EMPIRICAL MANUSCRIPT

The Effects of a Vocabulary Intervention on Teaching Multiple-Meaning Words to Students Who Are d/Deaf and Hard of Hearing

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Abstract

Building vocabulary knowledge, especially breadth and depth of word meanings, is a crucial step in assisting students to read and comprehend print independently. A large body of research has documented the low reading achievement levels of a number of Deaf and hard-of-hearing (DHH) students. The goal of the present study was to examine the effects of a vocabulary intervention to teach 24 multiple-meaning words to fourth-grade DHH students in Saudi Arabia by utilizing a single-case experimental design (multiple probe design across participants). A total of 5 students with a profound hearing loss participated in the study. About 3 of 5 received the intervention, whereas two other students served as an additional control component and were administered the pretest and posttest only. The data showed that there was a significant improvement in the recognition and comprehension scores of students who received the intervention. In contrast, students who did not receive the intervention showed no significant improvement on the posttest.

Vocabulary knowledge is strongly correlated to reading comprehension (Davis, 1944; Paul, 1989; Stahl, 1991; Stahl & Nagy, 2006). There is little doubt that knowledge of word meanings plays a vital role in the development of reading comprehension skills (Davis, 1944; McKeown & Beck, 1988; Paul, 1989, 1998; Stahl & Nagy, 2006; Williams, 2012). There are two broad dimensions of vocabulary knowledge: depth and breadth (Nagy, 2005). Both dimensions are fundamental to understanding the connection between vocabulary knowledge and reading comprehension (Qian, 1999). Breadth of vocabulary knowledge refers to vocabulary size, or the number of words that are known (Paul, Stallman, & O'Rourke, 1990), and depth of vocabulary knowledge refers to a learner's knowledge of the more subtle aspects of words, including their meanings, figurative uses, and nuances (Paul, 2009; Paul, Stallman, & O'Rourke, 1990).

Both breadth and depth of vocabulary knowledge play a significant role in facilitating reading comprehension. It is easier for readers to understand the content of a text if they possessed knowledge of a wide range of words (Curtis, 2006). Because nearly two thirds of words in reading materials in the primary grades are multiple-meaning words (e.g., Paul & Gustafson, 1991), it is important for readers to possess depth of vocabulary knowledge, particularly knowing what words mean in specific contexts (Paul, 1989, 1996).

Studies suggest that early vocabulary acquisition in schools assist students in developing reading comprehension skills later in life. Tabors, Snow, and Dickinson (2001) stated that vocabulary knowledge in young students is strongly correlated to reading comprehension skills in the fourth and seventh grades. Cunningham and Stanovich (1997) also pointed out that vocabulary knowledge in the first grade predicts reading comprehension, in particular, at the 11th grade level. If a student does not know 90–95% of the total words in a passage, it may be difficult to comprehend the passage (Luckner & Cooke, 2010; Paul, 1998).

Vocabulary Research and Deaf and Hard-of-Hearing Students

There is a large body of research documenting the low reading achievement levels of a number of Deaf and hard-of-hearing students (DHH). For instance, many studies (in the United States) have reported that the average DHH student, especially those with severe-to-profound hearing loss, graduates from high school with reading skills at or around a fourth-grade level. Some of these students leave school with reading skills at or lower than the second-grade level (Luckner & Handley, 2008; Paul, 2003, 2009; Paul, Wang, & Williams, 2013; Trezek, Wang, & Paul, 2011). The annual development rate is roughly .3 grade level each year as compared to about 1.0 grade level for students who are typical literacy learners (Trezek, Wang, & Paul, 2011). Mayer and Trezek (2018) reviewed empirical literature for DHH children who received a cochlear implant (CI) in order to ascertain the literacy achievements in DHH children with CI. Of the total studies that were reviewed, 21 reported the literacy outcomes in reading comprehension and writing for over 1,000 CI recipients. They concluded that the majority of deaf children achieved scores in the average range while their writing was lower than average.

One of several challenges to reading and comprehending written content for DHH students is the delayed acquisition of vocabulary during the optimal period of language and cognitive development. Most learning, especially in the first years of life, takes place through indirect conversations with parents and others, playing with peers, incidental listening, and watching TV and other media (Luckner & Cooke, 2010; Trezek et al., 2011). Because a number of DHH students may not be able to participate in typical through-the-air, that is, listening and spoken language, learning situations, they may not have beneficial experiences through which vocabulary is typically developed and enhanced. The limited level of vocabulary knowledge, in turn, results in difficulties in the overall literacy learning process, especially in reading and writing.

A number of empirical research studies and descriptive analyses have documented the limited vocabulary knowledge of DHH students when compared to their peers who are typical literacy learners (see reviews in Paul, 1996, 1998, 2009; Paul & Gustafson, 1991; Trezek, Wang, & Paul, 2010; Williams, 2012). Research has found that difficult vocabulary, for example, homonyms, which are words that sound the same but have different and multiple meanings, negatively impacts growth in literacy (see discussions in Nagy, 2005; Stahl & Nagy, 2006). In addition, DHH students struggle with semantic understandings, including the use of synonyms and antonyms and figurative usage of words (see discussions in Paul, 1996, 1998, 2009). Minimal vocabulary knowledge contributes not only to a lack of text comprehension but also to the limited use of sophisticated written language. In their written compositions, DHH students tended to use more nouns and verbs than the adverbs, adjectives, and conjunctions—which often adds to richer descriptions and complex sentence structures (Paul, 1998, 2009; Trezek et al., 2011).

