The purpose of the present study was to examine the results of implementing remedial instruction in the alphabetic principle with deaf and hard-of-hearing (DHH) students educated in a sign bilingual setting. Data were analyzed in 2 phases, with the first using paired-sample t tests and Pearson correlations and the second phase employing structural equation modeling. Results indicate that study participants (N = 127) from a range of grade placements, with various degrees of hearing loss, and including those with additional disabilities, can acquire an understanding of the alphabetic principle, apply this knowledge to the reading of words, and demonstrate generalization of skills through a pseudoword decoding task. Given the ongoing debates regarding the relevance of phonologically based instruction for DHH learners, the findings of this investigation will also serve to address some of the misconceptions regarding the instructional methods and strategies employed in interventions of this type.

Learning to read is a complex, developmental process that involves the coordination of skills from two broad domains, typically referred to as language-related and code-related domains (Adams, 1990, 1994, 2002; McGuinness, 2004, 2005; National Early Literacy Panel, 2008; Whitehurst & Lonigan, 1998). Language-related skills include the knowledge and use of the structures of English (i.e., morphology, syntax, semantics, and pragmatics), whereas code-related skills include an understanding of print principles (e.g., graphemes, word boundaries, and directionality), phonological skills (e.g., alliteration, phonological awareness, and syllabication), and the development of the alphabetic principle (i.e., phonics) and its associate prerequisite skills (e.g., letter knowledge and phonemic awareness). In advanced readers, skills from both the language- and code-related domains interact and work in tandem to achieve automaticity with word recognition and foster reading comprehension (Adams, 1990; Chall, 1996).

In recent publications in the field of deafness, some researchers have questioned the relative contribution of code-related skills to reading achievement among deaf and hard-of-hearing (DHH) individuals, indicating that language-related skills have a greater impact on overall reading proficiency (Allen et al., 2009; Mayberry, del Guidice, & Lieberman, 2011; Miller & Clark, 2011). Others (LaSasso, Crain, & Leybaert, 2010; LaSasso & Metzger, 1998; Leybaert, 1993; Mayer, 2007, 2010; Paul, 2009; Paul, Wang, Trezek, & Luckner, 2009; Trezek, Wang, & Paul, 2010; Wang, Trezek, Luckner, & Paul, 2008; Williams, 2011) have suggested that the lack of attention to the code-related components of instruction has contributed to the 4th-grade median reading level of DHH high school graduates that has persisted for nearly a century (Allen, 1986; King & Quigley, 1985; Pintner & Patterson, 1916; Qi & Mitchell, 2012; Quigley & Kretschmer, 1982; Traxler, 2000). This either/or language versus code debate, polarizing both researchers and practitioners, is reminiscent of the “reading wars” between whole language and phonics instruction (see Chall, 1967, 1996, for discussions) that plagued the field of reading for decades.
More recently, in the field of reading, the either/or instructional dichotomy has been replaced with a balanced approach to teaching and learning. Building on both language-related (e.g., vocabulary and comprehension) and code-related (e.g., letter knowledge and phonological awareness) knowledge acquired in the preschool years, there is a strong emphasis on developing phonemic awareness (i.e., the ability to identify and manipulate the individual phonemes within words “through the air” without the aid of print) and an understanding of the alphabetic principle through systematic and explicit instruction provided in kindergarten through 2nd grade. Once students acquire basic knowledge of phonemic awareness and the alphabetic principle, or an understanding of the systematic and predictable relation between phonemes (i.e., sounds) and graphemes (i.e., letters), instruction shifts to developing automaticity in applying these skills to multisyllabic word reading and developing fluency (i.e., accuracy, rate, and prosody) in reading connected text. When these code-related skills are well established, the transition from “learning to read” to “reading to learn” occurs and instruction can be aimed toward skills more directly associated with the language-related domain, such as developing advanced vocabulary and reading comprehension strategies (Adams, 1990; Chall, 1996; National Early Literacy Panel, 2008; National Reading Panel, 2000).

Although research has documented the differential contribution of skills from each of these domains relative to the stages of development, in a balanced interactive model of reading development, both language- and code-related skills are considered critical components in emergent as well as conventional literacy learning (McGuinness, 2004, 2005; Shanahan, 2006; Snowling & Hulme, 2005; Whitehurst & Lonigan, 2002). For scholars and teachers utilizing this model to describe the development of skills and inform instructional practices, discussions are not centered on disputing the importance of either language- or code-related skills, but these are rather concentrated on exploring the reciprocal relations that exist between them and determining how this reciprocity can be cultivated through pedagogical practices at the various stages of development (Adams, 1990; Chall, 1996; National Early Literacy Panel, 2008; National Reading Panel, 2000).

As previously indicated, instruction in the alphabetic principle is generally completed by the end of the 2nd grade. Students who lack these fundamental code-related skills often experience difficulty transitioning to the “reading to learn” phase of development and their reading tends to plateau at approximately a 3rd- or 4th-grade level (Chall, 1996). Considering the hierarchical nature of reading skill development, in which progression to advanced stages relies on the acquisition of code-related requisites, students who have not mastered the alphabetic principle by the 2nd grade will require remedial instruction. A recent meta-analytic review of interventions for adolescent struggling readers indicated that even older students with disabilities benefit from targeted interventions focused on these code-related skills (Scammacca et al., 2007).

Based on review of the extensive research available in the field of reading and supported by the view that the process of learning to read for DHH learners is qualitatively similar to that of hearing readers (e.g., Paul & Lee, 2010), we would suggest that the lack of attention to developing code-related skills among DHH learners accounts in part for the 4th-grade-level plateau in reading achievement historically experienced by this group of students (e.g., Pintner & Patterson, 1916; Qi & Mitchell, 2012; Traxler, 2000). Therefore, we advocate for balanced reading instruction for DHH students, with a particular focus on developing the alphabetic principle through initial or remedial instruction.

