunities for the target consonant production multiplied by 100. The SLP transferred the percentage from the paper data sheet to the Google Form at the end of each session. The SLP had a goal of 50 to 75 productions per session, which was consistently met throughout the study.

Spelling Grades

The Google Form also tracked the spelling grades (from spelling tests and classroom activities) for students during each phase of the study. The students took a spelling test on the list of words used as AITM on Friday each week with the exception of one week during the study that was just before a vacation. In addition, the students received three other spelling grades per week when completing classroom worksheets that involved reading and writing the targeted spelling words. Once a week, the SLP checked the averages of all of the students' spelling grades the teacher had taken for the week and then added them to the Google Form.

Inter-Observer Reliability

In order to ensure reliable data collection and evaluation, the PI listened to 30% of the total number of sessions in all phases of the study and marked target consonant production as correct (+) or incorrect (-) and then calculated the PTCC. That percentage was compared to the percentage the SLP recorded on the Google Form after each session. Inter-observer reliability was calculated by dividing the number of agreements by total observed intervals and multiplying the quotient by 100. The mean agreement between the SLP and the PI during the study was 93%.

Procedural Integrity

In order to ensure procedural fidelity of the study, the PI listened to recordings of the SLP providing therapy during 30% of the total number of sessions in all phases of the study and completed a procedural checklist to ensure that: The only materials used were those assigned to each student; The servicing SLP provided the SDI listed in each students' IEP regardless of the materials used; The servicing SLP used the same reinforcement strategies for both types of materials with a similar number of responses in each session regardless of material type. The SLP followed the procedural checklist in 100% of sessions that were analyzed. In addition, the SLP had a goal of 50-75 productions per 5-minute session. She noted the number of productions correct out of the number of productions per session to determine the PTCC, and this was documented in the Google Form. The PI listened to recordings and counted and averaged the productions in 30% of the sessions. The average number of productions per session was 54.

Procedures

Baseline

Speech Sound Production. Baseline data were collected for three sessions to determine stable performance prior to beginning intervention. Students were asked to say 10 words with

their target sound from a list of words not included in spelling lists (AITM) or sound-specific digital flashcards (CATM). The PTCC was calculated for each session and recorded on the Google Form

Spelling Grades. The SLP accessed each students' averaged spelling grade (calculated by the teacher) that included both spelling tests and classroom spelling activities at the end of the week for 3 weeks. These grades were recorded on the Google Form.

Pre-Test. The spelling subtest of the KTEA:3 (2014) was administered to obtain a standard score for spelling. The subtest was administered individually at the same table in the hallway between the classrooms where the intervention took place.

Intervention

Materials used during therapy were either typically-utilized CATM or AITM. The CATM were digital flashcards and the AITM were 10, single-syllable-word spelling lists taken from the weekly curricular framework. Students received therapy using CATM for 2 weeks and then AITM for 2 weeks with documentation of speech sound production recorded after each therapy session (2 times per week) and spelling grades on tests and assignments recorded at the end of every week (1 time per week). Students then rotated through CATM and AITM again for 2 weeks each with data points recorded for speech sound production and spelling performance for a total of 8 weeks of intervention.

Speech intervention (regardless of material type) that used the SDI (e.g., modeling, shaping speech sound productions, guided rehearsal, auditory bombardment) listed in each students' IEP was provided using words containing their target sound chosen from the AITM or CATM. The SDI provided to all students in the study was similar and reflected standard operating procedure for 5-minute, individual therapy sessions. The SLP used verbal, visual and

tactile cues (e.g., verbal models, mirrors, placement directives for the students' tongue, lips, and teeth) to elicit responses. The SLP recorded the students' speech sound productions on a data sheet and transferred the data to a Google Form at the end of each session.

Therapy occurred at the same time each week, was provided by the same SLP, and was the same frequency and duration for each session. The SLP used a timer set for 7 minutes at the beginning of each session and used 1 minute at the beginning of the session to introduce the target for the session. One minute at the end was used to recap the session and chat with the student. The therapist followed the IEP and worked at the level of progress they had achieved toward their speech sound production goal (e.g., spontaneous word level, imitated syllable level). Students would imitate and/or spontaneously produce the target sound or words chosen from either CATM or AITM based on their current level of performance. The students could have been performing at a variety of levels including, but not limited to imitated syllable level (e.g., the SLP showed the word, modeled the word, modeled a syllable in the word that contained their target sound and waited for an imitation), imitated word level (e.g., the SLP modeled the word and prompted an imitation), or spontaneous sentence level (e.g., the SLP showed the word and asked them to use it in a sentence orally) depending on their progress toward their individualized IEP goals. The students' speech sound production performance was documented using plus/minus (+/-) symbols and a percentage correct for the target sound was calculated at the end of each session. Each week, the SLP accessed the students' spelling grades (entered by the teacher) that were an average of the weekly spelling test and daily classroom spelling task scores and recorded them in the Google Form.

AITM Procedures. At the onset of each treatment session, the SLP sat down with the student and read all 10 spelling words aloud, wrote them on a portable white board while

spelling them aloud, and then asked the student to find any words that contained their target speech sound and circle it. Lastly, she asked them to underline their sound in each circled word. The circled words with underlined sounds were then the target words for speech intervention during that session. The majority of the time, there were at least several (e.g., 2-4) spelling words that contained the target sound that were able to be utilized to practice speech sound production. If there was only one word on the spelling list that fit the student's IEP goal, that word was repeated throughout the session for articulation drill and then the SLP used the other spelling words for auditory bombardment ("do you hear your sound in this word?") in order to continue to expose the students to all of the spelling words during the session. If no words that fit the students' IEP goal were on the spelling list that week, the SLP had a pre-determined phrase or sentence for each target sound to pair with the ten spelling words (e.g., a pre-determined sentence for /k/ was "I can spell the word _____" with the student filling in the blank with a spelling word and then spelling the word). Or, if the student was working at word level, the SLP would present a rhyming word (nonsense or real) that incorporated the spelling pattern of each of the ten spelling words, but also contained the target sound (e.g., If the spelling word was "chat" the SLP modeled "sat" for the student who was working on /s/). While the 10 spelling words were graphically displayed on the portable whiteboard and the SLP would comment on the spelling patterns or rules, no explicit spelling instruction (e.g., word study activities) was provided during the speech sound production intervention.

CATM Procedures. The SLP pre-selected 10 words/pictures from the app that contained the students' targeted speech sound. The SLP would elicit speech sound production using the pre-selected words/pictures depending on the individual level at which the students were

working (word level, phrase level, sentence level) and word position of the sound (beginning, middle, end of the word).

Post-Treatment Data

Final Treatment Probe. After 8 weeks of intervention, the SLP stopped using the spelling lists and the digital flashcards during intervention. She used a therapist-created card matching game during 5-minute, individualized sessions that targeted their speech targeted speech sound. At the end of the week, a final data point was taken for PTCC and the spelling grade in the classroom.

Post-Test. The spelling subtest of the KTEA:3 (2014) was re-administered to obtain a standard score for spelling to compare to the pretest score. The subtest was administered individually at the same table in the hallway between the classrooms where the intervention took place.

Data Analysis

Visual Analysis

Visual inspection of graphed data from all sessions (baseline, intervention, final treatment probe administration) was the primary method of analysis for the study. Visual inspection of the data was used to examine individual trends/changes in speech sound production and classroom spelling performance between phases and over time when using AITM and CATM during intervention.

Effect Size

A d-statistic was used to examine the magnitude of the difference between the alternating materials (spelling lists/AITM and digital flashcards/CATM). The formula to calculate the d-statistic was: (treatment 1 (AITM) mean – treatment 2 (CATM) mean) / pooled standard

deviation for the spelling grades or speech sound production percentages. Values used to rate the magnitude of the difference between the materials were .20 = small; . = .50=medium; .8 or higher = large (Perugini et al., 2018).

Percentage of Nonoverlapping Data

A PND was used to assess the relative effectiveness of each material type (AITM or CATM) to determine if variations across conditions existed. The PND was used as a non-parametric index to calculate the nonoverlap of the greatest baseline data point and the intervention data for each material. Guidelines from Scruggs and Mastopieri (1998) were used to guide interpretation of PND effect sizes. The guidelines were as follows: (a) $\geq$ 90% non-overlap indicates "highly effective," (b) $\geq$ 70 to < 90% indicates "effective," (c) $\geq$ 50% to < 70% indicates "questionable" effects, and (d) <50% indicates "ineffective." A PND calculator from Tarlow and Powland (2016) was used for the calculations.

Pre- and Post-Test

The spelling section of the KTEA:3 (2014) was individually administered pre- and post-study to compare the standard scores. Confidence intervals for the pre- and post-test standard scores were also compared for overlap. For those confidence intervals that did not overlap, clinically significant improvement in spelling could be inferred (Cumming & Finch, 2005).

Social Validity

Student Questionnaire. A questionnaire was given to the first-grade students after each 2-week segment of using AITM or CATM during speech therapy that asked five age-appropriate yes/no questions regarding their experiences during the study. Specifically, the student questionnaire targeted their perspectives on using spelling words during speech therapy and

whether speech therapy in general helped them in the classroom. The questions were read aloud and the participants answered verbally. The SLP marked their responses on a paper data sheet.

Teacher Questionnaire. A questionnaire was given to the teachers to complete at the beginning and end of the study. It was not given at the beginning and end of each phase (CATM and AITM) in order to be respectful of their heavy workloads, Each survey, comprised of five, Likert-scale questions with a 5-point rating system (i.e., 1 = great difficulty; 2 = difficulty; 3 = mildly delayed; 4 = capable; 5 = very capable) and one open-ended question, targeted the teachers' perceptions of the educational impact of each students' speech sound disorder.

CHAPTER IV

RESULTS

Purpose

The purpose of this study was to determine if materials used during public school speech therapy could impact spelling performance in the classroom. The study compared the effectiveness of using classroom spelling lists vs. commercially available speech-sound-specific digital flashcards as therapy materials during intervention with students who qualified for SSDs in school-based settings. The PI hypothesized that the use of AITM like spelling lists would similarly support improved speech sound production while also providing a positive academic impact in the classroom.

Research Question One

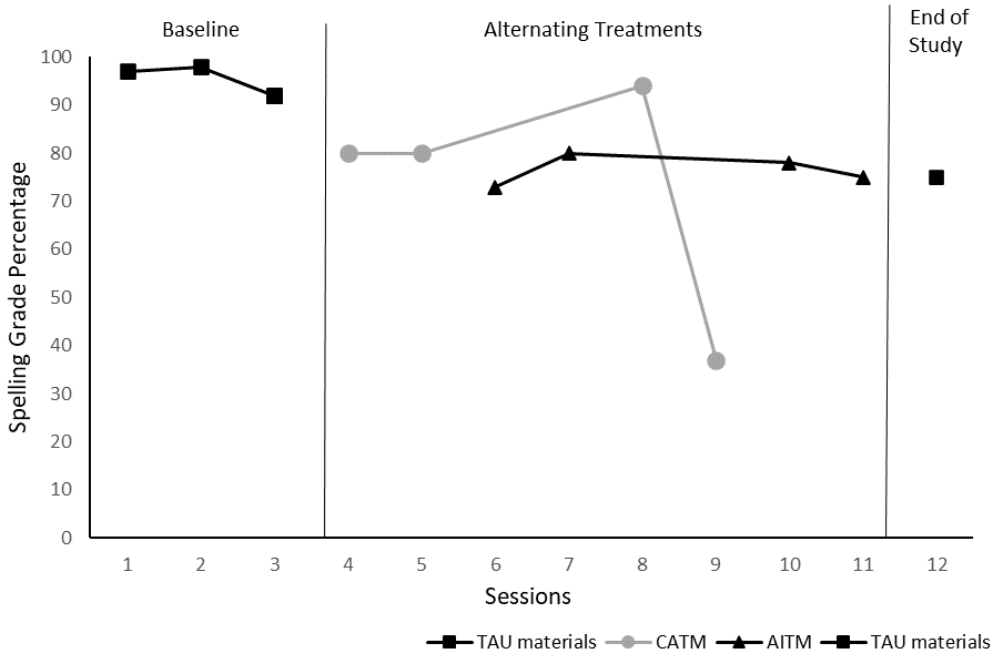
Does the use of academically integrated materials during speech therapy for students with speech sound disorders improve the educational impact of services, namely spelling performance, more than commercially available speech therapy products? Figures 1 through 5 display average grade percentages for classroom spelling tasks at baseline during TAU conditions (progress monitoring), during the intervention phase when CATM (iPad app) and AITM (spelling lists) were compared, and at the end of the study for a final data probe when neither material type was used during TAU conditions (intervention). Figures 6 through 10 represent the teachers' ratings of improved spelling performance in the classroom for each participant.