There are a few studies that have focused on the effects of direct instruction on the learning of words. Direct instruction is defined by Rosenshine (1987) as "a systematic method of teaching with emphasis on proceeding in small steps, checking for students' understanding, and achieving active and successful participation by all students" (p. 34; see also, the discussion in Birsh, 2011). For example, Lund and Schuele (2014) used a single-case multiple design to evaluate the efficacy of word-learning training on rapid word-learning performance by providing direct instruction to five preschool DHH (pre-amplified severe-to-profound hearing loss) children, one boy and four girls, with cochlear implants. They concluded that there is a functional relation between word-learning training and receptive vocabulary knowledge; however, there was no functional relation between the word-learning training and expressive vocabulary knowledge. The researchers also concluded that direct instruction with repeated exposures is more significant and effective in supporting DHH children than with one-time exposure. In the same vein, Aceti and Wang (2010) examined the effects of explicit instruction on teaching words with multiple meanings to four DHH students with and without additional disabilities (range of hearing loss not reported). Aceti and Wang reported that all of their participants demonstrated 100% accuracy during a posttest in selecting pictures that illustrated the correct meanings.

Massaro and Light (2004) examined the effects of a *Language Wizard/Player* by using *Baldi*, a computer-animated tutor, which "provides accurate visible and audible speech in the tutoring situation" (p. 144) to teach new words directly to DHH students aged 6–10 years, who varied in hearing loss (range of hearing loss not reported). Individualized vocabulary lessons were developed for each student, and the lessons included word presentation, perception, reading, spelling, imitation, elicitation, and posttest activities. The students worked through the lessons for approximately 20–30 min, 2 days a week for 10 weeks. On the posttests, students were required to click on the image of the item that corresponded to the word that Baldi verbalized. In this study, the researchers tested specific vocabulary words on a continuous basis, while training and testing additional words simultaneously. Results indicated that students notably advanced in both listening vocabulary and word production, and 4 weeks post intervention, students had retained almost all of the target vocabulary words.

Dimling (2010) examined the efficacy of conceptually based vocabulary interventions, which included Dolch words and bridge phrases. Bridge phrases are English phrases that need to be translated into American Sign Language (ASL) for conceptual understanding—examples include phrases such as "clean up" or "fall down." The Dolch words are common high-frequency words in the early grades, and some words are multiple-meaning words (e.g., can).

The objective of Dimling's (2010) research was to identify ways in which vocabulary interventions influence students' recognition, production, and comprehension of the target words and phrases. The research participants included six second-grade students, ranging from ages 7- to 9-years-old, and those who had a moderate-to-profound hearing loss. The children used ASL signs in an English word order, also known as English signing.

All students mastered more than 60% of the Dolch words and showed significant increases in the mean number of bridge phrases that they recognized and comprehended, and a majority of students exhibited substantial increases in producing bridge phrases. It was concluded that Dolch sight words were more successfully mastered than the bridge phrases. Students mastered more than 80% of the Dolch sight words, whereas only 60% of the bridge phrases were mastered. The researchers suggested that the bridge phrases may have been difficult to comprehend and may have even exceeded the second-grade reading level of the students.

Cannon, Fredrick, and Easterbrooks (2010) researched the efficacy of reading expository books repeatedly in ASL on DVD. There were four student participants ranging from ages 10 to

12 years and who had immigrated to the United States during the past 5 years; all had severe-to-profound degrees of hearing loss. The participants read below kindergarten level according to the *Basic Reading Inventory* (Johns, 2005), and they came from high-poverty backgrounds. This multiple baseline designed study utilized three sets of five vocabulary words. The researchers used DVDs to introduce the students to each set of words; each DVD contained five vocabulary words. Achieving mastery level on one set of vocabulary words allowed the student to move to the next set of words. The DVDs included illustrations and printed text to support reading vocabulary and expressive vocabulary, and this allowed the student to see the printed vocabulary simultaneously as the expository text was being signed.

This was a 6-week-long study from baseline through the final intervention. The research revealed that the signed DVDs alone minimally impacted the students' recognition of target words during the first phase. Pre-teaching accompanied by the DVDs yielded more effective results, which suggests that direct instruction in addition to the repeated use of target words in the DVDs is critical for students' increased recognition of target words.

Barker (2003) used nouns as the target vocabulary words, which were commonly used words. There were 10–15 words in each of the 27 lessons of this intervention, and the students completed each vocabulary lesson independently. These lessons included a pretest, word presentation, practice, posttest, and word production sequence. The posttest was developed to assess listening vocabulary only. Students were required to click on the visual image of the item as Baldi spoke its name and had to receive a 100% score on the test or the lesson was repeated. After receiving 100% on a lesson's posttest, the student was able to advance to another lesson the next day. Not all of the students completed all of the lessons; however, the researchers were able to obtain data from 217 vocabulary training sessions.

Four weeks after each lesson was successfully completed, the students were tested for knowledge retention. It was revealed that the 16 DHH students with profound hearing loss, ranging from ages 8- to14-years-old, memorized a statistically significant number of new words. The results also revealed that over half of these words were still in the students' memory bank.

Another single-case multiple baseline design study was conducted by Trussell and Easterbrooks (2014). These researchers investigated the ways an adapted dialogic reading intervention called "Enhanced Storybook Interaction" impacted six young DHH (K-1) students' expressive vocabulary knowledge. A simultaneous communication approach, that is, speaking and signing simultaneously, was used in this setting, and all of the students had a mild hearing loss. The ages of the participants ranged from 4- to 6-years-old, inclusive. The researchers employed the intervention during whole class instruction.

To begin the intervention, the researchers shared storybook pictures with the students and talked about the pictures as they were being shown. During the conversations about the pictures, the researchers frequently used the target words to facilitate the participants' retaining of the words. At no point was the story that accompanied the pictures actually read. Three different books were used for this intervention; five target words were chosen for each book.

While introducing the books to the students, the researchers initiated dialogue that attempted to compel students to say or think about a target word. The intervention lasted 4 weeks, 4 days a week, for 20 min a day. A functional relationship was found between the intervention and each student's expressive vocabulary knowledge. The results indicated that students

labeled four to five target words correctly if they had had three to five exposures to the words. In addition, the researchers reported that all students sustained their knowledge of these words 1–2 weeks postintervention.