Misconceptions Within the Field of Deafness

Unfortunately, in the field of deafness, the “reading wars” continue to wage. Those challenging instruction in the alphabetic principle for DHH learners indicate that “the role of phonology in reading is currently being overstated” (Miller & Clark, 2011, p. 464), a position they suggest even for hearing individuals. These researchers also criticize methods of teaching phonological skills to DHH students, suggesting that instructional strategies can be equated with a strict adherence to an oral philosophy of education, an overemphasis on the acquisition of oral language, and the rejection of sign language. In addition, when assessing
the phonological skills of DHH learners, implications are that hearing loss and speech production are actually being measured instead of skills associated with phonology (Mayberry et al., 2011; Miller & Clark, 2011). Claims have been made by these researchers that instruction focuses solely on students’ ability to retain phonological skills rather than the ability to apply knowledge of the alphabetic principle to read words and comprehend text (Allen et al., 2009; Miller & Clark, 2011). These statements are made despite the presence of published studies that included standardized measures of reading achievement, which included word reading and comprehension (see Trezek et al., 2010, for review).

Furthermore, much of the evidence used in arguments against instruction in the alphabetic principle for DHH learners is drawn from studies relying on rhyme judgment tasks as a measure of DHH individuals’ phonological abilities (Mayberry et al., 2011). However, there is a significant body of literature indicating that the relation of rhyme to reading development is negligible even for hearing readers, especially when compared to phonemic awareness skills such as segmenting and blending (Hatcher & Hulme, 1999; Hatcher, Hulme, & Elli, 1994; Hulme, 2002; Hulme et al., 2002; Hulme, Muter, & Snowling, 1998; Muter, Hulme, Snowling, & Taylor, 1997; Nation & Hulme, 1997).

Additionally, strong assertions have been made that phonemic awareness is not necessary for DHH individuals to become skilled readers (e.g., Allen et al., 2009; Miller & Clark, 2011); however, there is no attempt to explain the persistent 4th-grade median reading level of DHH high school graduates in light of these claims. Moreover, an alternative theoretical framework is not offered to explain this phenomenon (Paul et al., 2009), and there is no instructional model presented that delineates strategies to support skill development. This is particularly concerning in the current accountability era where teachers, including those serving DHH students, are required to implement theory- and research-based instructional practices and to frequently monitor student progress as a result of interventions (see National Center on Response to Intervention, 2011; Senate and House of Representatives of the United States of America, 2002).

What is evident from the body of reading research is that skills in the alphabetic principle do not develop spontaneously but rather require specific instruction (Adams, 1990; Braze, McRoberts, & McDounough, 2011; Chall, 1996; National Early Literacy Panel, 2008; National Reading Panel, 2000). Therefore, surprisingly absent from recent meta-analytic and literature reviews (Allen et al., 2009; Mayberry et al., 2011; Miller & Clark, 2011) is the growing body of research evidence evaluating the implementation of instruction in the alphabetic principle with DHH learners (e.g., Beal-Alvarez, Lederberg, & Easterbrooks, 2012; Bergeron, Lederberg, Easterbrooks, Miller, & Connor, 2009; Guardino, Syverud, Joyner, Nichols, & King, 2011; Narr, 2008; Syverud, Guardino, & Selznick, 2009; Trezek & Malmgren, 2005; Trezek & Wang, 2006; Trezek, Wang, Woods, Gampp, & Paul, 2007). For example, many recent intervention studies have employed a multisensory instructional tool called See-the-Sound Visual Phonics (more commonly known as Visual Phonics) that relies on using visual, tactile, and kinesthetic information to augment or substitute auditory and verbal information when teaching the alphabetic principle (International Communication Learning Institute, 1996). Most of these studies have been conducted with young children in Total Communication or oral–aural environments; therefore, less is known about the impacts of both remedial instruction (Trezek & Malmgren, 2005) and implementation of phonologically based instruction on DHH students attending schools that have adopted a sign bilingual model and utilize American Sign Language (ASL) as the primary language of instruction.

**Purpose of the Study**

The aim of the present study was to examine the results of implementing remedial instruction in the alphabetic principle with DHH students in the 2nd grade and higher in a setting employing a sign bilingual model. Specifically, the goal of this inquiry was to explore participants’ acquisition and generalization of skills as a result of remedial instruction supplemented by Visual Phonics. Given the ongoing debates regarding the relevance of this instruction for the population of DHH students, the results of this research will illustrate that a variety of students,
including those with severe to profound hearing loss and additional disabilities, can acquire an understanding of the alphabetic principle, apply this knowledge to the reading of words, and demonstrate generalization of skills through pseudoword decoding. This study will make a unique contribution to the field as it represents the first large-scale investigation of this type and has been conducted in a setting employing a sign bilingual approach.

This research investigation was guided by the following research question: To what extent do initial amounts of, and growth in, identifying phonemes in isolation, phoneme blending, and word reading affect generalization to phoneme blending within pseudowords and pseudoword reading, above and beyond hearing loss, controlling for age and additional disabilities?

Method
Setting and Participants
This research investigation was conducted over a 3-year period in a residential school for the deaf located in the Midwest region of the United States, which served approximately 240 DHH students from preschool through high school at the time of the study. For more than 10 years, educators at the school have participated in professional development activities offered through the Center for ASL/English Bilingual Education and Research (CAEBER), supported by Gallaudet University (2011). More specifically, 37 staff members—including the superintendent and elementary, junior high, and high school principals, as well as educators—teaching students in preschool through high school have participated in the Language Planning and Leadership conference or ASL/English Bilingual Professional Development (AEBPD) offered through CAEBER. Within this particular educational setting, an accessible bilingual communication philosophy was also adopted that emphasized the separation of ASL and English when communicating. This philosophical perspective led the majority of teachers to choose ASL as the primary language of instruction during reading instructional sessions.

The overwhelming majority of students enrolled in 2nd grade through high school met the criteria for inclusion in the study (i.e., scores of 40 or less on the pretest measure, as described below). During the 3 years, 28 elementary, 42 junior high, and 57 high school students (N = 127) enrolled in 2nd grade through high school and ranging in age from 7 years 2 months to 19 years 8 months (M = 13 years 9 months) served as study participants. Of the 127 participants, 61% were male (n = 77) and 39% (n = 50) female, which closely mirrors the most recent demographic data reported for the overall population of DHH students (i.e., 54% male, 46% female) educated in the United States (Gallaudet Research Institute, 2010).