Quantitative Results

Participant 1

Figure 1

Participant 1 Classroom Spelling Grades With Alternating Therapy Materials



Visual Analysis. Upon visual inspection of the data in Figure 1, spelling performance decreased from baseline with the introduction of both CATM and AITM into therapy. During baseline, his mean classroom spelling grade was 96.67% (range 92-97%). For the 4 weeks of speech intervention using CATM, his mean classroom spelling grade was 72.75% (range 37-94%). For the 4 weeks of speech intervention using AITM, his mean classroom spelling grade was 76.5% (range 73-80%). At the end of the study, the final data probe showed a decrease in his classroom spelling grade from baseline and during use of both material types with his grade at 75%.

Calculation of d-Statistic for Spelling. When the two material types were compared, the treatment mean for spelling grades was higher during the AITM phase when compared to the use of CATM. The d-statistic that measured the magnitude of that difference between the two material types for Participant 1 was .24. While the effect size was small, it does indicate spelling grades were slightly higher when AITM were used during intervention than when traditional CATM were used.

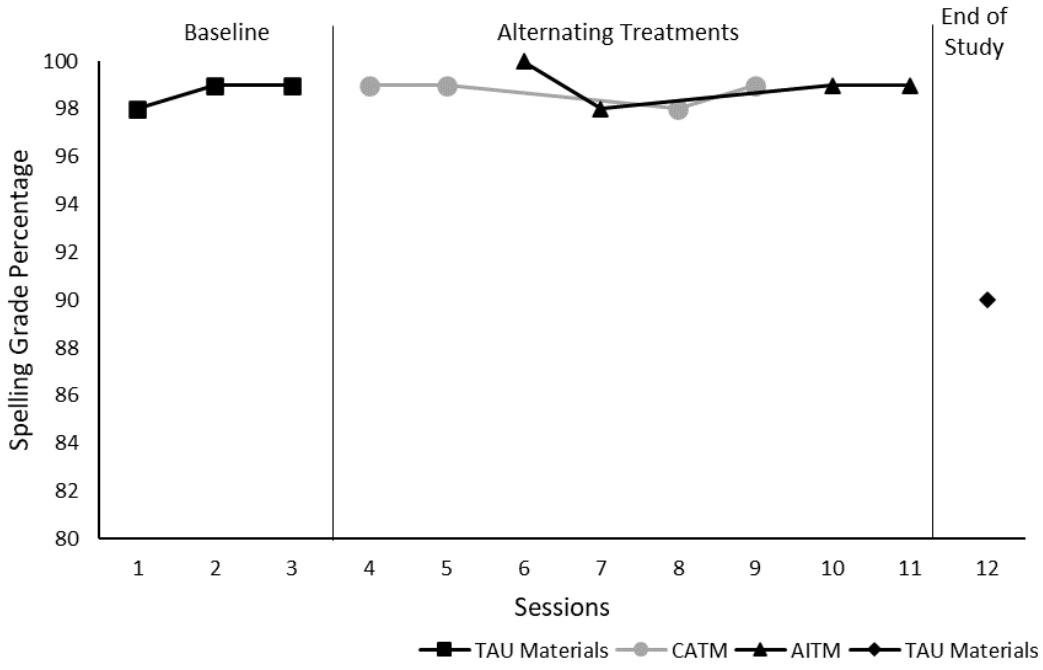
Percentage of Nonoverlapping Data. PND results for Participant 1 for spelling performance using AITM was 0%, indicating it was ineffective based on the guidelines from Scruggs and Mastopieri (1998). PND results for Participant 1 for spelling performance using CATM was 0%. While PND was not expected to support a treatment effect for CATM, it was calculated as a comparison measure to further examine differences in performance between the alternating treatments. Of note, Participant 1 was absent for 12 days during the study and even though all grades were eventually added, many of his assignments were completed at home and his spelling tests were administered much later than the rest of the class.

KTEA:3 Confidence Intervals. The pre-test standard score on the spelling subtest of the KTEA:3 for Participant 1 was 82. The standard score on the posttest was 84. At 95% confidence level, the confidence intervals overlapped indicating that the change in the spelling standard scores was not clinically significant.

Participant 2

Figure 2

Participant 2 Classroom Spelling Grades With Alternating Therapy Materials



Visual Analysis. Upon visual inspection of the data in Figure 2, it was noted that during baseline, his mean classroom spelling grade was 98.67% (range 98-99%). For the 4 weeks of speech intervention using CATM, his mean classroom spelling grade was 98.75% (range 98-99%). For the 4 weeks of speech intervention using AITM, his mean classroom spelling grade was 99% (range 98-100%). Even as a high performing student from baseline, Participant 2 showed marginal gains in spelling grades with introduction of AITM but then returned to baseline by the end of the intervention phase. He maintained his scores at baseline with the introduction of CATM, followed by a slight decrease in his spelling grade before returning to baseline by the end of the intervention phase. At the end of the study, the final data probe data

point showed a slight decrease in performance in spelling from baseline and during use of both material types with his classroom spelling grade at 75%.

Calculation of d-Statistic for Spelling. When the two material types were compared, AITM had the higher treatment mean for spelling grades when compared to CATM. The d-statistic that measured the magnitude of that difference between the two material types for Participant 2 was .43. While the effect size was small, it does indicate spelling grades were higher when AITM were used during intervention than when traditional CATM were used.

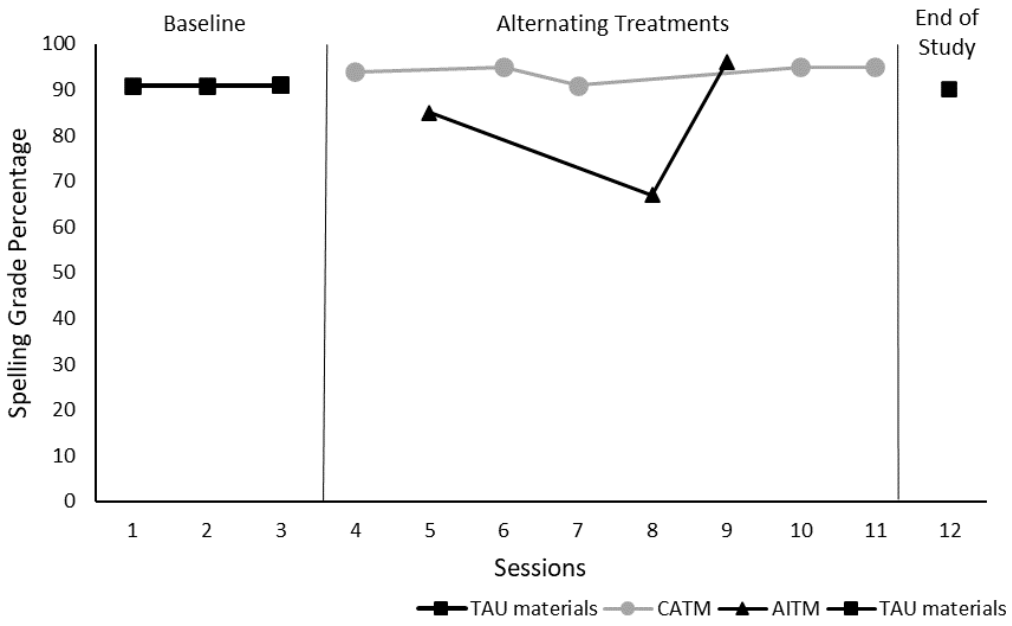
Percentage of Nonoverlapping Data for Spelling. PND results for Participant 2 for spelling performance using AITM was 25%, indicating it was ineffective based on the guidelines from Scruggs and Mastopieri (1998). PND results for Participant 2 for spelling performance using CATM was 0%. Again, since he was already a high performing student in spelling, the baseline performance was high (near 100%) with this performance maintained throughout the study regardless of the material type.

KTEA:3 Confidence Intervals. The pre-test standard score on the spelling subtest of the KTEA:3 for Participant 2 was 111. The standard score on the posttest was 121. At 95% confidence level, the confidence intervals just barely overlapped (106-116 and 116-126), indicating possibly clinically significant changes in the standard scores on the spelling subtest of the KTEA:3 during the study.

Participant 3

Figure 3

Participant 3 Classroom Spelling Grades With Alternating Therapy Materials



Visual Analysis. Upon visual inspection of the data in Figure 3, Participant 3 showed marginal gains in her classroom spelling grade from baseline upon introduction of CATM, but her spelling grade decreased from baseline upon introduction of the AITM. During baseline, all three baseline grades were 91%. For 5 weeks of speech intervention using CATM, her mean classroom spelling grade was 94% (range 91-95%). For 3 weeks of speech intervention using AITM, her mean classroom spelling grade was 82.67% (range 67-96%). At the end of the study, the final data probe showed a slight decrease in performance in spelling from baseline and during use of CATM. The final data point showed a slight improvement from her performance during use of AITM with her classroom spelling grade at 90%. Of note, due to some absences and

scheduling conflicts, Participant 3 had five data points with CATM used during intervention and three with AITM.

Calculation of d-Statistic for Spelling. When the two material types were compared, CATM had the higher treatment mean for spelling grades when compared to AITM. The d-statistic that measured the magnitude of that difference between the two material types for Participant 3 was 1.31 indicating a large difference in spelling grades when comparing the use of AITM to CATM during speech therapy.

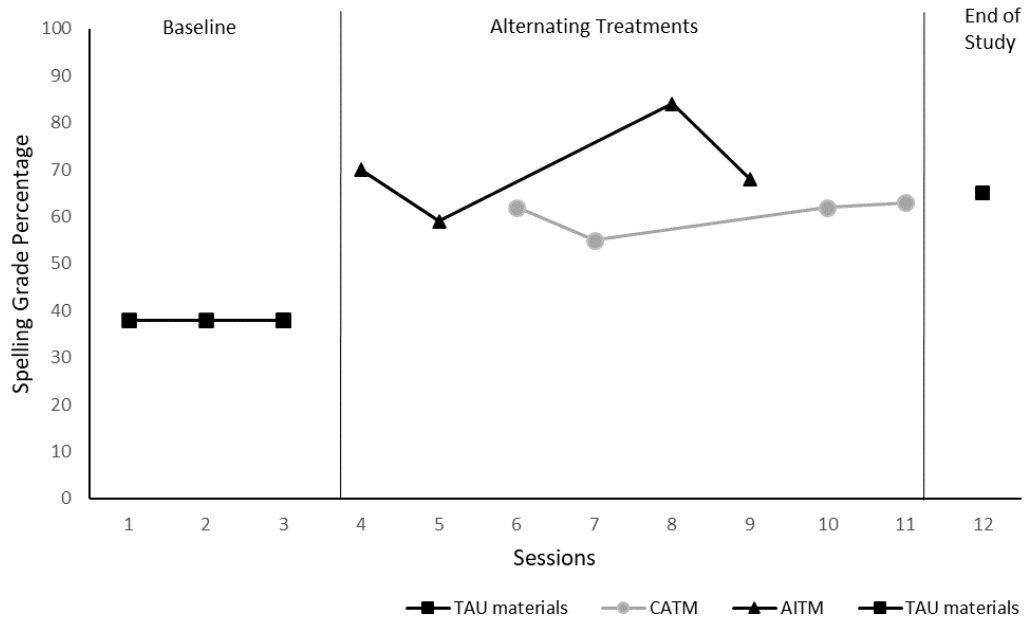
Percentage of Nonoverlapping Data for Spelling. PND results for Participant 3 for spelling performance using AITM was 33%, indicating it was ineffective based on the guidelines from Scruggs and Mastopieri (1998). PND results for Participant 3 for spelling performance using CATM was 80%.