Considering the above studies, the data analysis revealed that students improved notably in both listening vocabulary and word production. Cannon et al. found that, even 4 weeks after the intervention, students had retained nearly all of the target vocabulary words (e.g., see additional reviews on the effects of direct vocabulary instruction in Barker, 2003; Coleman, MacLauchlan, Cihak, Martin, & Wolbers, 2015; Dimling, 2010; Reitsma, 2009; Wauters, Knoors, Vervloed, & Aarnoutse, 2001).

Research-Based Evidence

There is a dearth of experimental studies in the field of Deaf education regarding the development of vocabulary knowledge, resulting in limited research-based evidence (Dimling, 2007; Easterbrooks, 2005; Paul, Wang, & Williams, 2013). Likewise, in general, the interventions that are presently used with DHH students lack well-constructed research designs (Luckner, Sebald, Cooney, Young, & Muir, 2005/2006). Similarly, Easterbrooks, 2005 stated: "[w]e cannot point to many programs, materials, strategies, or interventions and declare there is experimental proof of their effectiveness. In addition, many of the practices that are considered sacred cows in deaf education have little or no evidence to support their efficacy" (p. 55).

The National Reading Panel (2000) and the No Child Left Behind (NCLB) Act (2002) [in the United States] strongly asserted that strategies for reading instruction must be based on scientific research. Currently, many instructional strategies that are used with DHH students are developed without the consideration and/or foundation of scientific research. Instead, the instructional strategies used are based on assumptions and historical practices (Hamm, 2010), and their effectiveness cannot be accurately determined. The Individuals with Disabilities Education Act (IDEA, 2004) [in the United States] asserted that instruction-based strategies must be used to teach students with disabilities who are receiving special education service (Luckner et al., 2005/2006).

The present study contributed to the research based on vocabulary instruction by identifying an educational method that improved knowledge of multiple-meaning words and offered an intervention model that might be effective in increasing vocabulary knowledge and reading comprehension of DHH students. The research literature addressing vocabulary interventions for students who are DHH is diversified; however, there seems to be a support for the use of direct instruction, with multiple exposures and activities, as an effective approach. There is also a support for focusing on teaching multiple meanings of words, given the relationship of this construct to developing reading comprehension. When compared to the present investigation, no studies were found that examined multiple meanings of words by using a single-case design for a longer intervention period, using a sizable number of words, and having a control group, not assigned to the intervention. Therefore, to the best of our knowledge, this is one of the first studies to date that utilized a single-case design to examine the effectiveness of a vocabulary intervention in enhancing the recognition and comprehension of words with multiple meanings with DHH students, especially DHH students in Saudi Arabia.

The goal of the study was to examine the use of a vocabulary intervention to teach 24 multiple meanings of words to

Table 1 Demographics for DHH participants receiving the intervention

Participant	Age	Hearing loss	Age at identification	Amplification	Age at receiving amplification
A	10 years 9 months	Bilateral profound	Birth	Hearing aids	2-years-old
B	10 years 2 months	Bilateral profound	Birth	Hearing aids	1-year-old
C	11 years 10 month	Bilateral profound	Birth	Hearing aids	9 months
Demographics for DHH participants not receiving the intervention					
D	11 years 9 months	Bilateral profound	Birth	Hearing aids	Unknown
E	10 years 6 months	Bilateral profound	Birth	Hearing aids	11 months

fourth-grade DHH students and to determine if this intervention can improve word recognition and comprehension skills. A single-case experimental design—multiple probe design across participants—was used to answer the following research questions:

1. What effect does the intervention have on the recognition of the multiple-meaning words?
2. What effect does the intervention have on the comprehension of multiple-meaning words?

Method

Setting

Two distinct approaches are used to communicate with students who are DHH in Saudi Arabia. One approach used in schools is the oral education approach, especially for hard-of-hearing students. The main purpose of the oral approach is to teach children via the use of spoken Arabic to develop listening and speaking skills; signing is not allowed in this setting. The second communication approach is labeled total or simultaneous communication, which essentially means that the teacher and students speak and sign the Arabic language simultaneously; this is similar to the use of simultaneous communication or signed English in the United States. This study was implemented in an elementary public school located in Riyadh, the capital of Saudi Arabia. Total or simultaneous communication was the mandated communication approach. Students attended classes from Sunday to Thursday from 7:00 a.m. to 12:00 noon.

Participants

One teacher, a Saudi male, participated in the study. He taught a fourth-grade reading class. This teacher earned a Bachelor's degree in Deaf education and had more than 11 years of teaching experience. He is professionally active and continuously presents at conferences and facilitates local workshops outside of Saudi Arabia.

The teacher had five male students in his class, who were fourth-grade DHH students with a profound hearing loss (see demographics in Table 1).

Of these five, only three students were randomly assigned to the intervention. The other two students were administered only a pretest and a posttest during the study and did not receive the intervention. The characteristics of these two students were roughly the same as the participants who received the intervention (see Table 1). All students came from families with Arabic spoken as their first language and are the only Deaf members of their families; these students spoke/signed in Arabic. All participants used amplification devices (hearing aids), and their medical history files did not document any additional disabilities.

The classroom teacher identified the three students, receiving the intervention, as having delayed reading skills, which meant that the students read below grade level; in fact, all student participants were reading below grade level. Saudi Arabia does not use standardized tests to measure formally the reading ability of typical students or students with special needs; therefore, teachers play a vital role in identifying the specific needs of each student. For this study, students were chosen based on their need for intervention services related to their delayed vocabulary and reading levels, as identified by their teacher.

This study received approval from an Institutional Review Board (IRB). Parental content and participant assent were obtained prior to its implementation.

Criteria for the Selection and Assessment of the Multiple-Meaning Words

The reading curriculum, used in the class for the present study, is titled لغتي الجميلة, which translates to "My Beautiful Language" in English. There are two textbooks: (a) a students' book that teachers use to teach all literacy skills that students need to master at their particular grade level and (b) an activity book in which all students complete each unit activity based on their individual skills. Each textbook has four units, and each unit takes 3 weeks, or 24 class sessions, to complete. After completing the first two units, there is a midway assessment that lasts for 1 week.