Information regarding participants’ degree of hearing loss and presence of comorbid disabilities was drawn from cumulative records on file at the school. Measures of unaided pure tone average (PTA) in the better ear indicated that participants’ degree of hearing loss ranged from 20 to 120 dB (M = 93.2 dB), with approximately 80% of the students (n = 100) in the severe to profound range (i.e., 80 dB or greater). Of the 127 students, nearly 40% (n = 49) had one or more documented disabilities (other than speech and language) in addition to their hearing loss. The categories of documented disabilities included attention deficit/hyperactivity (n = 14), autism (n = 3), emotional disturbance (n = 6), mental retardation (n = 9), other health impairments (n = 10), specific learning disability (n = 20), and visual impairment (n = 1).

Curriculum
Based on a previous investigation implementing remedial phonics-based reading instruction for DHH students at the middle school level (Trezek & Malmgren, 2005), this study also utilized the first 20 lessons of the Direct Instruction Corrective Reading-Decoding A curriculum (Engelmann, Carnine, & Johnson, 2008) for instruction. This remedial reading curriculum, the first in a series of four levels, focuses on teaching the fundamental code-related skills necessary to develop the alphabetic principle. Research findings have documented the effectiveness of the Corrective Reading-Decoding series for a variety of remedial readers, including noncategorical poor readers and special education students (see Przychodzin-Havis, Marchand-Martella, & Martella, 2005, for review).
The 65 lessons of the Decoding A program offer age-appropriate activities for the remedial reader within each lesson, provide cumulative review between lessons, and detail the specific instructional strategies to use within a teaching script. Skills necessary to develop the alphabetic principle are first introduced in isolation, reinforced over time, and finally applied to reading decodable passages. To maximize the amount of practice students receive, unison responding is used during all teacher-directed activities. In addition to the teacher-directed portions of the lessons, skills are further reviewed and reinforced through workbook activities. Using the scripted presentation manual, teachers guide students through three primary activities during each Decoding A lesson: pronunciations, sound introduction, and word reading (Engelmann et al., 2008).

The pronunciation activities are considered phonemic awareness tasks because they require students to produce phonemes in isolation, to blend phonemes to form words, and to segment individual phonemes within words without the aid of print (Engelmann et al., 2008). Aligned with a systematic phonics instructional approach, a predetermined sequence of grapheme–phoneme relations is taught in isolation through the sound introduction activities and then applied in the word reading exercises included in the curriculum.

In the first 20 lessons of the curriculum, students are taught 15 grapheme–phoneme relations, including five continuous consonants (i.e., /m/, /s/, /r/, /f/, and /n/), four stop consonants (i.e., /t/, /d/, /h/, and /c/), two digraphs (i.e., /th/ and /ch/), and four vowels (i.e., long /e/ and short /a/, /i/, and /o/). These relations are then applied to blending tasks that require students to apply the alphabetic principle to read approximately 150 words during the first 20 lessons (Engelmann et al., 2008). Considering that the majority of teachers used ASL as the primary language of instruction and vocalizations were not used, Visual Phonics provided students with access to phonemes during reading instructional sessions.

Visual Phonics

Visual Phonics is the abbreviated title for See the Sound/Visual Phonics. Visual Phonics is not “a classroom based phonics curriculum,” as suggested by Miller and Clark (2011, p. 460), but rather a multisensory instructional tool that consists of 46 hand cues and written symbols used in conjunction with speech and/or speechreading to represent the individual phonemes of a language. The Visual Phonics hand cues were developed to mimic the articulatory features of phonemes and simple line-drawn symbols mirror the gestures used to produce the cues (International Communication Learning Institute, 1996; Morrison, Trezéck, & Paul, 2008).

Using this instructional tool, DHH learners are not “doomed to rely on often underspecified lip patterns and/or vague kinesthetic sensations in the vocal track for the representation of the sounds of spoken words” (Miller & Clark, 2011, p. 461), but instead, they have an additional visual route to support speechreading that allows them to differentiate phonemes with similar articulatory placements. For example, without Visual Phonics, learners may confuse phonemes such as /t/ and /d/; however, the hand cues developed to represent these phonemes are distinctive.

The Visual Phonics hand cue for the /t/ sound is produced in three steps. First, the hand is held in a fist near the mouth with the fingers facing the body. Second, the index finger is quickly extended upward representing the tongue striking the roof of the mouth. In the third step of the hand cue, the index finger is returned to the original position (Morrison et al., 2008). The hand cue for the /d/ sound, by comparison, is produced by holding a crooked index finger at the side of the mouth and quickly “dotting” the finger downward and then returning it to the original position. The brisk movement used to produce both of these cues also provides the learner with information about the manner of phoneme production (i.e., stop sound). Similarly, the Visual Phonics hand cues for continuous phonemes were designed to give the learner information about production. For example, the cue for the phoneme /f/ is produced by placing the fingers and thumb together in an o-shape at the corner of the mouth with the palm facing the mouth. The four fingers are then slowly raised off the thumb to represent the air being blown upward as this continuous phoneme is produced (Morrison et al., 2008).
It is important to note that the Visual Phonics hand cues and corresponding mouth movements are produced simultaneously, whether or not vocalizations are included (Trezek et al., 2010). This allows the hand cues to augment information provided through speechreading and/or vocalizations or, in the case of this study conducted in a sign bilingual setting, to serve as a visual substitute for the auditory and verbal information typically provided when teaching the alphabetic principle. Because the Visual Phonics system is also considered “curriculum neutral,” it can be integrated into various instructional curricula.

### Blending Instruction and Phonics Chaining

In this implementation, Visual Phonics was used any time the Decoding A teacher script indicated that an individual phoneme or string of phonemes needed to be produced. Because researchers have indicated that many DHH individuals rely on a combination of sources such as speechreading, articulatory, and/or tactile–kinesthetic feedback (see LaSasso, 1996; Leybaert, 1993; Mayer, 1998, 1999, 2007; see also Trezek et al., 2010, for review), it is vital for teachers to emphasize the importance of producing mouth movements, and possibly vocal sensations, in conjunction with the Visual Phonics cues. It is important to note that only the Visual Phonics hand cues (not the written symbols) were used in this investigation.