KTEA:3 Confidence Intervals. The pre-test standard score on the spelling subtest of the KTEA:3 for Participant 3 was 84. The standard score on the posttest was 94. At 95% confidence level, the confidence intervals just barely overlapped (78-89 and 89-99), indicating potentially clinically significant change in the standard scores on the spelling subtest of the KTEA:3 during the study.

Participant 4

Figure 4

Participant 4 Classroom Spelling Grades With Alternating Therapy Materials



Visual Analysis. Upon visual inspection of the data in Figure 4, Participant 4 showed gains in his classroom spelling grade from baseline upon introduction of both AITM and CATM. During baseline, his classroom spelling grade was steady at 38% for all three data points. For the speech intervention using CATM, his mean classroom spelling grade was 60.5% (range 55-62%). For the 4 weeks of speech intervention using AITM, his mean classroom spelling grade was 70.25% (range 59-84%). His overall classroom spelling grade was greater when AITM were used during speech therapy. At the end of the study, the final data probe showed an increase in spelling performance from baseline and a marginal increase in performance from the intervention

phase using CATM. The final data point showed an overall decrease in spelling performance from the intervention phase using AITM with a spelling grade at 65%.

Calculation of d-Statistic for Spelling. When the two material types were compared, AITM had the higher treatment mean for spelling grades when compared to CATM. The d-statistic that measured the magnitude of that difference between the two material types for Participant 4 was 1.45. This was a large effect size that indicated that spelling grades were higher when AITM were used during intervention than when traditional CATM were used.

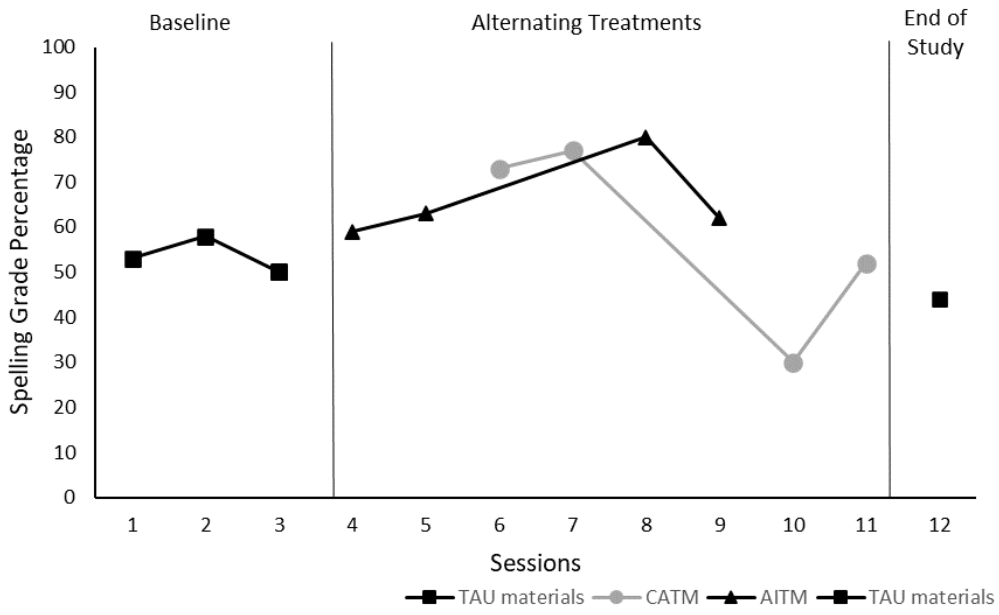
Percentage of Nonoverlapping Data for Spelling. PND results for Participant 4 for spelling performance using AITM was 100%, indicating it was highly effective based on the guidelines from Scruggs and Mastopieri (1998). PND results for Participant 4 for spelling performance using CATM was 100%.

KTEA:3 Confidence Intervals. The pre-test standard score on the spelling subtest of the KTEA:3 for Participant 4 was 70. The standard score on the posttest was 71. At 95% confidence level, the confidence intervals overlapped indicating that the change in spelling standard scores was not clinically significant.

Participant 5

Figure 5

Participant 5 Classroom Spelling Grades With Alternating Therapy Materials



Visual Analysis. Upon visual inspection of the data in, Participant 5 showed initial gains in spelling performance upon the introduction of CATM with a large decline in performance before returning to baseline at the end of the intervention phase of the study. He showed steady gains in spelling performance with the introduction of AITM and throughout the intervention phase with scores above baseline at the end of the intervention phase of the study. During baseline, all grades were 83%. For the speech intervention using CATM, his mean classroom spelling grade was 58% (range 30-77%). For the speech intervention using AITM, his mean classroom spelling grade was 66% (range 59-80%). At the end of the study, the final data probe showed a slight decrease in spelling performance from baseline and a marginal increase in

performance from the intervention phase using CATM. The final data point showed an overall decrease in spelling performance from the intervention phase when using AITM with a spelling grade at 44%.

Calculation of d-Statistic for Spelling. When the two material types were compared, AITM had the higher treatment mean for spelling grades when compared to CATM. The d-statistic that measured the magnitude of that difference between the two material types for Participant 5 was .55 indicating a medium effect size when comparing the use of AITM to CATM during speech therapy.

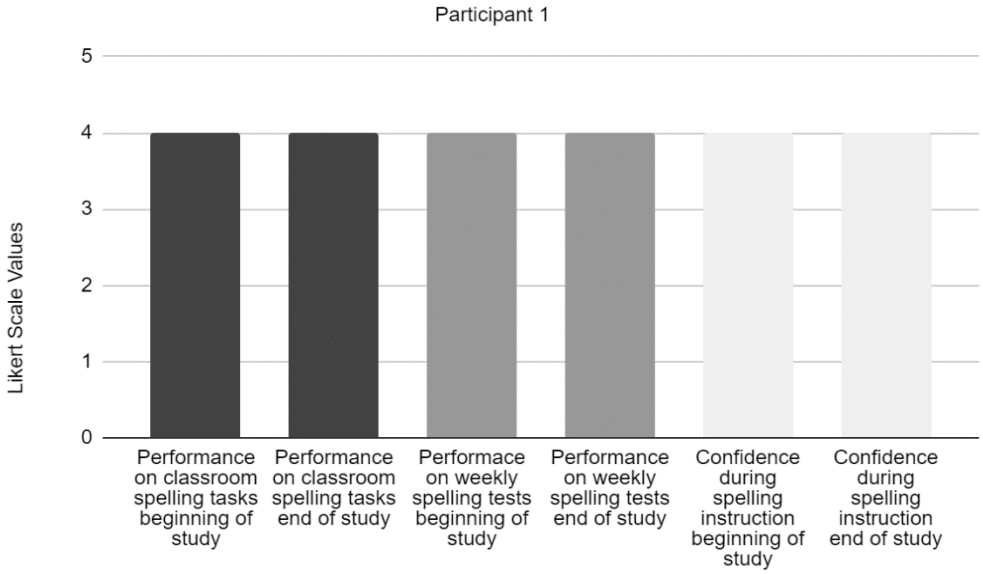
Percentage of Nonoverlapping Data for Spelling. PND results for Participant 5 for spelling performance using AITM was 100%, indicating it was highly effective based on the guidelines from Scruggs and Mastopieri (1998). PND results for Participant 5 for spelling performance using CATM was 50%.

KTEA:3 Confidence Intervals. The pre-test standard score on the spelling subtest of the KTEA:3 for Participant 5 was 93. The standard score on the posttest was also 93. Since there was no change in the spelling standard scores from pretest to post-test, the confidence intervals were the same.

Qualitative Results

Figure 6

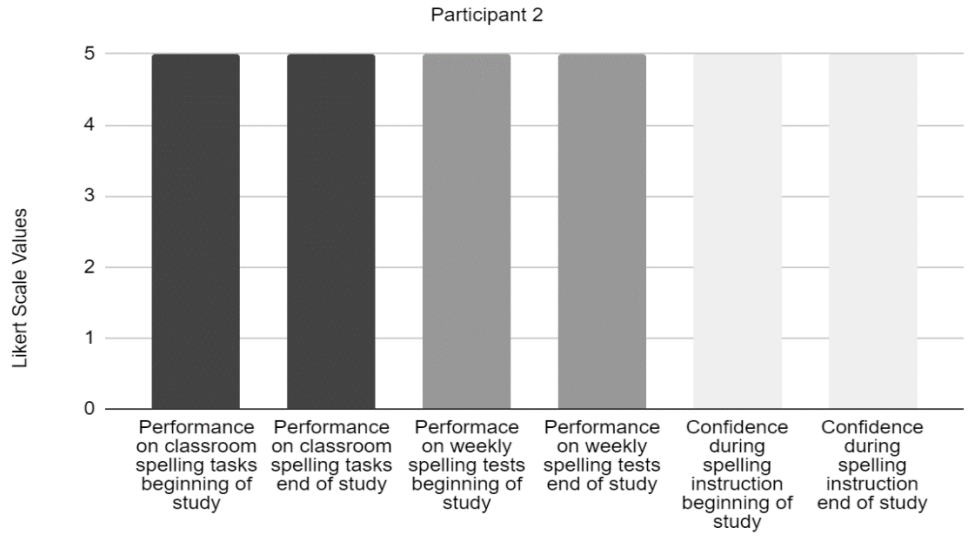
Teacher's Rating of Improved Spelling Performance in the Classroom Participant 1



Note. Likert Scale Values: 1-great difficulty; 2-difficulty; 3-mildly delayed; 4-capable; 5- very capable

Figure 7

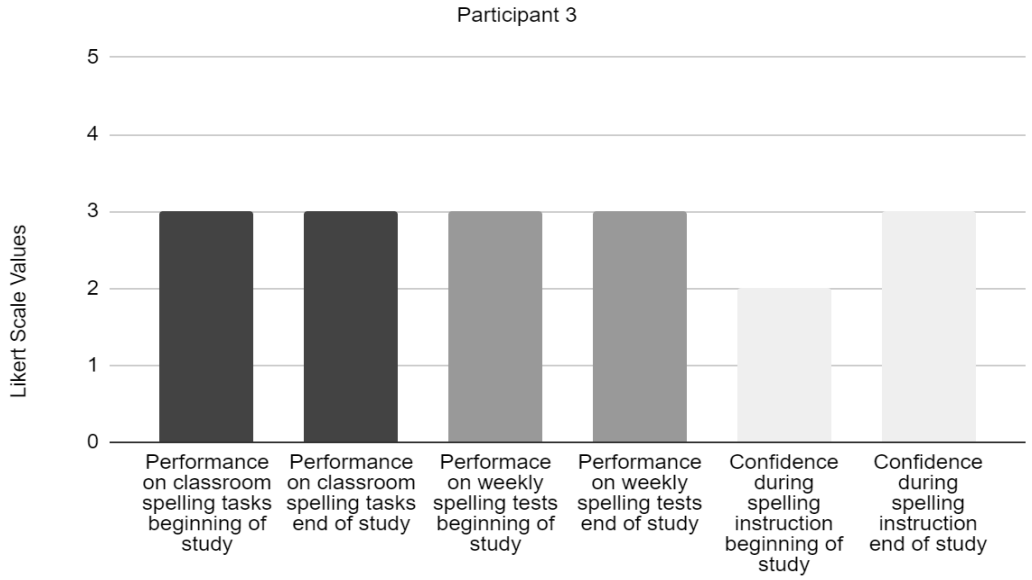
Teacher's Rating of Improved Spelling Performance in the Classroom Participant 2



Note. Likert Scale Values: 1-great difficulty; 2-difficulty; 3-mildly delayed; 4-capable; 5- very capable