The reading curriculum was designed by the Center for Development of Curricula in the Ministry of Education, Saudi Arabia (2010). Experts in Arabic literacy have reviewed the content to determine whether it was appropriate for students' chronological age and cognitive level. The curriculum is mandatory for all teachers and is the only curriculum; no other instructional materials may be utilized. The multiple-meaning words for this study were selected from this curriculum; these words included nouns, verbs, and adjectives.

The first investigator analyzed the *My Beautiful Language* textbook to select a corpus of multiple-meaning words. The selection of multiple-meaning words was based on the recommendations of the National Reading Panel (2000): (a) important words and (b) useful words. For the present study, a word was considered important and useful if it was used in sentences across the curriculum and had more than one meaning.

Seventy-five words were selected from the curriculum, *My Beautiful Language*. The criteria for the selection of the words and the process that was used were as follows. First, the first researcher read passages in the curriculum and identified words with multiple meanings. Second, the first researcher determined if two meanings of this corpus of words were used in the curriculum. Third, the corpus of words was selected if both meanings

could be illustrated clearly by pictures. Fourth, there were few multiple-meaning words in the corpus of words for which only one meaning was used in the curriculum. The researcher felt that these words were important—so a dictionary was used to obtain a second meaning. It was also ascertained that both meanings could be illustrated clearly.

After obtaining two meanings for 75 words, the word list was submitted to two experts, with a PhD in Arabic literacy and 20 years of experience in this field, who evaluated the word selections and the words' meanings. The experts were asked to provide their opinion on whether the 75 words and meanings were appropriate for fourth-grade students; the two experts eliminated 24 words, leaving a total of 51 words.

The English versions of these words and their corresponding correct pictures were evaluated by the two researchers. It was determined and agreed that both correct pictures illustrated the meanings of the words clearly. A sample of the picture vocabulary test can be found in Appendix A.

Independent Variable

The independent variable is a vocabulary intervention, which involves direct instruction of targeted words through word web activities. Specifically, this is the use of semantic or word maps, placing written target words in the center of a chalkboard or on the table (on a card) and placing pictures, depicting meanings of the words, a short distance from the center. Direct vocabulary instruction was most suitable for the development of vocabulary knowledge in students with limited reading skills or delayed reading skills. Even efficient readers benefit from direct vocabulary instruction, as it has aided in the development of certain complex words (National Reading Panel (2000); Trezek, Wang, & Paul, 2011).

One direct instruction strategy that the National Reading Panel (2000) recommended was specific word instruction, that is, teaching students words explicitly, to promote students' vocabulary development. This method was used in the present study.

Dependent Variables

The dependent variables in the study were (a) recognition and (b) comprehension of the multiple meanings of words. Recognition was defined as a student's ability to recognize the printed word and was made apparent by the student's ability to sign or pronounce a word correctly. Comprehension was defined as a student's ability to select the two pictures of the five available pictures that correspond to the two meanings of the target word. For example, the Arabic word (فصل /فصول) has more than two meanings. The word may mean chapters of a book, seasons of a year, or semesters in school, all of which are commonly used. When a student saw the word (فصل /فصول), he had to select the two pictures that represent the selected meanings of the target word.

Assessment of the Words

Word recognition The teacher showed a target print word to the student and then asked the student to identify the word by signing it. After the student responded, the teacher completed the assessment sheet. Correct answers were labeled if the student was able to sign the printed word correctly, and an incorrect label was given if a student did not sign the printed word, that is, he did not know or did not respond, or gave an incorrect sign.

Comprehension of word meanings After the recognition assessment was completed, the teacher showed the student a printed target word and five accompanying pictures—two of the pictures correctly illustrated the word. The student needed to point to the picture(s) that correctly illustrated the word. The student then signed the meaning of the word while pointing to the picture. However, the student was only given the full credit or 1 point after he pointed to both pictures that represented the meanings of the word. The student was given *partial* credit or .5 points when he pointed to one picture that represented the meaning of the word. *Incorrect* credit or 0 point was given when the student was unable to point to the correct pictures that represented the word or he claimed that he did not know or gave no response.

Procedures

The researchers developed a protocol explaining the research project, and the first researcher obtained a list of possible teachers who might be interested in participating. The names on the list were recommended by other teachers of DHH students and the first researcher's own knowledge of available teachers. The list was prioritized based on the ratings/opinions of professionals who were teachers, but were not interested in participating. Then the first investigator contacted the individuals in a prioritized order until a person agreed to participate.

Pretest Assessment

Prior to the baseline phases, all students, whether receiving an intervention or not, were pretested on 51 words to determine their ability to recognize the targeted words and comprehend both meanings. See Appendix B for the list of 51 words. This process helped eliminate words that the intervention students might have known or could identify. All intervention students were individually assessed as well as students in the control group. The final list of 24 words used in the intervention phase were words that students did not identify and did not select two correct pictures that corresponded to the two meanings of a word. The final list of words for each student receiving the intervention can be found in Appendix C.

Baseline phase The teacher–participant prompted each intervention student with target words a minimum of three times during the baseline phase. A minimum of three probes occurred prior to an intervention. For example, data for student A were collected during the baseline phase three times in sessions 1, 2, and 4 and then the student received the intervention, starting in session 5, while students B and C stayed on the baseline. Baseline data on student B were collected during sessions 1, 5, 9, and 10, and then that student received an intervention during session 11. Baseline data on student C were collected during sessions 1, 3, 7, 15, and 16, and then that student received an intervention during session 17. The two students who were not assigned to the intervention were only pretested and posttested during the study. These data provided additional evidence that the change in scores was due to the effects of the intervention.

Intervention phase After baseline data were gathered, an intervention for each variable, recognition and comprehension, was applied to student A, whereas students B and C remained in the baseline phase. Meanwhile, all of the students received direct instruction on two target vocabulary words during each session. Student A worked with the teacher at a table behind students

B and C so that the other students, B and C, could not see the teacher.