As previously indicated, a systematic phonics approach requires that specific instruction is provided to teach students to blend individual phonemes to form words. For those struggling with this skill, a synthetic blending strategy is also suggested (National Reading Panel, 2000). Using this method, phonemes are held closely together, or synthesized, to form words rather than produced phoneme-by-phoneme with a slight pause between each. For example, when blending the word *man*, /mmm/ /aaa/ /nnn/ would be easier for students and more likely result in word recognition compared with /m/ /a/ /n/. Synthetic blending is also conducive to instructing DHH learners because it offers a better model of speechreading compared with phoneme-by-phoneme production of words.

A synthetic blending strategy is employed in the Decoding A curriculum and to prompt its application, the teacher script includes the phrases, “Sound it out. Get ready. Again, get ready. Say it fast. What word?” (Engelmann et al., 2008). To differentiate this instruction for DHH learners and to make the script more appropriate for presentation in ASL, a slightly modified version of the four-step phonics chaining procedure (see Trezek et al., 2010) was employed in this investigation.

Using the chaining procedure, the goal of the synthetic phonics approach (i.e., blending phonemes to form words) remains constant; however, instead of “Sound it out,” the teachers signed, “Show me the Visual Phonics” or simply, “Visual Phonics.” In this first step of phonics chaining, the students were expected to provide the correct Visual Phonics cue and associated mouth movement corresponding to each individual phoneme introduced in the pronunciation activities or grapheme being visually displayed in sound introduction and word reading instruction. If students chose to simultaneously provide vocalization while producing the hand cues, the correct vocal sensation (i.e., voiced/unvoiced) was also required. This task was then repeated in the second step of the chaining process when the teacher signed, “Again, Visual Phonics.” (Trezek et al., 2010).

Instead of using the phrase “Say it fast” in the third step of the chaining process, the sign “English” was used to prompt students to provide only the mouth movements and potentially the associated vocalizations for the resulting word. During this phase of the procedure, the Visual Phonics cues were not employed because it was found that students had difficulty producing the hand cues while simultaneously maintaining proper articulatory movements. The teachers implementing the program suggested using the sign “English” because producing the word on the mouth was a representation of English. They also believed that using this sign helped reinforce the school’s communication philosophy to separate languages (i.e., English and ASL) during instructional activities. In the fourth stage of the chaining procedure, it was decided that students would produce the corresponding sign or fingerspelled representation of the resulting word when the teacher prompted them with, “What word?” (Trezek et al., 2010).
Vocabulary Instruction

The 150 words included in the first 20 lessons of the Decoding A curriculum are typically within the vocabulary repertoire of the remedial reader. In other words, once a reader learns to decode the word through phonics instruction, meaning can be immediately associated. This was not necessarily the case for many of the DHH participants in this study who experienced deficits in English vocabulary skills; therefore, direct vocabulary instruction was incorporated into each lesson. PowerPoint presentations containing pictures and brief written definitions to illustrate the range of meanings were created for each lesson and displayed on an interactive white board to facilitate instruction.

In addition, teachers viewed vocabulary instruction sessions as an opportunity to introduce students to multiple meanings of words and various ways to represent English words in ASL. For example, when introducing the word mat, teachers shared pictures to illustrate three examples (i.e., a mat used in gym class, a placemat, and a welcome mat) and for the word dash, students learned that this word could mean a sudden movement (e.g., he made a dash for the door) or a mark used in writing (i.e., –). When the word miss was encountered in the curriculum, teachers taught the students that it could represent three different meanings, using three different signs in ASL (i.e., failure/omission, feel longing for, and a title of respect for an unmarried woman).

Intervention

Educators at the school had received training in Visual Phonics prior to the onset of the study; however, use had been limited to speech and language clinicians for supporting students’ speech articulation development and correction. During the first year of this investigation, the school adopted the Direct Instruction series of reading programs to serve as the primary intervention for students in preschool through high school. To prepare for the implementation, professional development and training was offered by the first author, who served as the school’s literacy instruction consultant throughout the study. In accordance with CAEBER (Gallaudet University, 2011) recommendations, approximately 75 staff members—including administrators, support personnel (e.g., library/media educator, director of evaluation center), and educators from various grade levels teaching a variety of subjects (e.g., history, physical education, and consumer education)—attended a 2-day training. Although the initial implementation focused on literacy instruction, all educators and key administrators were encouraged to attend the professional development workshop.

While theoretical models of reading development and research findings were shared with participants during the workshop, the primary purpose of the training was to review the Visual Phonics hand cues and demonstrate and practice the specific teaching cues (e.g., phonics chaining, signaling to initiate a unison response, and correction procedures) to effectively implement the Direct Instruction curricula. The first author is a Visual Phonics trainer with more than 10 years of experience in training and coaching teachers in implementing Direct Instruction curricula for DHH students.

Implementation began in September of Year 1 with students enrolled in 2nd through 6th grades at the elementary level. In January of that same year, teachers at the junior high school started implementing the intervention with 7th- and 8th-grade students. Program implementation expanded to the high school in September of Year 2 and then was offered as needed thereafter to new cohorts of students enrolling in the school at all three levels (i.e., elementary, junior high, and high school). Study participants received approximately 40 min of daily reading instruction from the Decoding A curriculum, supplemented by Visual Phonics.

The teacher scripts included in the Decoding A program provide consistency of instruction from lesson to lesson and teacher to teacher. To further monitor the fidelity of implementation and provide ongoing mentoring and coaching to the teachers, monthly classroom observations were conducted by the first author throughout Year 1. Beginning in Year 2, the reading specialist employed at the school accompanied the first author during observations and also conducted independent monthly observations in classrooms. A summary of anecdotal notes of lesson observations and instructional recommendations was shared with teachers and administrators in a monthly report; however,
formal fidelity data (e.g., percentage of lesson elements observed) were not collected. In addition to observations, at least two teacher meetings were held per year to review teaching techniques and discuss strategies for effectively implementing instruction with students.

Because the school had adopted the Direct Instruction curricula as its primary instructional intervention, convenience sampling was used in this investigation. In other words, students received instruction from the Decoding A curriculum in groups based on their previously assigned literacy class placement. During the 3-year study, 26 groups of students received instruction from a total of 11 educators (i.e., 4 elementary, 4 junior high, and 3 high school) who were assigned to teach reading classes. Due to scheduling constraints, one-on-one instruction was required in a single situation, but in most instances, group instruction was provided, with groupings ranging from two to eight students ($M = 5$), with class sizes of four and six students occurring most frequently (i.e., in seven and six instances, respectively).