Figure 8

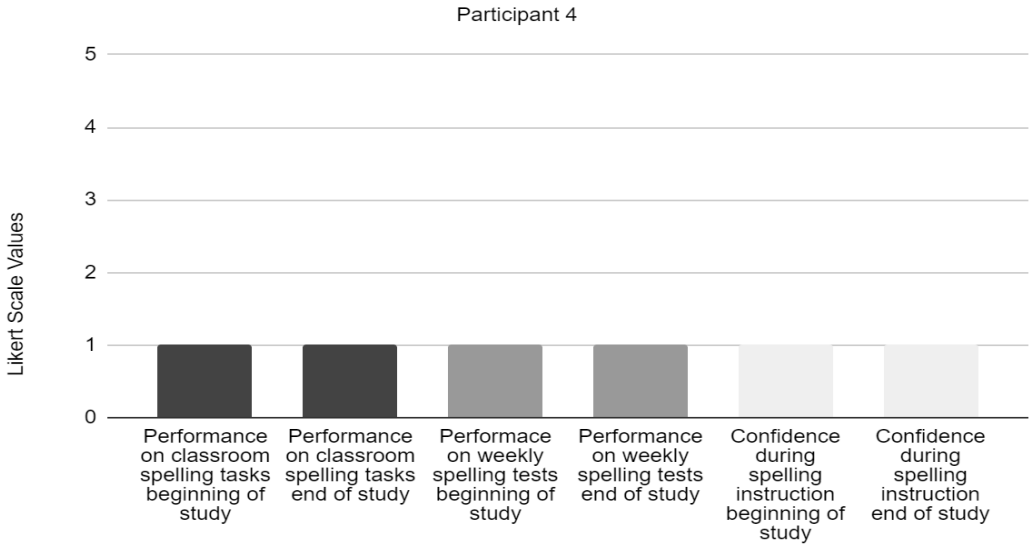
Teacher's Rating of Improved Spelling Performance in the Classroom Participant 3



Note. Likert Scale Values: 1-great difficulty; 2-difficulty; 3-mildly delayed; 4-capable; 5- very capable

Figure 9

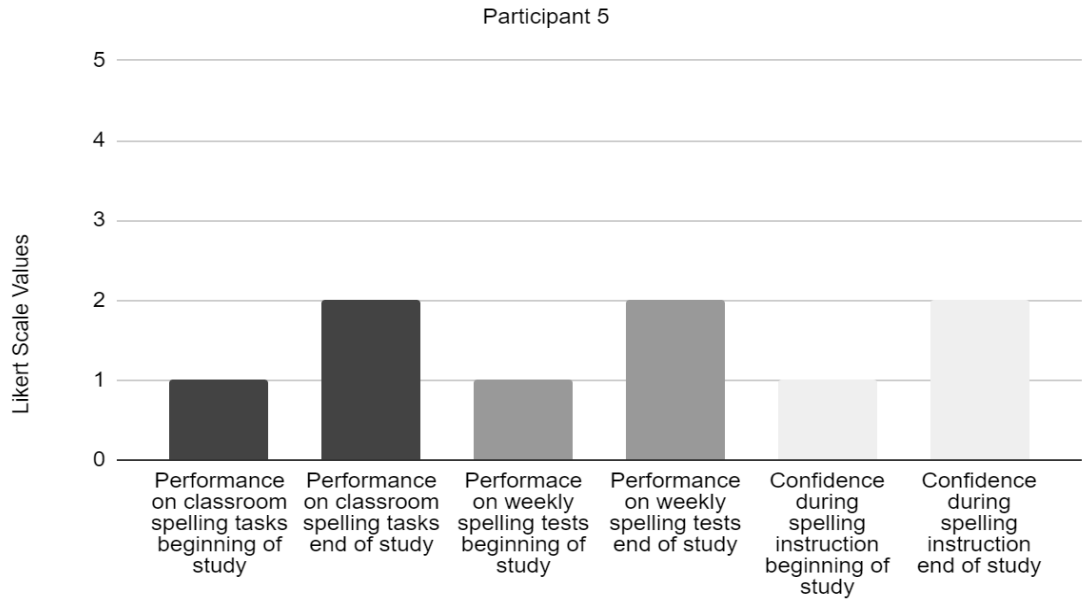
Teacher's Rating of Improved Spelling Performance in the Classroom Participant 4



Note. Likert Scale Values: 1-great difficulty; 2-difficulty; 3-mildly delayed; 4-capable; 5- very capable

Figure 10

Teacher's Rating of Improved Spelling Performance in the Classroom Participant 5



Note. Likert Scale Values: 1-great difficulty; 2-difficulty; 3-mildly delayed; 4-capable; 5- very capable

Teacher Questionnaire Summary

The Likert scales results indicated that teachers saw observable improvement in performance on classroom spelling activities or weekly spelling tests from the beginning to the end of the study for one out of five of the participants with gains noted in overall confidence during spelling instruction for two out of five of the participants.

Participant Questionnaire Summary

A questionnaire that asked age-appropriate yes/no questions regarding materials preference and the impact of intervention materials on classroom performance was administered to the first-grade students at the end of each two-week phase of alternating materials. Each participant answered "yes" 100% of the time to the questions that asked whether they knew their

spelling words that week, if they felt ready for the spelling test, and whether time in speech therapy helped them in the classroom. The results indicated that participants felt that both AITM and CATM allowed them to really know their spelling words that week and to feel ready for the spelling test.

Research Question Two

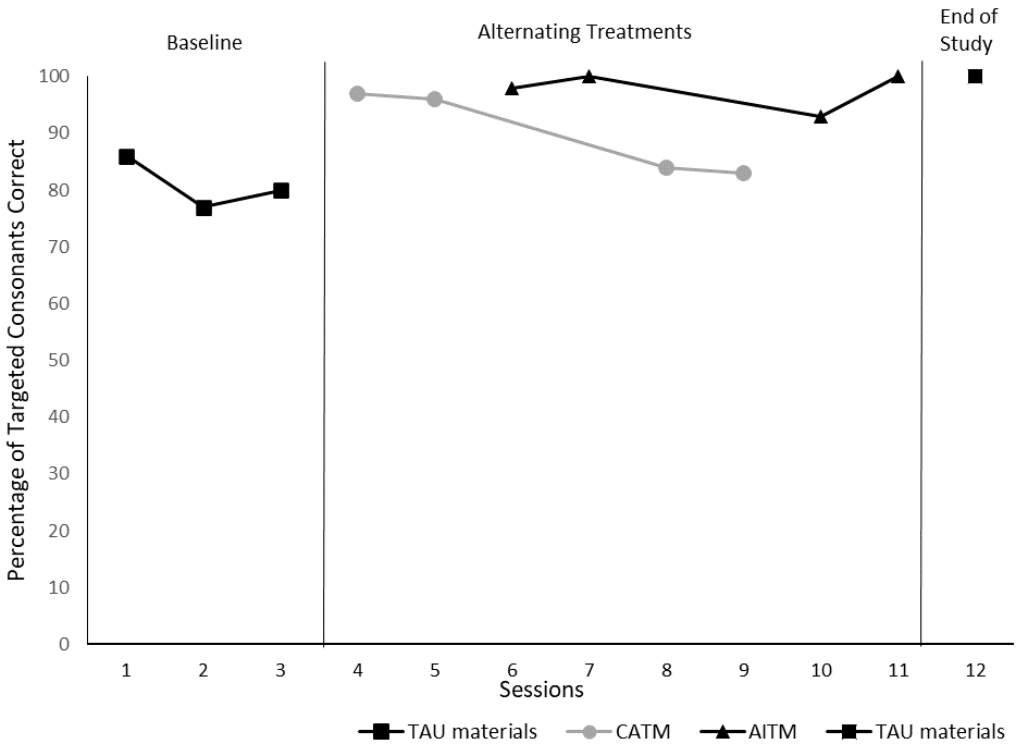
Are there comparative differences noted in speech sound production performance when AITM vs. CATM are utilized in therapy? Figures 11 through 15 represent the PTCC at baseline during TAU, during the intervention phase when CATM (digital flashcards on an iPad app) and AITM (spelling lists) were compared, and at the end of the study when neither material type was used during TAU. Figures 16 through 20 report the teachers' perspectives on whether the students' speech sound production continued to improve during the study regardless of the types of materials used in speech therapy.

Quantitative Results

Participant 1

Figure 11

Participant 1 Percentage of Targeted Consonants Correct With Alternating Materials



Visual Analysis. Upon visual inspection of the data in Figure 11, Participant 1 demonstrated an increase in speech sound production performance upon introduction of and throughout the intervention phase for both AITM and CATM. During baseline, his mean PTCC was 81% (range 77-86%). For the 4 weeks of speech intervention using CATM, his mean PTCC was 90% (range 83-97%). For the 4 weeks of speech intervention using AITM, his mean PTCC was 97.75% (range 93-100%). At the end of the study, the final data probe showed an increase in

PTCC from baseline and during the intervention phases for both CATM and AITM with the final data point at 100% for speech sound production.

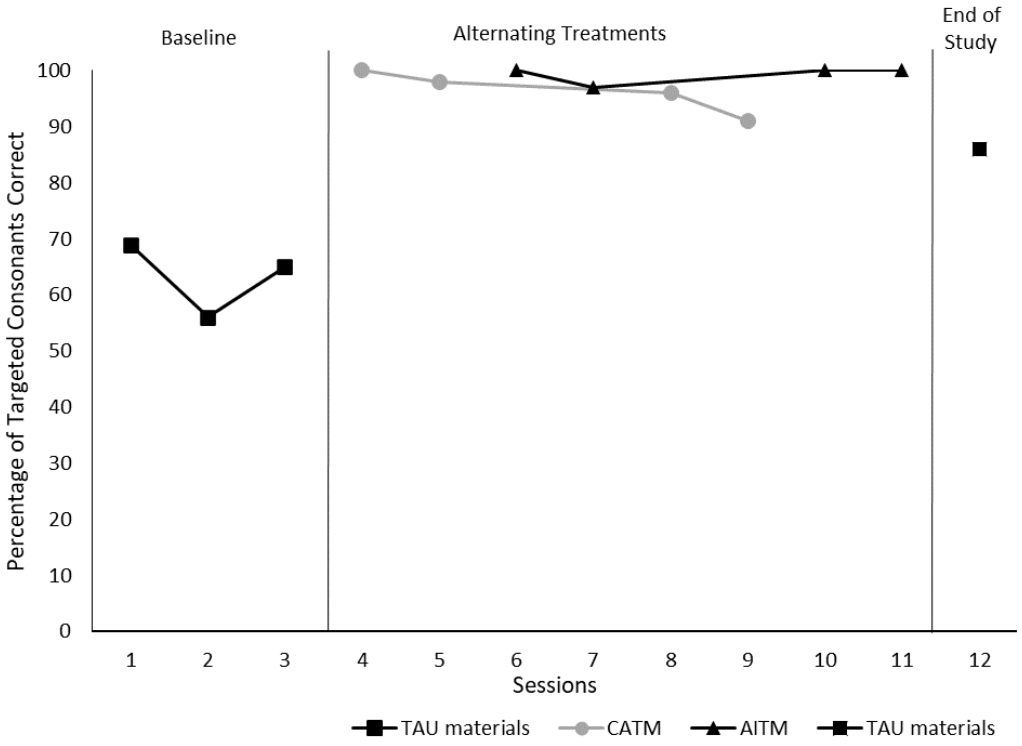
Calculation of d-Statistic for Speech Sound Production. When the two material types were compared, AITM had the higher treatment mean for speech sound production when compared to CATM. The d-statistic that measured the magnitude of that difference between the two material types for Participant 1 was 1.54 indicating a large effect size when comparing the use of AITM to CATM on speech sound production performance. While it was hypothesized that the choice of material type would not impact speech sound production performance with effects sizes close to 0, the effect size of 1.54 indicates that there were higher PTCC scores in speech sound production when AITM were used during intervention than when traditional CATM were used.