Each intervention session included three components: opening, modeling, and closing, completed in sequential order. In the opening phase, the teacher gained the students' attention, stated the lesson's purpose, discussed the target words' importance, and reviewed the words learned in the last session (as applicable). In the modeling phase, he introduced a target word to the students first by presenting it in writing and by signing/fingerspelling it. The students were then asked to repeat the word by signing. Next, the teacher used word web activities to teach the target words. The target word was printed in the center of the board, and then he told the students that the word had two meanings. The teacher showed the first picture, which corresponded to one of the target word's meanings and then signed that meaning. He explained the first meaning of the word and then used the word in a sentence that represented the first meaning. To introduce the second meaning of the word, the teacher showed the students the second picture, signed the meaning, explained it, and then used the word in a sentence that represented the second meaning. After the instruction on both meanings of the word, the students wrote the word. At the end of the modeling phase, the teacher provided the students with a word web sheet and printed a target word in the center of the board. He placed five pictures facing up on the table and then asked the students to point to the pictures that represented the correct meanings. Lastly, the teacher asked the students to write the word. In the closing phase, the teacher reviewed what the students learned.

Each intervention required 3 weeks with 12 sessions per student 4 days per week: Sunday, Monday, Tuesday, and Wednesday.

Follow-up phase A follow-up phase assessed whether the intervention students maintained the knowledge they acquired for both recognition and comprehension during the intervention period. The first session of follow-up was 1 week after completing the intervention for each student, and the second session was 1 month after completing the intervention for each student.

Treatment Integrity

The first researcher assessed treatment integrity for a minimum of 50% of the six intervention sessions for each student. This helped determine the accuracy and delivery of the intervention components. The first researcher conducted random observations of the teacher to observe the manner in which he implemented the intervention. The mean percentage of all intervention sessions was calculated to obtain treatment integrity. If the classroom teacher delivered 8 of 10 components of a vocabulary intervention, the treatment integrity for that session was 80%. If the teacher scored lower than 80% on one of the intervention sessions, he was retrained in implementing the components. The provided instructions guided him to implement the intervention systematically. The mean percentage treatment integrity score for 18 sessions for all students was 96%.

Research Design

The present study employed a multiple probe design across participants. The single-case experimental design is feasible for evaluating the effects of interventions on low-incidence populations such as DHH students (Antia, Guardino, & Cannon, 2017; Kratochwill et al., 2010). Students are systematically introduced to the intervention over varying periods of time. The repeated measurement of the dependent variables illustrated the causal relationship between the independent and the dependent variables. Each participant, receiving the intervention, served as his own control. A student's performance prior to the intervention was compared to performance during and/or after the intervention (Cooper, Heron, & Heward, 2007; Horner et al., 2005). The researchers then used individual data analysis to document the effectiveness of the intervention.

In general, in a multiple probe design, researchers combine a baseline condition involving sporadic sessions with a treatment condition across participants. A stable baseline is obtained for participant 1; then the treatment is implemented over several sessions, and improvements in performance are observed. Once participant 1's improvement is documented over several sessions, then participant 2 will receive the treatment. The procedure is repeated with the third participant, the fourth participant, and so on (Cooper, Heron, & Heward, 2007).

The advantage of a multiple probe design is that it does not require or depend on withdrawing treatment to prove that the behavior alteration is a function of the intervention.

Inter-rater Agreement

During the pretest stage, the first investigator assessed the students on the dependent variables, and the classroom teacher was trained to document students' answers based on the assessment criteria. To calculate the inter-rater agreement, both the first researcher and the teacher recorded the students' responses to the questions for at least 33% of the baseline, 50% of the intervention, and 50% of the follow-up sessions independently and simultaneously. The researcher compared his ratings with the teacher's ratings to compute the number of agreements and disagreements. The results of inter-rater agreement are reported in Table 2.

The inter-rater agreement was calculated separately for word recognition and word comprehension using the point-by-point agreement method (Kazdin, 2011) that entails dividing the number of agreements by the number of agreements plus disagreements and then multiplying by 100. According to *What Works Clearinghouse*, the lowest acceptable inter-rater agreement is 80%. If the inter-rater agreement was lower, the researcher and teacher discussed ways to resolve disagreements so that at least a 80% agreement was obtained (Kratochwill et al., 2010).

Social Validity

Social validity was assessed by using a survey to evaluate students' opinions in relation to the acceptability of experimental procedures and its effects on learning multiple-meaning words. The researcher rated participants' acceptability by using a Likert scale (1–4), with a 1 denoting *strongly disagree* and 4 denoting *strongly agree* on four items.

Data Analysis

Visual analysis of single-case data was the fundamental and common method for analyzing data (Kahng et al., 2010). Analysis of the data is shown in Figures 1 and 2 for the baseline, intervention, and follow-up phases. Based on the visual analysis of the data, we determined the existence of a relationship between the independent and outcome variables and the strength of that relationship (Kratochwill et al., 2010). We also examined within- and between-phase data patterns using a visual analysis of (a) level, (b) trend, (c) variability, (d) immediacy of the effect, (e) overlap, and (f) consistency (Horner et al., 2005; Kratochwill et al., 2010).

Table 2 Inter-rater agreement percentages for baseline, intervention, and follow-up phases

	Student A	Student B	Student C	Across students
Phase	WR CM	WR CM	WR CM	WR CM
Baseline	100% 100%	100% 100%	100% 100%	100% 100%
Intervention	100% 83%	100% 100%	100% 100%	100% 94%
Follow-up	100% 100%	100% 100%	100% 100%	100% 100%