According to the teacher’s guide accompanying the Decoding A curriculum (Engelmann et al., 2008), approximately 35 to 45 min of daily instructional time is typically needed to complete the teacher-directed portion of the lesson as well as the independent workbook activities. Considering the time allocated to reading instruction at the school (i.e., 40 min), it would be expected that at least 20 instructional days would be necessary to complete the first 20 lessons of the curriculum. In this investigation, the overall number of instructional days required ranged from 20 to 77 ($M = 43$): 23–52 days ($M = 37$) at the elementary school, 36–77 ($M = 57$) days at the junior high, and 20–65 ($M = 39$) days at the high school level. Correlations between number of instructional days and participant demographic characteristics (i.e., degree of hearing loss, presence of additional disabilities, and grade level) will be addressed in the Analysis and Discussion sections.

Measures

A curriculum-based pre–post test and generalization probe utilized in a previous investigation evaluating the use of the Decoding A curriculum and Visual Phonics with DHH students (Trezek & Malmgren, 2005) was also used in this study. The first section of the pre–post test was designed to assess the participants’ knowledge of the alphabetic principle by requiring them to identify phonemes in isolation. The 15 graphemes taught in the first 20 lessons of the curriculum were listed and students were asked to produce the corresponding phonemes. The second section of this test was created to assess students’ ability to apply the alphabetic principle to read words that were taught in the curriculum. In creating this measure, 15 words representing the various patterns included in the curriculum (e.g., consonant–vowel–consonant, consonant–consonant–vowel–consonant, consonant–vowel–consonant–consonant) were randomly chosen for inclusion (e.g., hot, this, and mist) and students were required to identify the individual phonemes within them and then blend the phonemes to form words. The maximum number of points possible on the pre–post test was 45.

The generalization probe was developed using the 15 phonemes taught in the first 20 lessons of the Decoding A program. These phonemes were used in combination to form a list of 15 pseudowords that paralleled the various word patterns taught (e.g., mon, thac, and hins). A pseudoword decoding task was chosen for this measure because it not only assesses the ability to generalize phonics skills to the reading of unknown words but also ensures that responses to test items are not influenced by knowledge of sight words. For these reasons, measures of pseudoword reading are a widely accepted assessment of phonics abilities and are considered a strong predictor of reading ability and later achievement (see National Reading Panel, 2000; Stanovich, 1988). The generalization test was administered after completion of the 20-lesson intervention and was worth a maximum of 30 points. Assessments were individually administered to the study participants by the first author. School personnel with experience in administering reading tests to DHH students (i.e., director of evaluation center, reading specialist) were present during all test sessions to monitor fidelity of administration and scoring procedures. See Table 1 for a summary of skills assessed, tasks involved, and sample items associated with the measures utilized in this investigation.

Participants responded to test items using a combination of sign language, fingerspelling, Visual Phonics
cues, and vocalizations. In all responses, associated mouth movements were also required in order to be considered correct. Furthermore, if a vocalization was produced to accompany the Visual Phonics cues, fingerspelled, or signed response, the correct vocal sensation had to be produced. These procedures are consistent with other studies of this type employing curriculum-based and standardized measures of reading achievement (see Trezek et al., 2010, for review).

In a few rare instances, an exception was made when a condition made it difficult or impossible for the student to produce a mouth movement (e.g., apraxia, cerebral palsy). In these cases, the Visual Phonics cues alone were accepted as a correct response.

Hypotheses

Based on the findings of the National Reading Panel (2000) favoring direct, explicit, and systematic phonics instruction over other instructional approaches, as well as the efficacy data reported for the Corrective Reading-Decoding series (Przychodzin-Havis et al., 2005), we hypothesized that the intervention of the Decoding A curriculum supplemented by Visual Phonics would result in growth in identifying phonemes in isolation, phoneme blending, and word reading and that the development of these skills would positively affect generalization to phoneme blending within pseudowords and pseudoword reading. Because this instructional series was specifically designed to address the needs of a wide age range of remedial readers (i.e., through adulthood), including those with identified disabilities, we assumed that grade placement and presence of additional disabilities would not be factors affecting performance. Finally, results obtained in previous investigations conducted with DHH learners using the Direct Instruction curricula supplemented by Visual Phonics have suggested that, although degree of hearing loss tends to be correlated with performance at pretests (i.e., lower scores associated with greater hearing loss), hearing loss has not been correlated with performance on posttest measures (see Trezek et al., 2010, for review). Therefore, we believed that consistent findings would emerge in this investigation.

Analysis

Data were analyzed in two phases. The first phase involved assessing the degree of change from the pre- to the posttest on all measures using paired-sample

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<td>Assessment</td>
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</table>
tests as well as Pearson correlations of individual change for those measures with relevant demographics (i.e., school level, degree of hearing loss, and presence of additional disabilities) and number of instructional days. These analyses were conducted using SPSS 19 (IBM Corp., 2010). The second phase embedded these variables within a larger structural equation modeling (SEM) analysis. SEM is a general framework for assessing hypothesized causal structures among measured and latent variables by comparing the observed relations among variables (i.e., the sample variances and covariances) with the relations implied by the hypothesized causal structures (i.e., the model-implied variances and covariances) (for a practical introduction to SEM, see Kline, 2011). These analyses were conducted using the SEM software LISREL 8.80 (Jöreskog & Sörbom, 2011).