Percentage of Nonoverlapping Data for Speech Sound Production. PND results for Participant 1 for speech sound production using AITM was 100%, indicating they were highly effective. PND results for Participant 1 for speech sound production using CATM was 50%. While PND was not expected to support a treatment effect for CATM, it was calculated as a comparison measure to further examine differences in performance between the alternating treatments. Although it was hypothesized that there would be no difference in effectiveness between material types when calculating PND for speech sound production, there was a significant difference for Participant 1.

Participant 2

Figure 12

Participant 2 Percentage of Targeted Consonants Correct With Alternating Materials



Visual Analysis. Upon visual inspection of the data, Participant 2 demonstrated an increase in speech sound production performance upon introduction of and throughout the intervention phase for both AITM and CATM. During baseline, his mean PTCC was 63.33% (range 56-69%). For the 4 weeks of speech intervention using CATM, his mean PTCC was 96.25% (range 91-100%). For the 4 weeks of speech intervention using AITM, his mean PTCC was 99.25% (range 97-100%). At the end of the study, the final data showed an increase in PTCC from baseline and a decrease in performance from the intervention phases for both CATM and AITM with the final data point at 86% for speech sound production.

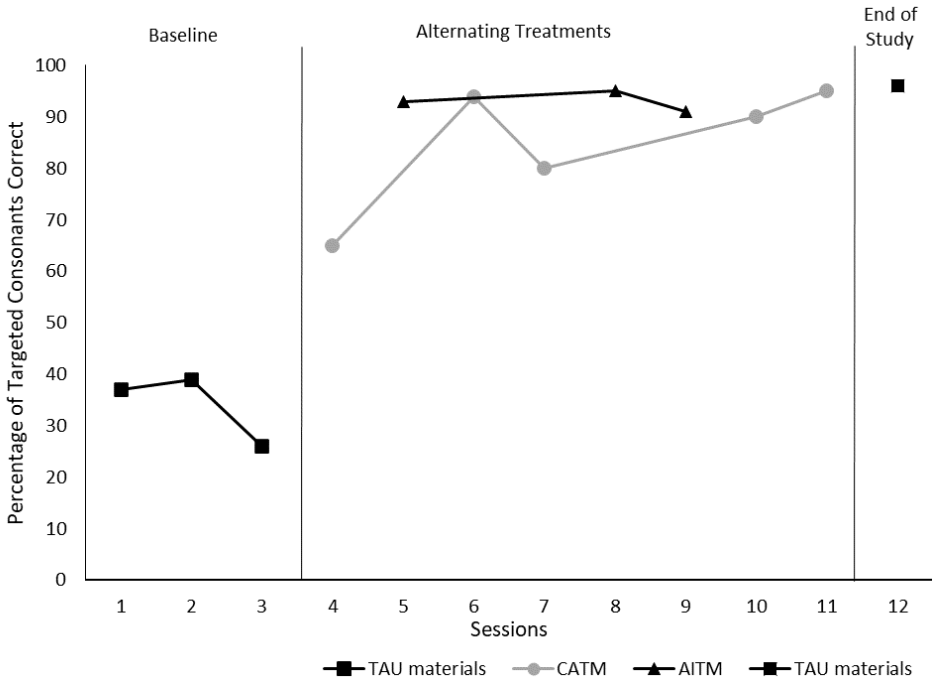
Calculation of d-Statistic for Speech Sound Production. When the two material types were compared, AITM had the higher treatment mean for speech sound production when compared to CATM. The d-statistic that measured the magnitude of that difference between the two material types for Participant 2 was 1.18 indicating a large effect size when comparing the use of AITM to CATM on speech sound production performance. While it was hypothesized that the choice of material type would not impact speech sound production performance with effects sizes close to 0, the effect size of 1.18 indicates that there were higher PTCC scores in speech sound production when AITM were used during intervention than when traditional CATM were used.

Percentage of Non-Overlapping Data for Speech Sound Production. PND results for Participant 2 for speech sound production using AITM was 100%, indicating it was highly effective. PND results for Participant 2 for speech sound production using CATM was also 100%. While PND was not expected to support a treatment effect for CATM, it was calculated as a comparison measure to further examine differences in performance between the alternating treatments.. As hypothesized, when considering PND, there was no difference in effectiveness of AITM or CATM in improving speech sound production for Participant 2.

Participant 3

Figure 13

Participant 3 Percentage of Targeted Consonants Correct With Alternating Materials



Visual Analysis. Upon visual inspection of the data, Participant 3 demonstrated an increase in speech sound production performance upon introduction of and throughout the intervention phase for both AITM and CATM. During baseline, her mean PTCC percentage was 34% (range 26-39%). For the 4 weeks of speech intervention using CATM, her mean PTCC was 84.8% (range 65-94%). For the 4 weeks of speech intervention using AITM, her mean PTCC was 93% (range 91-95%). At the end of the study, the final data probe showed an increase in PTCC from baseline as well as an increase from performance during the intervention phases for both CATM and AITM at 96%.

Calculation of d-Statistic for Speech Sound Production. When the two material types were compared, AITM had the higher treatment mean for speech sound production when

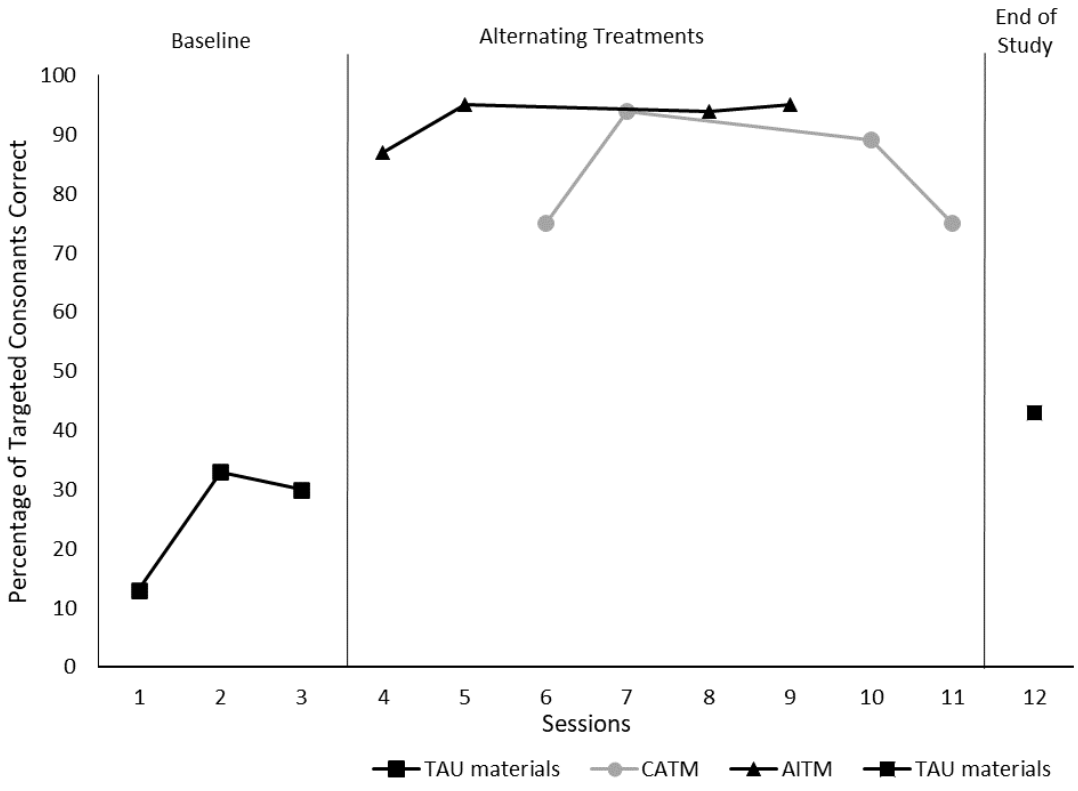
compared to CATM. The d-statistic that measured the magnitude of that difference between the two material types for Participant 3 was 1.02 indicating a large effect size when comparing the use of AITM to CATM on speech sound production performance. While it was hypothesized that the choice of material type would not impact speech sound production performance with effects sizes close to 0, the effect size of 1.02 indicates that there were higher PTCC scores in speech sound production when AITM were used during intervention than when traditional CATM were used.

Percentage of Nonoverlapping Data for Speech Sound Production. PND results for Participant 3 for speech sound production using AITM was 100%, indicating it was highly effective. PND results for Participant 3 for speech sound production using CATM was also 100%. While PND was not expected to support a treatment effect for CATM, it was calculated as a comparison measure to further examine differences in performance between the alternating treatments. As hypothesized, when considering PND, there was no difference in effectiveness of AITM or CATM in improving speech sound production for Participant 3.

Participant 4

Figure 14

Participant 4 Percentage of Targeted Consonants Correct With Alternating Materials



Visual Analysis. Upon visual inspection of the data, Participant 4 demonstrated an increase in speech sound production performance upon introduction of and throughout the intervention phase for both AITM and CATM. During baseline, his mean PTCC was 25.33% (range 13-33%). For the 4 weeks of speech intervention using CATM, his mean PTCC was 83.25% (range 75-94%). For the 4 weeks of speech intervention using AITM, his mean PTCC was 92.75% (range 87-95%). At the end of the study, the final data probe showed an increase in PTCC from baseline and a decrease in performance from the intervention phases for both CATM

and AITM with a speech sound production percentage at 43%. Same as baseline for speech sound production, no intervention was provided during the end of study probe.

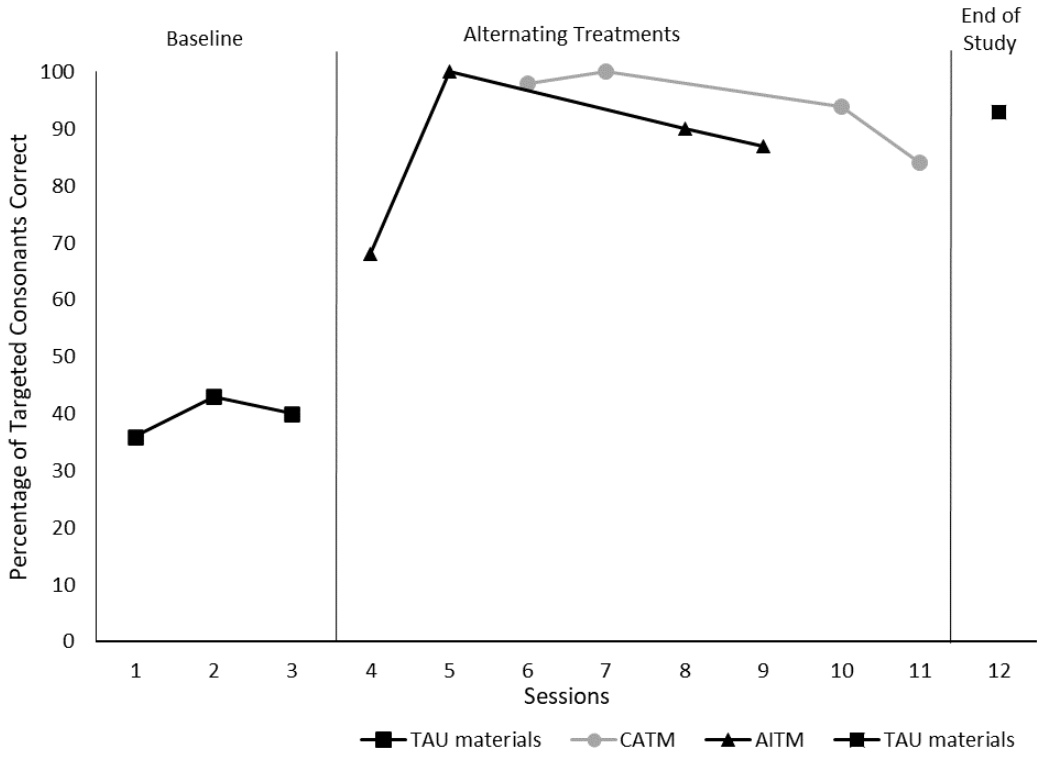
Calculation of d-Statistic for Speech Sound Production. When the two material types were compared, AITM had the higher treatment mean for speech sound production when compared to CATM. The d-statistic that measured the magnitude of that difference between the two material types for Participant 4 was 1.48 indicating a large effect size when comparing the use of AITM to CATM on speech sound production performance. While it was hypothesized that the choice of material type would not impact speech sound production performance with effects sizes close to 0, the effect size of 1.48 indicates that there were higher PTCC scores in speech sound production when AITM were used during intervention than when traditional CATM were used.