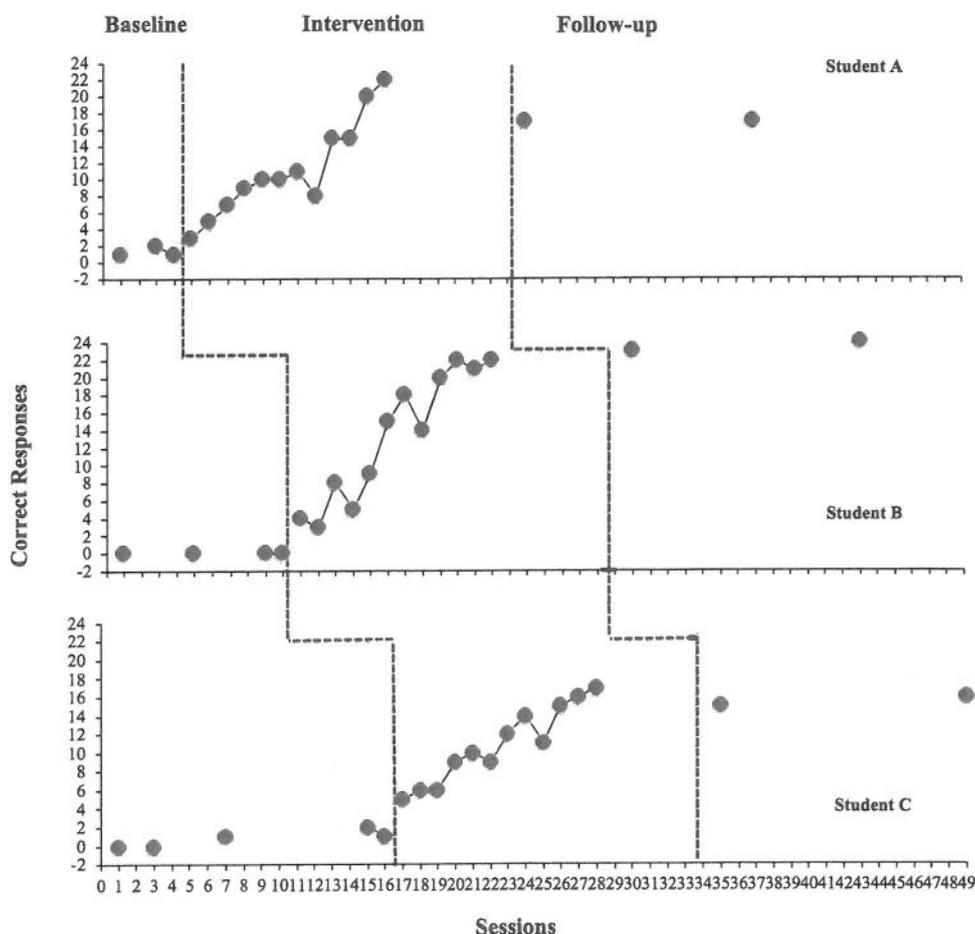Note: WR indicates word recognition and CW comprehension of words with multiple meanings.

Figure 1 Students' word recognition performance during baseline, intervention, and follow-up phases.

Thus, we assessed the level, variability, trend, immediacy of the effect, and overlap. Level referred to the mean of the data points within a phase (Kratochwill et al., 2010). Variability indicated the amount of variation in performance or the fluctuation in a participant's performance over time, which resulted in the researchers' inability to draw conclusions about treatment (Cooper et al., 2007; Horner et al., 2005). Trend, also called *slope*, referred to the tendency for a participant's performance to increase or decrease systematically during the baseline or intervention phase. The most desired baseline is a horizontal line because it better indicates the effectiveness of treatment (Kazdin, 2011). To assess the immediacy of the effect, we compared the level, trend, and variability of the last three data points in the baseline phase to the first three data points in the intervention phase as recommended by Kratochwill et al. (2010). Overlap is the data points in baseline phase that overlap with data points in the intervention phase (Kratochwill et al.,

2010). Visual analysis findings offer conservative conclusions regarding intervention effects.

We reported descriptive measures, including means, standard deviations, and ranges. Effect-size calculations were used such as percentage of non-overlapping data (PND) and standard mean difference (SMD) to supplement the visual evidence of the effects of the vocabulary intervention. New evidence for the efficacy of an intervention requires additional information. In essence, the PND procedure is the appropriate technique for quantifying intervention effectiveness (Scruggs & Mastropieri, 2013).

The SMD approach has many benefits because the results of the SMD have an actual effect size value. One of most common SMD statistics is Hedge's *g* (Durlak, 2009) that provides a powerful analysis for multiple baseline designs (Parker, Hagan-Burke, & Vannest, 2007). To obtain SMD scores by using Hedge's *g*, investigators subtract the intervention mean phase from the
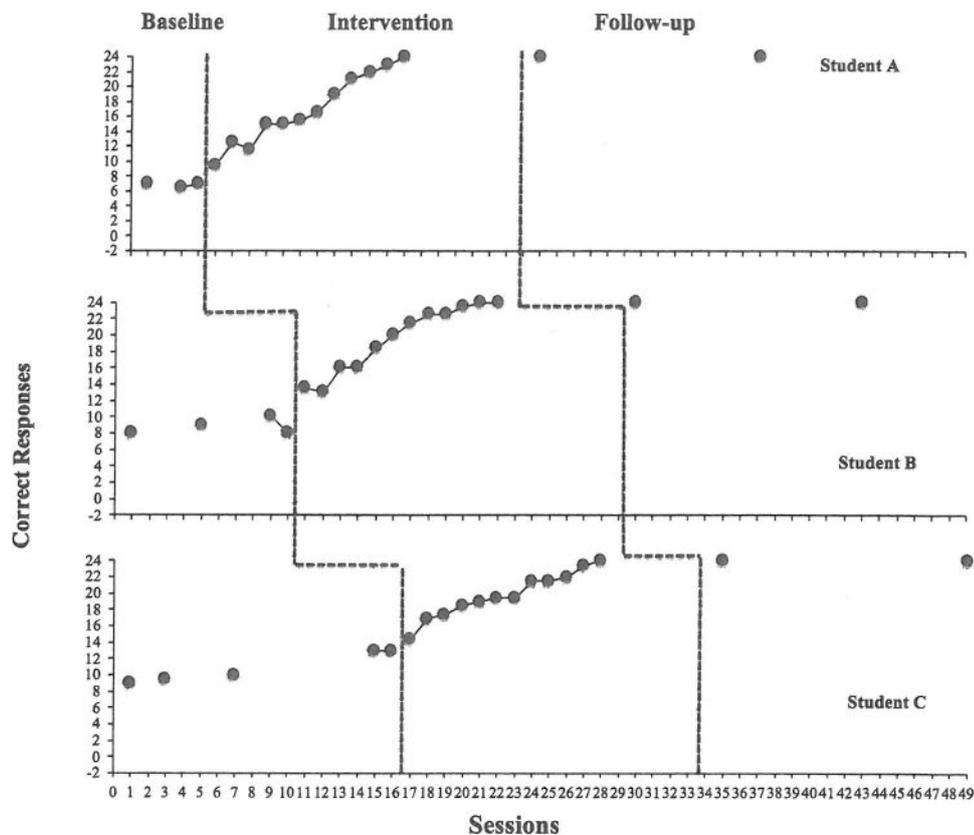
Figure 2 Students' performance during baseline, intervention, and follow-up phases on comprehension of the meanings of multiple-meaning words.