The hypothesized structure for the current data took the form of a particular type of structural model, specifically a multidomain measured variable difference score structural equation model with time-independent covariates. To elaborate briefly, within this model, the growth in identifying phonemes in isolation (ISOL growth), in phoneme blending (BLEND growth), and in word reading (WORD growth; i.e., the multidomain difference score component of the model), along with the respective predictor baseline levels in these variables (ISOL pre, BLEND pre, WORD pre), served as predictors of accuracy in phoneme blending within pseudowords and in pseudoword reading (GENERAL; i.e., the structural equation portion of the model). Examining and controlling for the effects of school level was achieved through two dummy variables coding elementary, junior high, and high school groups, degree of hearing loss (PTA), and presence of additional disabilities (i.e., the time-independent covariates element of the model). Analyses also controlled for the clustering in the data due to the group-based instruction through the specification of a group cluster variable in LISREL. Overall, this model allowed for the estimation and testing of the effects of growth in knowledge of phonics on the subsequent generalization of those phonics skills and the extent to which both depend on salient individual characteristics. The full model is presented in Figure 1. Note that residuals for the baseline (pre) variables were allowed to covary, as were the residuals of the growth variables. Analyses were conducted using full information maximum likelihood estimation and the data–model fit was excellent (e.g., \( \chi^2 = 4.61, df = 6, p = .59; \) RMSEA (root mean square error of approximation) = .00). Results for standardized direct effects, indirect effects, and total effects are detailed in the next section.

Results

Pre–Post Change and Correlations

Paired-sample \( t \) tests found the pre–post difference for all three measures to be large and to have statistically significant effects. For ISOL, the average increase from the pre- to posttest score was 7.81 (\( t(126) = 19.75, p < .001, d = 1.75 \)); for BLEND, the average increase from the pre- to the posttest score was 9.73 (\( t(126) = 24.62, p < .001, d = 2.18 \); and for WORD, the average increase for the same was 10.66 (\( t(126) = 26.95, p < .001, d = 2.39 \)). In terms of the relation of change in ISOL, BLEND, and WORD with the three demographic variables (i.e., school level, degree of hearing loss, and presence of additional disabilities) and with number of instructional days, only one Pearson correlation was statistically significant. This was the correlation between a high school dummy variable (1 = high school, 0 = below high school) and change in ISOL, with a value of \( r = .199 (p = .025) \), indicating that greater positive change in ISOL tended to be experienced by those in high school than for those below high school. No other correlations were statistically significant, including those relating number of instructional days to the change variables or the other demographic variables.

Structural Model Covariates

Regarding the model depicted in Figure 1, Table 2 shows the standardized direct, indirect, and total effects of the covariates on all variables as depicted within the top, middle, and bottom of each table’s cell, respectively. The direct effect of a covariate reflects its role as a control variable within the model, rendering all remaining relations (discussed in the following paragraphs) as above and beyond those induced spuriously by the control variables. The total effect of a covariate reflects the
Figure 1  Multidomain measured variable difference score structural equation model with time-independent covariates.

Table 2  Standardized direct, indirect, and total effects of covariates

<table>
<thead>
<tr>
<th></th>
<th>Elementary</th>
<th>Junior high</th>
<th>PTA</th>
<th>Additional disability</th>
</tr>
</thead>
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<td></td>
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<tr>
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<td>-.15</td>
<td>-.16</td>
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<td></td>
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</tr>
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<td>.00</td>
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<td>.18</td>
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<td></td>
<td>-.03</td>
<td>-.19</td>
<td>.17*</td>
<td>.15</td>
</tr>
<tr>
<td>GENERAL</td>
<td>.03</td>
<td>.13*</td>
<td>.00</td>
<td>-.02</td>
</tr>
<tr>
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<td>.01</td>
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<td>.16</td>
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</table>

PTA, pure tone average; ISOL, identifying phonemes in isolation; BLEND, phoneme blending; WORD, word reading; pre, score in pretest; GENERAL, generalization to pseudoword reading.

*p < .05.
overall contribution it makes to each subsequent variable within the model (baseline, growth, and GENERAL), and is the sum of the direct and any indirect (mediated) effects it may have within the model.

With regard to school level, recall that this was coded with two dummy variables (Elementary and Junior High), thus using high school as the reference group (note that utilizing other groups as the reference revealed nothing that was not evident from this coding scheme). The only statistically significant total effect was of the Junior High variable on the BLEND baseline variable, meaning that there were initial differences related to this variable favoring junior high school students over high school students. No other total effects associated with school level were statistically significant.

Three statistically significant total effects were found for PTA and Additional Disability, all for the former. The negative total effect in the case of the WORD baseline variable implied that a greater hearing loss was associated with a lower initial score on this variable. Meanwhile, the positive effect on both the BLEND and WORD growth variables implied that a greater hearing loss was associated with greater increase on BLEND and WORD (i.e., participants had more room for improvement). No statistically significant effects were associated with school level were statistically significant.

Structural Model Baseline Measures

Table 3 shows the standardized direct, indirect, and total effects of the baseline measures on all sequelae within the model (i.e., growth variables and GENERAL), after controlling for the covariates. The extremely strong negative statistically significant paths from baseline to the corresponding growth measures reflect the common scenario that individuals who are low on baseline measures are those who grow the most, whereas those who are higher on the baseline measures have less room for improvement. With regard to the GENERAL outcome, the ISOL baseline measure has no statistically significant relations, whereas both the BLEND and WORD baseline measures do. Specifically, for the BLEND baseline measure, there is a statistically significant positive direct effect on GENERAL, a statistically significant negative effect, and overall a statistically significant positive total effect. Thus, in spite of the fact that a higher initial level of BLEND is associated with lower growth in BLEND, overall higher BLEND skills at baseline have a positive effect on GENERAL.

In the case of WORD, again statistically significant positive direct and negative indirect effects are seen, but in this case, the net total effect is not statistically significant. This means that, although higher WORD skills at baseline have a positive impact, they cannot overcome the inhibited WORD growth that results from that higher initial level. Finally, it should be noted that, similar to multiple regression, standardized path coefficients exceeding one in magnitude are not uncommon in systems with collinearity, in this case occurring as a result of the strong connections between corresponding baseline and growth measures.

Structural Model Growth Measures

Table 4 shows the standardized direct effects of the growth measures on the GENERAL outcome, after controlling for the covariates and baseline measures. Similar to the pattern for the baseline measures, the ISOL growth variable has no statistically significant relation to the outcome, whereas growth in BLEND and WORD are both positively influential on GENERAL. That is, the more growth a student experiences in BLEND and WORD, the better the GENERAL outcome.
Because the program (i.e., 37 for elementary, 57 for junior high, and 39 for high school) was greater than that expected based on information provided in the teacher’s guide and 39 for high school) was greater than that expected based on information provided in the teacher’s guide and 39 for high school) was greater than that expected based on information provided in the teacher’s guide

Table 4 Standardized direct effects of growth variables

<table>
<thead>
<tr>
<th></th>
<th>ISOL growth</th>
<th>BLEND growth</th>
<th>WORD growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENERAL</td>
<td>-0.54</td>
<td>1.19*</td>
<td>0.64*</td>
</tr>
</tbody>
</table>

ISOL, identifying phonemes in isolation; BLEND, phoneme blending; WORD, word reading; pre, score in pretest; GENERAL, generalization to pseudoword reading.