Percentage of Non-Overlapping Data for Speech Sound Production. PND results for Participant 4 for speech sound production using AITM was 100%, indicating it was highly effective. PND results for Participant 4 for speech sound production using CATM was also 100%. While PND was not expected to support a treatment effect for CATM, it was calculated as a comparison measure to further examine differences in performance between the alternating treatments. As hypothesized, when considering PND, there was no difference in effectiveness of AITM or CATM in improving speech sound production for Participant 4.

Participant 5

Figure 15

Participant 5 Percentage of Targeted Consonants Correct With Alternating Materials



Visual Analysis. Upon visual inspection of the data, Participant 5 demonstrated an increase in speech sound production performance upon introduction of and throughout the intervention phase for both AITM and CATM. During baseline, his mean PTCC was 39.67% (range 36-43%). For the 4 weeks of speech intervention using CATM, his mean PTCC was 94% (range 84-100%). For the 4 weeks of speech intervention using AITM, his mean PTCC was 88.25% (range 68-100%). At the end of the study, the final data probe showed an increase in PTCC from baseline and an increase in performance from the intervention phases for AITM and a slight decrease from CATM at 93%.

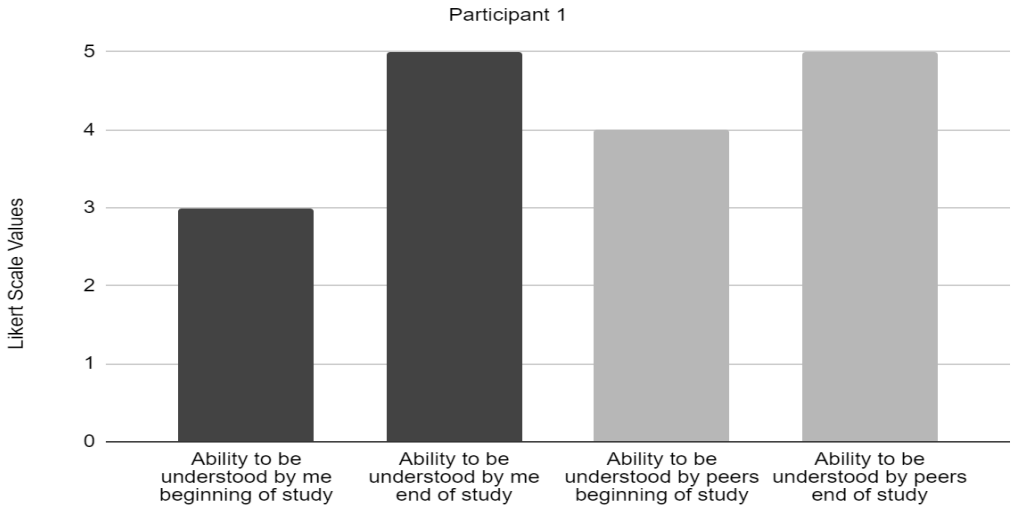
Calculation of d-Statistic for Speech Sound Production. When the two material types were compared, CATM had the higher treatment mean for speech sound production when compared to AITM. The d-statistic that measured the magnitude of that difference between the two material types for Participant 5 was .84 indicating a large effect size when comparing the use of AITM to CATM on speech sound production performance. While it was hypothesized that the choice of material type would not impact speech sound production performance with effects sizes close to 0, the effect size of -84 indicates that there were higher PTCC scores in speech sound production when CATM were used during intervention than when traditional AITM were used.

Percentage of Nonoverlapping Data for Speech Sound Production. PND results for Participant 5 for speech sound production using AITM was 100%, indicating it was highly effective. PND results for Participant 5 for speech sound production using CATM was also 100%. While PND was not expected to support a treatment effect for CATM, it was calculated as a comparison measure to further examine differences in performance between the alternating treatments. As hypothesized, when considering PND, there was no difference in effectiveness of AITM or CATM in improving speech sound production for Participant 5.

Qualitative Results

Figure 16

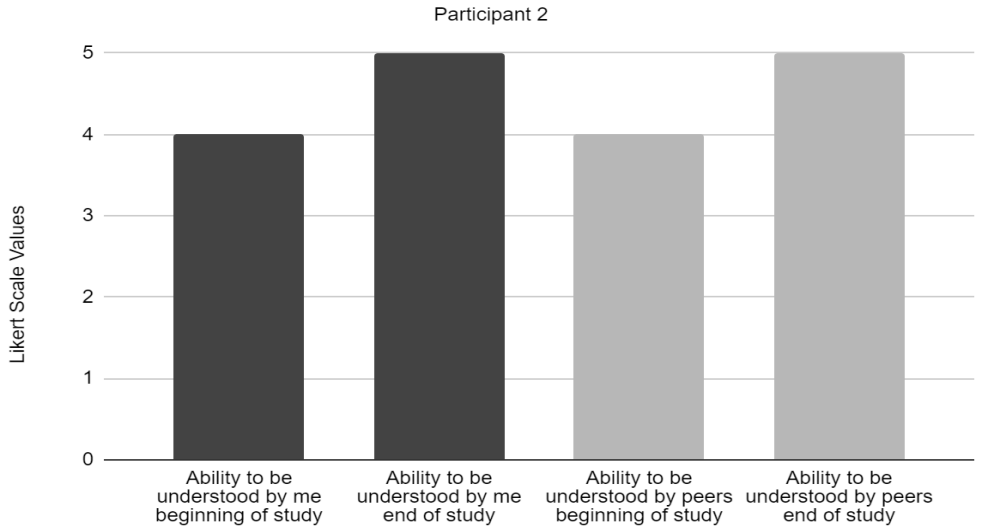
Teacher's Rating of Improved Speech Sound Production Participant 1



Note. Likert Scale Values: 1-great difficulty; 2-difficulty; 3-mildly delayed; 4-capable; 5- very capable

Figure 17

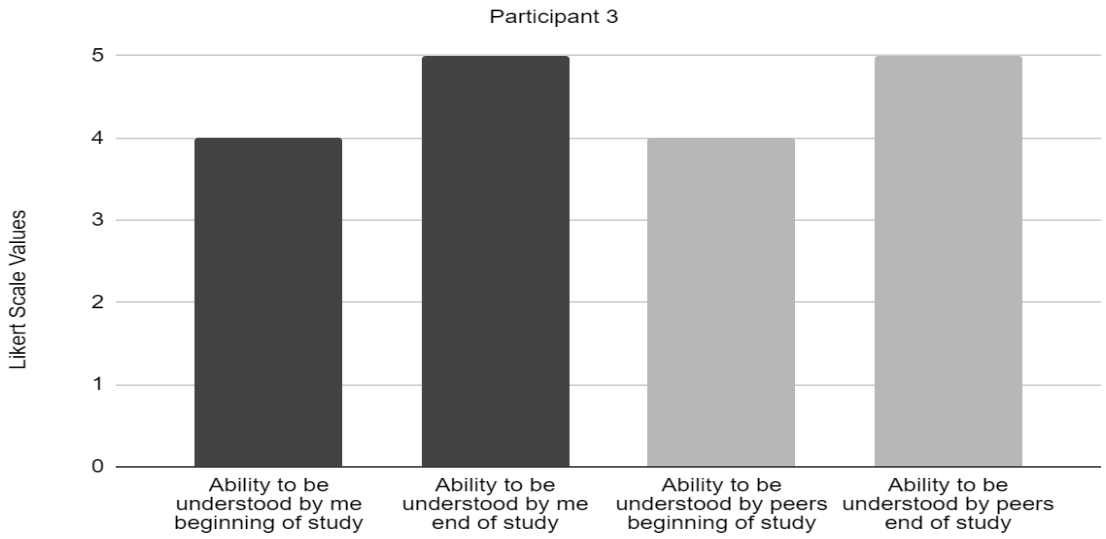
Teacher's Rating of Improved Speech Sound Production Participant 2



Note. Likert Scale Values: 1-great difficulty; 2-difficulty; 3-mildly delayed; 4-capable; 5- very capable

Figure 18

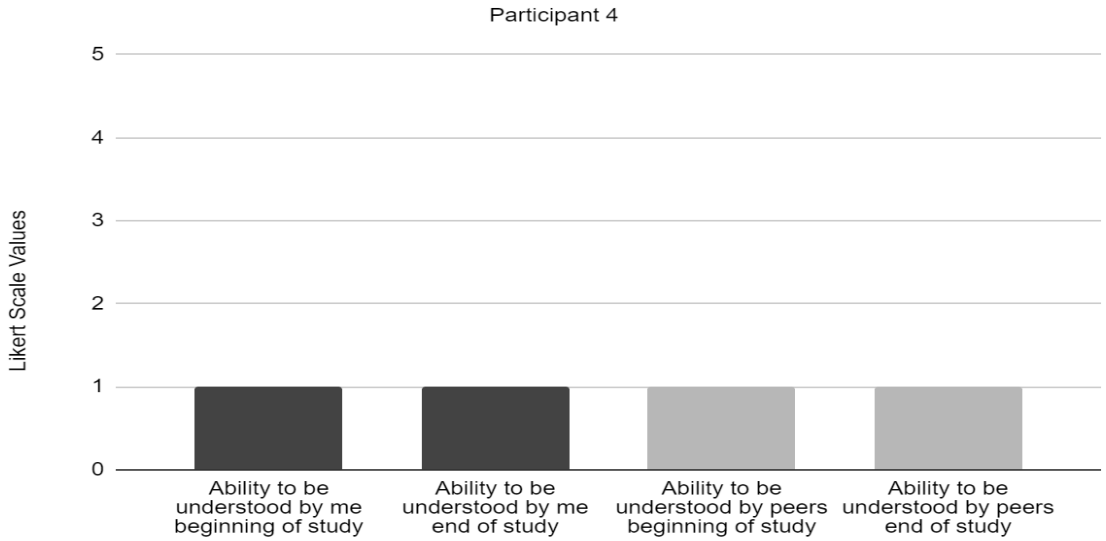
Teacher's Rating of Improved Speech Sound Production Participant 3



Note. Likert Scale Values: 1-great difficulty; 2-difficulty; 3-mildly delayed; 4-capable; 5- very capable

Figure 19

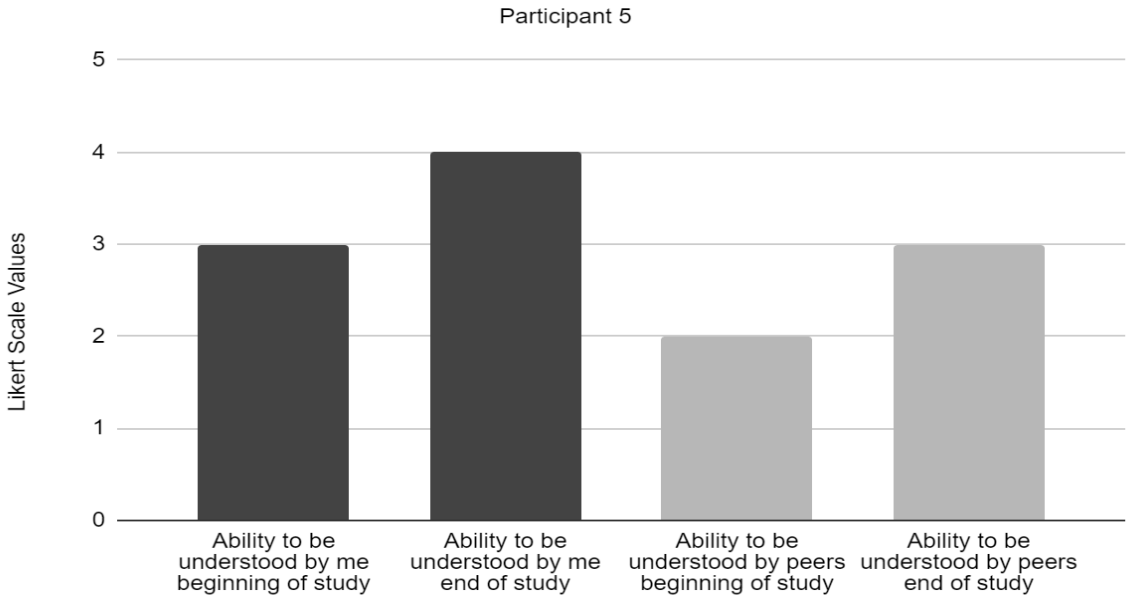
Teacher's Rating of Improved Speech Sound Production Participant 4



Note. Likert Scale Values: 1-great difficulty; 2-difficulty; 3-mildly delayed; 4-capable; 5- very capable

Figure 20

Teacher's Rating of Improved Speech Sound Production Participant 5



Note. Likert Scale Values: 1-great difficulty; 2-difficulty; 3-mildly delayed; 4-capable; 5- very capable.