baseline mean phase and divide by the average of standard deviation of both groups—baseline and intervention (Durlak, 2009).

Results

The rule in changing from a baseline phase to an intervention involves assessing the level, variability, trend, immediacy of the effect, and overlap. We implemented the intervention when the baseline was stable for at least two sessions. With respect to overlap, the results revealed that the non-overlap effect sizes obtained in the present study were large (100%), which is a limitation because, at 100%, there is no way to tell how much difference there is between the groups—baseline and intervention. For example, a mean of 0 for a baseline and a mean of 10 for an intervention may be 100%, and a mean of 0 for baseline and a mean of 24 for an intervention may also be 100%, but these are clearly different scenarios. Hedge's *g* is a good additional value to include because it shows exactly how far apart the baseline and intervention data are in standardized units even though both have 100% non-overlap (Gage & Lewis, 2013; Parker, Hagan-Burke, & Vannest, 2007).

Word Recognition

This section presents the results that addressed the first research question: (a) what effect does the intervention have on the recognition of multiple-meaning words? All students were tested during baseline, intervention, and follow-up phases with respect to the 24 target words. Table 3 shows the mean, SD, range, PND, and Hedge's *g* for word recognition in the baseline and

intervention phases for the three students. It can be seen that, in the baseline phases, word recognition mean scores ranged from 0 to 1.33, whereas during the intervention phases, word recognition scores increased and ranged from 10.83 to 13.41.

Student A

The baseline phase for student A continued for three sessions before the intervention was implemented to judge its effectiveness. The mean and standard deviation of student A's performance in word recognition during the baseline phase were $M = 1.33$ and $SD = .47$. The baseline data were largely stable before the intervention, and there was no variability in performance. The percentage of correct word recognition responses in the baseline phase ranged from 4% to 8% (range = 1 word). The intervention data indicated an immediate and positive increase in the mean word recognition score ($M = 11.25$, $SD = 5.51$) with an accelerating trend. The percentage of correct word recognition responses in the intervention phase ranged from 13% to 92%, range = 19 words. The PND for word recognition was 100%, and the Hedge's *g* was 1.71, reflecting a large effect of the intervention. The baseline data and intervention data showed no overlap between the two phases (see Figure 1).

To assess the immediacy of the effect, the researchers compared the level, trend, and variability in the last three data points in the baseline phase to the first three data points in the intervention phase as recommended by Kratochwill et al. (2010). The three data points in the baseline phase ranged from 4% to 8%, whereas those in the intervention phase ranged from 13% to 29%. Therefore, the intervention had an immediate effect. At the end of the intervention, student A had recognized 92% of 24

Table 3 Mean, SD, range, PND, and Hedge's g of word recognition across participants

Student	Baseline	Intervention	Follow-up
Student A			
Mean (SD)	M = 1.33 (.47)	M = 11.25 (5.51)	M = 17.00 (.00)
Range	1	19	0
PND	100%		
Hedge's g	1.71		
Student B			
Mean (SD)	M = .00 (.00)	M = 13.42 (7.01)	M = 23.50 (.50)
Range	0	19	0
PND	100%		
Hedge's g	1.91		
Student C			
Mean (SD)	M = .80 (.75)	M = 10.83 (3.89)	M = 15.50 (.50)
Range	2	12	1
PND	100%		
Hedge's g	2.67		

target words. During follow-up 1 week and 1 month later, student A recognized 71% in session one and 71% in session 2.

Student B

Student B was probed during four sessions of the baseline phase before the intervention to judge its effectiveness (see Figure 1). The mean and standard deviation of student B's performance in word recognition during baseline were M = .00 and SD = .00. The baseline data were stable and indicated no increase in recognition before the intervention began. The percentage of correct word recognition responses in the baseline phase was 0% (range = 0). During the intervention phase, student B showed an increase in the mean word recognition score (M = 13.42, SD = 7.01), with a range of 13–92% (range = 19). The effect of the intervention on student B's performance was immediate, and the data showed an accelerating trend followed by a ceiling effect. The three data points in the baseline phase were 0%, and the first three in the intervention phase ranged from 13% to 33%. The PND for word recognition was 100%, and Hedge's g was 1.91. These results showed a consistent pattern with no overlap. The total improvement in word recognition at the end of the intervention was 92%. During follow-up 1 week and 1 month later, student B recognized 96% in session 1 and 100% in session 2.

Student C

Student C was tested five times intermittently during the baseline phase (see Figure 1), and the mean level and standard deviation of the student's performance in word recognition during baseline were M = .80 and SD = .75. The baseline data were largely stable and invariant before the intervention. The percentage of correct word recognition responses in the baseline phase ranged from 0% to 8% (range = 2). Word recognition during the intervention phase increased (M = 10.83, SD = 3.89) and ranged from 21% to 71% (range = 12). The last three data points during baseline ranged from 4% to 8%, and the first three data points in the intervention ranged from 21% to 25%. The PND and Hedge's g were 100% and 2.67, respectively. The intervention and baseline data showed a consistent pattern with no overlap. At the end of the intervention, student C recognized correctly 71% of the 24 target words. During follow-up 1 week and 1 month later, student C recognized 63% in session 1 and 67% in session 2.