*p < .05.

Discussion

The purpose of this study was to examine the results of implementing remedial instruction in the alphabetic principle with DHH students in the 2nd grade or higher and educated in a setting employing a sign bilingual model. More specifically, the goal of this inquiry was to explore participants’ acquisition and generalization of skills as a result of remedial instruction. As hypothesized, the intervention of the Decoding A curriculum supplemented by Visual Phonics resulted in growth in identifying phonemes in isolation, phoneme blending, and word reading. Results of the analysis indicated that there was statistically significant difference between pre- and posttest scores and Cohen’s $d$ estimates revealed effect sizes of 1.75, 2.18, and 2.39 for the three dependent measures, respectively. Cohen (1988) defined effect sizes as small when $d = .2$, medium when $d = .5$, and large when $d = .8$. Therefore, the calculated Cohen’s $d$ on participants’ difference scores can be considered large. These findings are consistent with similar studies evaluating the efficacy of using the Direct Instruction series of curricula with DHH students (see Trezek et al., 2010, for review).

Although grade placement, presence of additional disabilities, and number of instructional days did not appear to be factors affecting participants’ overall performance on the measures, the mean number of days needed to complete the first 20 lessons in the Decoding A curriculum (i.e., 37 for elementary, 57 for junior high, and 39 for high school) was greater than that expected based on information provided in the teacher’s guide accompanying the curriculum. In a previous study employing the Decoding A curriculum supplemented by Visual Phonics for middle school students educated in a Total Communication environment, 30 instructional days were required to complete the first 20 lessons in the program (Trezek & Malmgren, 2005). Because access to phonemes in this study was primarily limited to visual representations produced through speechreading supplemented by Visual Phonics, instructional time was needed to teach the hand cues and ensure that appropriate mouth movements were being associated with phonemes as they were introduced in the curriculum. Additional instructional time was also dedicated to vocabulary instruction to ensure acquisition of English vocabulary. These situations individually or collectively could account for the increased instructional time required by educators to implement the Decoding A curriculum with the DHH learners in this investigation.

As with previous investigations of this type (see, Trezek et al., 2010, for review), degree of hearing loss was not a factor affecting participant performance on posttest measures. This finding is especially compelling considering the high number of participants with hearing loss in the severe to profound range (i.e., 80% of participants with hearing loss of 80 dB or greater) and the context in which the study took place. Within this particular sign bilingual setting, an accessible bilingual communication philosophy was adopted, which led the teachers to choose ASL as the primary language of instruction during reading instructional sessions. This meant that students needed to rely solely on the visual, tactile, and kinesthetic information provided by Visual Phonics because verbal representations of the phonemes were not produced during instruction.

Considering this mode of curricular presentation, the majority of students represented phonemes by providing appropriate articulatory movements of the mouth and the associated Visual Phonics cues without accompanying vocal responses during both instructional activities and assessment sessions. Although this response mode has been observed and accepted in previous investigations (e.g., Trezek & Malmgren, 2005; Trezek & Wang, 2006; Trezek et al., 2007), only those students who did not use speech for communicative purposes typically responded in this manner.

In this investigation, many more students provided this type of response, regardless of degree of hearing loss and/or speech production abilities. This instructional situation supports previous research hypotheses suggesting that some DHH individuals may be able to visually link phonemes to printed letters and words...
(e.g., Chalifoux, 1991; Chincotta & Chincotta, 1996) through mouth movements and that auditory access to, and verbal production of, phonemes is not essential for the acquisition of phonological knowledge (e.g., Adams, 1990; Hanson, 1989). It may also serve to mitigate concerns raised about the administration of assessments in a recent meta-analysis suggesting, “hearing loss and speech ability were being assessed” (Mayberry et al., 2011, p. 181).

As expected, performance at the pretest affected the amount of growth possible. Given that the pre- and posttest measures were each worth a total of 45 points, a higher pretest score limited the amount of growth that could occur. In considering the extent to which identifying phonemes in isolation, phoneme blending, and word reading affect generalization, greater growth in both phoneme blending and word reading positively influenced generalization. In other words, participants’ ability to identify phonemes in isolation alone was not sufficient to foster generalization; the ability to blend phonemes and read words also appeared to be necessary elements. These results are supported by the findings indicating that a direct, explicit, and systematic phonics instructional approach, which includes teaching phoneme blending and segmenting, produces more favorable results than curricula that do not include these features, benefitting even older students experiencing difficulty learning to read (National Reading Panel, 2000; Scammacca et al., 2007).

Limitations
We recognize and acknowledge the limitations of this research. First, because the Decoding A curriculum was adopted by the school as its primary intervention for remedial readers, including a comparison group in this study was not possible. However, the similarities in both methods and results of this investigation and those in a previously conducted study that did utilize a comparison group (Trezek & Malmgren, 2005) assists in minimizing this limitation. Second, because Visual Phonics was utilized by all teachers to implement the intervention, it is difficult to ascertain whether the Decoding A curriculum, the inclusion of Visual Phonics, or a combination thereof affected student performance. Therefore, future investigations of this type could evaluate the efficacy of this curriculum in comparison with other instructional approaches and/or utilize an instructional component analysis design to mitigate these limitations.

Third, because this study was based on the first 20 lessons of the Decoding A curriculum, skills associated with developing the alphabetic principle (i.e., phoneme identification, phoneme blending, word reading, and pseudoword reading) were the only reading skills assessed. Studies that explore the application of these skills to word reading accuracy in connected text, reading fluency, and comprehension abilities will be necessary to assess the impact of code-related reading instruction on skill development for DHH learners in the advanced stages of reading.