Teacher Questionnaire Summary

The results indicated that teachers noted improvements in speech intelligibility during all phases of the study in all but one participant (Participant 4) who was re-evaluated for other possible special education eligibility areas at the end of the study (Intellectual Disability, Specific Learning Disability, and Language Impairment). Teachers' responses on the Likert scales also indicated that all but one participant (Participant 4) improved in their abilities to be understood by peers. In general, teachers perceived that the type of materials used during therapy did not negatively impact progress in speech sound production. In their open-ended responses on the overall impact of SSDs on classroom performance at the beginning and end of the study, as shown in Table 2, all teachers indicated small improvements socially and academically in the

classroom with the exception of one participant who had a severe articulation disorder and who had historically made very slow gains in speech therapy and in the classroom.

Table 2

Responses Regarding the Impact of Speech Sound Disorders in the Classroom

Teacher	Beginning of Study	End of Study
1	Student's speech sounds have not impacted performance in the classroom so far in first grade.	Not at all.
1	Student's speech has not impacted classroom performance too much. At times student has problems with /s/ sound and replaces it with a /z/. He has a harder time reading digraphs and blends.	Student's speech sound disorder does not impact performance in the classroom at all. Student does still have a little trouble pronouncing /ch/ and /sh/.
2	Student is hesitant to speak and participate in academic discussions and lessons.	At times, student still has some difficulty encoding. Student is speaking up more in class
2	Decoding and encoding blends are skills student has difficulty with and this impacts reading and spelling.	Peers sometimes have difficulty understanding the student and, at times, the inability to produce some sounds still affects encoding skills, but not as often.
2	Student sometimes does not get his needs met when I cannot understand him. Peers very often do not interact with him due to his unintelligible speech.	Student is not fully understood by peers which continues to impact his relationships. He is not yet able to encode or properly decode many words.

Participant Questionnaire Summary

A questionnaire that asked age-appropriate yes/no questions regarding materials preference and speech production outcomes was administered to the first-grade students at the end of each 2-week phase of alternating materials. Each participant answered "yes" to "I got a lot of practice on my sounds this week" and "I like the way we practiced sounds this week." They also indicated that, regardless of material type used in therapy, speech time helped them in the classroom as well. The consistent "yes" responses could indicate that the materials used in therapy did not impact the participants' perceptions of the effectiveness of speech sound production practice.

CHAPTER V

DISCUSSION

Implications

School-based SLPs are charged with minimizing the negative educational impact of their students' speech and language disorders (Ehren, 2000; Wallach, 2014). However, traditional service delivery models in which students are seen two times per week for 30-minutes in separate speech therapy rooms (Brandel, 2020; Brumbaugh & Smit, 2013) while using traditional speech therapy materials (CATM) may not easily translate to a positive educational impact (Wallach, 2014). Thus, the purpose of this study was to compare the effects of using curriculum-based therapy materials (i.e., spelling lists/AITM) that could theoretically impact educational performance (McNeill et al., 2017; Wallach, 2014) and the more traditional speech therapy materials (i.e., digital, app-based flash cards/CATM) used in schools. The two types of therapy materials were alternately used in treatment with first graders with speech sound disorders in order to examine their effects on spelling grades and speech sound production.

Spelling

When comparing the relative effects of the two therapy materials on spelling grades in the classroom, visual analysis of data from all phases, a PND calculation, analysis using a d-statistic, and a pre- and post-test measure indicated variable results. While results were varied for each participant, the impact of using AITM during speech interventions was detected and noted for each. Given the individual variability, spelling results for each participant are discussed below.

Participant 1

When measuring the magnitude of the difference between the two types of materials, AITM were only slightly favored for Participant 1 based on a higher treatment mean and a small effect size. The PND for spelling scores was 0%, since the baseline scores for spelling were higher than those during treatment and the final data probe. Thus, the sensitivity of the PND measure in discriminating treatment effectiveness for Participant 1 was limited (Parker et al., 2007). On the standardized pre- and post-test spelling measure, he did not show clinically significant improvement on the standardized measure of spelling (see Table 3). Of note, however, was that he maintained progress in spelling during the study even with excessive absences. Theoretically, when considering the potential impact of using AITM on his spelling grades, a decrease in competing resources could have been one influential factor (Lahey & Bloom, 1994). Since he did not need to learn a new therapy game or activity during speech intervention and instead worked with his existing weekly spelling list, he was perhaps able to focus more of his cognitive energy on these tasks (Lahey & Bloom, 1994).

Participant 2

As indicated by his baseline data, Participant 2 demonstrated spelling grades between 98% and 100% during all phases of the study. Even as a high performing student, upon visual inspection of the data, he demonstrated marginal gains in spelling grades with introduction of AITM. The effect size was small when comparing the magnitude of the difference between the two materials, but with a slightly higher AITM treatment mean. PND results for Participant 2 for spelling performance were again not beneficial in determining the magnitude of the impact of materials on spelling performance since the baseline scores and spelling grades were all near 100% throughout the study. While the classroom data were not indicative of a treatment effect,

Participant 2 demonstrated clinically significant improvement on the pre- and post-test standardized spelling assessment (see Table 3). This lends preliminary support to the idea that using AITM during speech intervention could even be beneficial to students who are performing at or above grade level.

Participant 3

Participant 3 achieved higher spelling grades on average when the SLP used CATM. When comparing the magnitude of the difference between the two materials, CATM was favored with a higher treatment mean and the effect size was large. The PND for spelling scores was 33% since the baseline scores for spelling were higher than most of the scores during treatment and the final data probe. While the sensitivity of the PND measure in discriminating treatment effectiveness for Participant 3 was limited (Parker et al., 2007), she did show clinically significant improvement on the pre-and post-test standardized spelling assessment (see Table 3). Relative to the large effect size of the CATM, it should be noted that at the conclusion of the study, she was diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) and prescribed medication to help support her learning in the classroom. Since the CATM were presented on an iPad and her teacher often indicated that technology-based materials were able to hold her attention better than paper prior to her diagnosis and starting medication, this may have contributed to her improved performance when using CATM. This theory is supported by the findings of Beyens et al. (2018) who noted that children with ADHD or related behaviors have low baseline arousal levels which is typically an unpleasant state that they will try to eliminate though seeking out more arousing activities like screens (iPads).

Participant 4

Upon visual inspection of the data, Participant 4 showed gains in his classroom spelling grade from baseline upon introduction of both AITM and CATM. AITM was favored based on a higher treatment mean with a large effect size when measuring the magnitude of the difference between the two materials. For Participant 4, PND was 100% for AITM indicating they were highly effective based on the guidelines from Scruggs and Mastopieri (1998). He did not show clinically significant improvement on the pre-and post-test spelling measure (see Table 3). Of note, after the study concluded, the case conference committee recommended a re-evaluation to determine if he was eligible for special education under additional qualifications including specific learning disabilities in reading and math, an intellectual disability, or other health impairment. Per teacher report, he made little to no progress throughout the study in any academic area in the classroom other than spelling. Using AITM during speech therapy may have provided him with the repetition, practice, and support from a highly trained interventionist (the SLP) that allowed him to make spelling gains in the classroom (Heisler & Thousand, 2021; McCabe & Nye-Lengerman, 2021).

Participant 5

Upon visual inspection of the data, Participant 5 demonstrated steady gains in spelling performance with the introduction of AITM and throughout the intervention phase. AITM were favored based on a higher treatment mean with a medium effect size when measuring the magnitude of the difference between the two materials. PND results for Participant 5 for spelling performance using AITM was 100%, indicating it was highly effective based on the guidelines from Scruggs and Mastopieri (1998). He did not show clinically significant improvement on the pre-and post-test spelling measure (see Table 3).

Table 3

KTEA:3 Spelling Subtest Standard Scores (SS) and Confidence Intervals (CI)

Participant #	Pre-Test SS	Post-Test SS	95 % CI Pre-Test	95% CI Post-Test
1	82	84	76-88	78-90
2	111	121	106-116	116-126
3	84	94	79-89	89-99
4	70	71	65-75	66-76
5	93	93	88-98	88-98

Teachers' Perception of Spelling Performance

Based on their responses on the social validity measure, teachers perceived improved spelling performance for one out of five and improvement in overall confidence in two out of five participants. Of note, both teachers stated that they did not specifically check grades in order to determine and report improved performance, which may be a reason that their perception of spelling growth did not match the quantitative data. Based on the answers to the question about increased confidence during spelling instruction that was more observable and did not require teachers to access and evaluate grades, they indicated greater improvement for more students. Overall, this measure may not have been sensitive enough to capture or measure a perception of improved spelling performance in such a short time-frame (8 weeks).

Overall Academic Impact of Using AITM During Speech Intervention

Although many studies have supported using curricular content during language interventions (Ehren, 2009; Wallach, 2014; Wallach et al., 2009), there is little theoretical and no

empirical evidence to demonstrate that using AITM during speech intervention could provide a positive educational impact for students with SSDs. Since students with SSDs are estimated to make up between 36% and 90% of an SLP's yearly caseload (ASHA, 2022; Jesus et al., 2019; Oliveira et al., 2015) with over 90% of school-based SLPs working with students with speech sound disorders (ASHA, 2022), studies that inform best practices to improve educational impact of services would be efficacious. This study added preliminary empirical evidence that supports using AITM when working with students with SSDs in school settings. Since the goal of the study was to determine if using curricular materials as therapy materials could influence spelling performance, not necessarily improve it, the study did not specifically recruit students with poor spelling. However, each participant, regardless of previous spelling performance, demonstrated improved spelling scores on at least one quantitative measure. Thus, when reviewing the data as a whole, the use of academically integrated materials during speech therapy for students with speech sound disorders had a noticeable effect on spelling performance. And, this effect was greater than that noted when using commercially available speech therapy products.

Speech Sound Production

It was hypothesized that the type of material used in speech sound disorder intervention would not impact PTCC since the skillset of the SLP (e.g., training in speech sound development and in best practices in intervention) was considered a more essential element in the fidelity of the intervention than the materials themselves. This hypothesis was supported by the PND data, as values were 100% for both AITM and CATM for Participants 2, 3, 4, and 5. As qualitative support, results from the teachers' social validity measure indicated that they perceived improved intelligibility regardless of the therapy material type for 4 out of the 5 participants. Both of these

findings lend preliminary support to the feasibility of using AITM to not only influence educational performance but to also successfully facilitate improved speech sound production.

Interestingly and in contrast to the initial hypothesis, when comparing the relative effects of the two therapy materials on speech sound production, visual analysis of the baseline, intervention, and final data probe results indicated that PTCC was higher for four out of five participants when AITM were used during intervention. Additionally, while it was hypothesized that using AITM would have a minimal impact on speech sound production with effect sizes close to 0, participants 1, 2, 3, and 4 all demonstrated higher PTCC in speech sound production when AITM were used during intervention than when traditional CATM were used with large effect sizes (ranging from 1.02 to 1.54). Theoretically, this could be potentially attributed to fewer competing resources (Lahey & Bloom, 1994) since there were no new CATM introduced into therapy, greater motivation from the students to perform as they recognized the potential positive effects in the classroom, or the additional focus on speech sound production from teachers through collaborative efforts (Suleman et al., 2014).

In sum, as schools are scrambling to recoup lost academic skills (Khan & Anderson, 2021; Robinson, 2022; Sanderson et al., 2021) due to pandemic shut-downs, and since school districts have adopted an "all hands on deck" mentality to improve students' access to instruction and intervention (Powell, 2018), the preliminary data from this study could allow SLPs to more confidently incorporate AITM like spelling lists into therapy without fear of a negative impact (and perhaps even the benefit of greater improvement) on speech sound production.

Clinical Implications

In addition to the quantitative and social validity data discussed above, several qualitative observations were made throughout the study. While not directly targeted or solicited, some

informally observed benefits of using AITM lend themselves to a discussion of preliminary clinical implications. During several meetings with the PI to review data and complete the procedural checklist, the SLP running the study and the participants' teachers made several comments that added anecdotal evidence to the quantitative and qualitative results.

Educational Impact

In its simplest form, educational impact could be measured through an improvement in grades for any academic area an SLP focuses on (through materials choice or collaborative efforts) during speech intervention. This positive impact on educational performance is an important responsibility of SLPs who choose to practice in a school setting (ASHA, 2010) and was the theoretical basis for this study. Near the end of the intervention phase, a participant ran to his SLP to show her his improved spelling test grade and said "Look, I got that one right!" The SLP reminded him it was because he worked so hard during speech therapy all week to both say and spell that word correctly. An unsolicited comment like this to his SLP could potentially indicate that the students noticed the positive impact of using AITM during intervention even though the students' social validity measures were not sensitive to the impact of the different materials. Thus, in addition to four out of the five participants demonstrating improved spelling performance when the SLP used AITM vs CATM during intervention, informal observations and student comments also support the use of AITM to improve the educational impact of speech intervention for students with SSDs.

At the core of the theoretical framework for this research was the charge of SLPs to ensure a positive educational impact of their speech therapy services (Ehren, 2000; Farquharson, 2015; Farquharson & Boldini, 2018; Hayiou-Thomas et al., 2017; Hitchcock et al., 2015; Tambyraja et al., 2020; Wallach, 2014). Interestingly, one of the first comments from the SLP

running the study was how using AITM helped her recognize that she had such limited training and experience ensuring and measuring the educational impact of her services. She noted that when SLPs are determining eligibility for school-based services, they must document the negative educational impact of the SSD (IDEA, 2004; Ireland & Conrad, 2016). However, after that initial eligibility for school-based services was established, she found that she often returned to a clinic-based mindset with correct speech sound production as the sole focus of intervention with educational impact forgotten (Powell, 2018). Experiencing this mindset shift through the course of this study helped her identify and define one of her core struggles as a school-based SLP: maintaining a therapeutic focus while incorporating curricular content (Ehren, 2000). Along with this paradigm shift struggle, she noted that there was also a logistical struggle. She had not been taught *how* to target the negative educational impact of SSDs, only that she *should* (Elledge et al., 2010). The SLP shared her realization that using spelling lists during speech therapy was a simple way that she could incorporate curriculum and target positive educational impact of services while working on the speech goals and objectives of her students.

Service Delivery

While ESSA (2015) indicated that curriculum and classroom performance should be at the forefront of decision-making criteria when choosing service delivery models, the SLP in this study often noted that the need to consider curriculum, materials choice, and classroom performance was left out of her university training (Ehren, 2000; Elledge et al., 2010) regarding service delivery. With a scarcity of evidence to support choice of service delivery models and the materials used during intervention, SLPs often must rely on their own data and logic when making decisions as to when, how, and where to provide services (Cirrin et al., 2010). The anecdotal evidence from informal interviews with the SLP suggested that, along with a scarcity

of research to guide them, SLPs may not feel they have been trained to employ service delivery models that allow them to focus on educational impact (Elledge et al., 2010) or how to incorporate curricular materials within these models. The SLP indicated that this struggle and lack of training most likely kept her in her previous comfort zone of seeing students two times per week for 5- to 30-minutes in separate spaces (Brandel, 2020; Brumbaugh & Smit, 2013) using CATM without exploring a wider variety of service delivery options that focused on the educational impact of services (e.g., using curriculum-based materials and collaborative models). Additionally, when the SLP focused on both effective and efficient services through use of AITM, she recognized and noted that her workload unexpectedly decreased.

Workload

The time needed for preparation of therapy materials is an often-overlooked portion of school-based SLPs' workload duties. Locating, creating, organizing, and transporting the materials needed to provide individualized intervention for large caseloads of students, often in two or more schools, prompts many posts to social media of SLPs "in search of materials" to target goals for students with SSDs. The 2022 ASHA survey results showed that school-based SLPs spent a majority of their average of 37.3 hours a week on direct services (22.2 hours) (ASHA, 2022). The SLP noted that with so much of her time spent on direct services, the weeks that therapy materials were easily accessible, already prepared, and educationally relevant (i.e., the weeks she used AITM), resulted in a reduction in her workload. She noted that through use of AITM, she saved time usually spent preparing materials that she instead devoted to reviewing the spelling concepts she would be using that week and consulting with teachers. At the end of the study, during a wrap-up meeting, the SLP noted that using AITM allowed her to both seek

out and support collaborative efforts with teachers more naturally since they were both using the same materials.

Collaboration

While collaborative efforts between SLPs and classroom teachers could be of benefit to both students' education and the large workloads of SLPs (Farber & Klein, 1999; Heisler & Thousand, 2021; McCabe & Nye-Lengerman, 2021), SLPs typically face several challenges when seeking to collaborate with teachers in and out of the classroom (ASHA, 2022; Edgar & Rosa-Lugo, 2007; Green et al., 2019; Pfeiffer et al., 2019). These challenges include: limited time for collaborative planning and to ensure common goals, different knowledge bases, and too much autonomy ("your job" vs. "my job;" Lindsay & Dockrell, 2002; Pampoulou, 2016; Suleman et al., 2014). Throughout the study, the SLP noted that when she used AITM during intervention, many of the challenges associated with collaboration between teachers and SLPs in school settings naturally resolved. For example, since the SLP and the classroom teacher were using the same materials (spelling lists) for both of their purposes (teaching spelling rules and improving speech sound production), planning and establishing common goals was more natural. In fact, one teacher indicated to the PI that she did not feel as "alone" in the classroom relative to teaching spelling concepts to her students with SSDs when the SLP was using curricular materials, even if the SLP was not physically present. The other teacher stated that it was easier for her to "let go" of her student to go to speech therapy since she knew the SLP was using curricular materials. Additionally, one teacher specifically noted that the SLP's knowledge of Participant 5's academic struggles based on her experiences using AITM during intervention was invaluable during the meeting to request testing for additional special education services. Namely, she was able to speak to the negative educational impact of his delays in letter

and sound knowledge as well as phonological awareness based on her experience with the curriculum.

Limitations

Although the results of this research are novel contributions to the current body of literature on interventions for speech sound disorders in schools, several limitations of this study must be considered. First, only five first graders participated in the study. Due to the small number of participants who were all in the same grade, results cannot be generalized to larger populations of students with SSDs, therefore affecting the external validity. However, the number of participants in this study does align with existing single case study participant numbers.

Second, implementing an intervention study within a school where the SLP must adhere to the goals and specially designed instruction listed in each student's IEP could negatively impact replication (external validity) of the study. Individual IEPs determine the level of instruction, modeling, and support each student receives, so this part of the intervention cannot easily be delineated in the methodology other than to say that the SLP followed the students' IEPs. While this positively supports the concept of implementation science in that it "promotes sustainability and effective use of evidence based programs and practices in typical service and social settings" (Boothroyd, 2014), it does impact replication. Fortunately, the independent variables in this study were the materials used during intervention and not specific speech production strategies that may not have aligned with the students IEPs.

Third, although the SLP was not targeting spelling skills during the baseline phase, the classroom teachers were still teaching this content. In addition, it was determined that the spelling lists and therefore spelling tests and activities during the first three weeks of school were

often a review of past concepts from kindergarten that the students have already mastered, possibly causing the higher baseline scores. Future studies should seek to gather pre-treatment data on academic skills that are not being explicitly taught during the baseline phase and that are a more accurate measure of performance with new content versus reviewed skills. Along the same line, using grades for a measure of performance during a study on educational impact could have been a limitation since grade averages can fluctuate based on a missing assignment or if a study performs poorly on one assignment.

Fourth, there were some limitations that impacted the social validity data. Since the social validity questionnaire for teachers was only given at the beginning and end of the study and not at the beginning and end of each phase (CATM and AITM) in order to be respectful of their heavy workloads, it was difficult to extract data that accurately examined their perspectives on which material was more beneficial to academic and speech sound performance. When the teachers returned the questionnaires to the PI, they made several comments regarding its limitations. When returning the open-ended question portion of the teacher social validity questionnaire, both teachers indicated that it was difficult to answer the question about how SSDs impacted students in their classrooms since the perception of an impact depended on the classroom activity. They explained that the amount of time spent in small group or large group settings, the amount of time spent responding orally, and the amount of contextual cues available to the teachers and peers (e.g., books, objects, materials that the student was talking about) all figured into the perceived impact. Teachers indicated that they attempted to consider all elements when discussing the impact of speech sound disorders, but the activities of the particular day they completed the survey most likely impacted their responses. There was also a limitation to the participants' questionnaire, as the SLP noted that the first graders appeared to simply answer

"yes" to all of the social validity questions, perhaps in order to please the SLP. All participants answered "yes" to each of the questions at the end of each 2-week segment for both AITM and CATM. This limited the amount of analysis that could be completed for the preferences of materials and their perceived impact of the intervention materials on classroom performance.

Finally, a social validity measure was not used with the school-based SLP who ran the study. Based on her verbal feedback, she experienced increased comfort using curricular materials and noted increased carry-over between speech therapy and the classroom for her students. Since SLPs are one of the important stakeholders in regards to the acceptability of using AITM during school-based speech intervention with students with SSDs, future research should prioritize collecting this data.

Future Research

As school-based SLPs struggle to meet all the workload demands of their jobs, strategies that can support more effective and efficient services for students with SSDs are paramount. This preliminary research supports the need for future study on whether the use of curricular materials during school-based intervention for speech sound disorders could impact educational performance in schools. Along with impacting educational performance, further study is needed to determine if use of curricular materials could be of benefit to students, teachers, and SLPs in other areas. Specifically, studies that seek to determine if using curricular materials during intervention for SSDs can help support and improve collaborative practices between SLPs and classroom teachers are needed. For example, for students like Participant 2 who are already high achieving academically, use of curricular materials could be studied more for the collaborative impact rather than academic impact. Additionally, future researchers should explore the educational impact (both social and academic) of a wider variety of curricular

materials (e.g., classroom novels, math worksheets, phonics activities) during intervention for speech sound disorders in schools.

Conclusion

The purpose of this study was to compare the effects of using AITM and CATM during school-based speech therapy on spelling performance and speech sound production for first-graders diagnosed with SSDs. Results were varied across the participants for spelling performance when comparing AITM and CATM. With the exception of one student, the participants' speech sound production improved more overall when AITM was used during speech intervention. Since the materials type not only did not negatively impact progress in speech sound production, but actually resulted in increased scores when AITM were utilized, SLPs could confidently consider this as a therapeutic option. This choice could potentially result in workload benefits such as decreased preparation time, reduced spending on therapy materials and improved collaborations.

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