Fourth, although lesson observations were conducted as part of this investigation, formal data on fidelity of implementation were not collected. To address this limitation, future studies should include formal measures and employ raters not directly involved in the implementation in order to monitor the fidelity of the curricular intervention and strategies (e.g., Visual Phonics) utilized.

Finally, the first author served as a consultant for the implementation of reading curricular interventions at the school, observing and advising teachers throughout the intervention. The likelihood that this level of mentoring would be available in other sites raises a potential issue of social validity. To address this issue, studies evaluating the effects of amount and type of professional development provided to teachers as it relates to student performance should be conducted to determine the optimal amount of support needed to foster student growth.

Directions for Future Research
Although the findings of this study are promising, given the lingering questions regarding the contribution of code-related skills to reading achievement for DHH learners (Allen et al., 2009; Mayberry et al., 2011; Miller & Clark, 2011), future research studies on this topic are certainly warranted. Research conducted with hearing readers indicates that instruction in the alphabetic principle provided in kindergarten and 1st grade is most effective. Although this instruction has
also been shown to improve the ability of older students to decode text and spell, comprehension of text does not necessarily improve following instruction (National Reading Panel, 2000). This phenomenon is due in part to the necessary interaction between language- and code-related abilities that occurs during the reading process (Chall, 1996). In other words, when students are asked to apply decoding skills during instruction, they probably know the meaning of the words they are reading. However, because many DHH learners also experience English language delays, the impact of these deficits on the literacy learning process may be more pronounced for this population of students, even at the beginning stages of development (Mayberry et al., 2011; Mayer & Trezek, 2011). Therefore, future studies should include specific measures of English language (e.g., morphology, semantics, and syntax), in addition to assessments of phonics, word reading, and pseudoword decoding.

It has been suggested that in the process of learning to read and write, DHH learners follow a developmental learning trajectory that is similar to that of hearing students (e.g., Paul & Lee, 2010). Considering the assertions about the differential impact of phonics instruction based on age for hearing readers, one would assume that a similar situation would also apply to DHH readers. Therefore, future studies should explore the influence of early intervention and remedial instruction on the acquisition and generalization of code-related skills and their impact on other reading skills such as fluency and comprehension.

A minimum of 3 years of phonics instruction is recommended for typical hearing children. It has also been suggested that struggling learners may require extended instruction to successfully learn to decode (Shanahan, 2006), and reportedly, some at-risk students continue to experience difficulties in acquiring phonics skills even when systematic instruction is provided (Torgesen et al., 1999). Intervention studies evaluating the efficacy of implementing direct, explicit, and systematic code-related reading instruction for DHH students have increased considerably during the past 5 years. Therefore, future investigations should evaluate the reading achievement outcomes of DHH students who have received phonics instruction from kindergarten through 2nd grade to explore the long-range benefits of this type of instruction. These investigations could also be used to assess the most effective strategies for differentiating instruction (e.g., Visual Phonics, Cued Speech). It is recommended that study participants representing the current demographic characteristics of the overall population of DHH learners (i.e., variation and diversity in degree of hearing loss, communication philosophies, and educational settings) be recruited for these proposed studies.

**Conclusion**

The results of this inquiry add to the literature on implementing code-related reading instruction with reference to DHH students in general and on implementing remedial instruction within a sign bilingual model specifically. The findings of this investigation can also serve to resolve some of the misconceptions regarding the instructional methods and strategies utilized in interventions of this type. As illustrated by the description of the methods employed, instruction in the alphabetic principle for DHH learners does not need to be associated with an oral philosophy of education, an overemphasis on the acquisition of oral language, or the rejection of sign language (Allen et al., 2009; Mayberry et al., 2011; Miller & Clark, 2011). Using the Visual Phonics instructional tool, assessment and instruction in the alphabetic principle can be differentiated to meet the needs of a variety of DHH learners and can be implemented within the context of a sign bilingual setting. Students receiving this type of instruction can develop an understanding of the alphabetic principle through visual means that do not rely on the ability to hear phonemes or articulate them verbally. In this way, our research supports Miller and Clark’s (2011) statement that for some students, “strategies focusing on visual learning are more valuable to visual learners” (p. 471).

With that said, it is also important to consider the role of multimodal (i.e., auditory, visual, tactile, and kinesthetic) instruction in the alphabetic principle for DHH learners. Recently published demographic data suggest that nearly 60% of the school-age population of DHH learners have hearing losses in the slight to moderately severe range (Gallaudet
Furthermore, considering early identification through universal newborn hearing screening and improved amplification technologies, particularly cochlear implantation, increasing numbers of DHH learners may be able to access instruction primarily through audition and may not need to rely on the Visual Phonics instructional tool for all phoneme representations. For these students, Visual Phonics could be used as needed to support instruction. For example, students with varying degrees of hearing loss may benefit from supplementary visual, tactile, and kinesthetic information to discern short vowel sounds or to produce word endings.

Findings of this study also demonstrate that instruction in the alphabetic principle does not simply focus on students’ ability to retain phonological skills but rather teaches them to apply this knowledge to read and understand new words. This exemplifies that using a visual learning strategy such as Visual Phonics and including vocabulary instruction can support DHH students in learning the alphabetic principle, which allows them to apply this knowledge to word-level reading. Additional studies are currently underway in both sign bilingual and Total Communication settings to evaluate the impact of providing instruction in the alphabetic principle within the context of balanced literacy instruction. These investigations are exploring the use of a variety of instructional supports (i.e., Visual Phonics, Cued Speech) on developing skills such as multisyllabic word decoding, reading fluency, reading comprehension, and written production to determine the impact on the advanced reading abilities of DHH learners.

It is time to bring to an end the reading wars that are polarizing researchers and practitioners in the field of deafness. Although we contend that code-related skills are a necessary element of the reading instruction, we also recognize that the development of these skills alone is not sufficient to support overall reading achievement. As members of a field, we must resolve the either/or dichotomy, acknowledge the importance of developing skills in both the language- and code-related domains, and collaborate to explore and evaluate pedagogical practices that support the development of overall reading proficiency among DHH learners.

Conflicts of Interest
No conflicts of interest were reported.

Acknowledgment
We would like to thank the students who participated in this study and the superintendent, principals, and educators for their support of this research.

References