Comprehension of the Meanings of Multiple-Meaning Words

In this section, the results of the vocabulary intervention on students' comprehension of the target words are presented during the baseline, intervention, and follow-up phases (see Figure 2). The specific research question examined was "what effect does the intervention have on comprehension of multiple meaning words?" The mean, standard deviations, range, PND, and Hedge's g in comprehension of the target words were reported during baseline and intervention phases. The data points in Figure 2 show the students' performance during baseline, intervention, and follow-up phases.

Student A

Student A was probed three times during the baseline phase, as shown in Figure 2, and the mean and SD of student A's comprehension of the target words during baseline were M = 6.83 and SD = .24. The baseline data was largely stable and invariant before the intervention, and the percentage of correct target word comprehension scores during baseline ranged from 27% to 29% (range = .5).

Comprehension of the target words' meanings during intervention increased immediately (M = 17.04, SD = 4.54) and ranged from 40% to 100% (range = 14.5). To assess the effect's immediacy, the last three data points in the baseline phase ranged from 27% to 29%, whereas the first three data points in the intervention phase ranged from 40% to 52%. There was no overlap between the intervention and baseline data. The PND and Hedge's g in comprehension of the target words' meanings were 100% and 2.14, respectively. At the end of the intervention, student A comprehended correctly 100% of the 24 target words. During the follow-up phase, student A comprehended correctly 100% in both session 1, which was 1 week post intervention, and session 2, which was 1 month postintervention.

Student B

Student B was probed four times during baseline as shown in Figure 2, and the mean and standard deviation of student B's performance during baseline were M = 8.75 and SD = .83. The baseline data were largely stable and invariant before the intervention. The percentage of target words comprehended
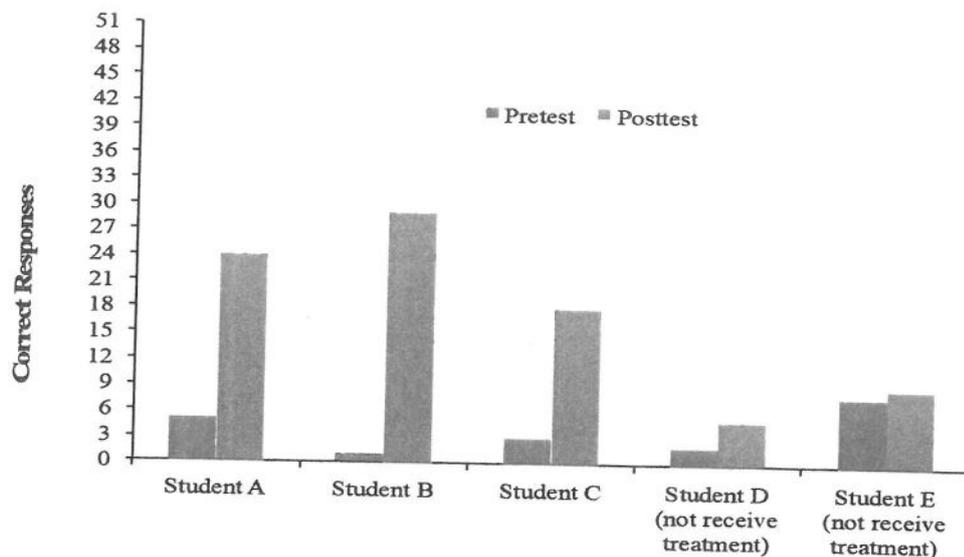
Figure 3 *Pre- and Post-Test Results.*

correctly during baseline ranged from 33% to 42% (range = 2). During the intervention, student B's word comprehension scores increased immediately ($M = 19.58$, $SD = 3.90$). The percentage of words comprehended correctly during intervention ranged from 54% to 100% (range = 11). To assess the immediacy of the effect, the last three data points during baseline ranged from 33% to 42%, and the first three data points during the intervention ranged from 54% to 67%. The intervention and baseline data showed no overlap and a consistent pattern. The PND and Hedge's g in comprehension of the target words' meanings were 100% and 2.76, respectively. At the end of the intervention, student B comprehended correctly 100% of the target words. During follow-up 1 week and 1 month later, student B achieved 100% comprehension in both sessions.

Student C

Student C was probed five times intermittently (as shown in Figure 2), and the mean and standard deviation of his comprehension of words with multiple meanings during baseline were $M = 10.9$ and $SD = 1.74$. The baseline data were less stable and showed an accelerating trend in the first three data points; however, the last two data points before the intervention were stable. The percentage of words comprehended correctly during baseline ranged from 38% to 54% (range = 4). Word comprehension during intervention increased immediately ($M = 19.83$, $SD = 2.67$), and the percentage of target words comprehended correctly during the intervention ranged from 60% to 100% (range = 9.5). To assess the immediacy of the effect, the last three data points during baseline ranged from 42% to 54%, and the first three data points during intervention ranged from 60% to 73%. The intervention and baseline data showed no overlap and were consistent. The PND and Hedge's g for comprehension of the target words' meanings were 100% and 3.24, respectively, suggesting the intervention was highly effective. At the end of the intervention, student C comprehended correctly 100% of the 24 target words. During follow-up 1 week and 1 month after the intervention, he achieved 100% in both sessions 1 and 2.

Pretest and Posttest

All students assigned to the intervention and those in the control group were pretested with 51 words before the baseline phase

and posttested 1 week after completion of the study. A control group in single-case experimental design is not necessary; however, this condition can indicate that extraneous influences are not likely to affect the data. This means that any positive results are due to the effects of the intervention (Kazdin, 2011).

Figure 3 depicts the pretest and posttest results for students who received the treatment and those who did not. The mean pretest and posttest scores for the intervention group were 3.00 and 23.67, respectively. For students who did not receive the treatment, the mean pretest and posttest scores were 5.00 and 7.00, respectively.

Students who received the treatment demonstrated a significant improvement in their mean posttest scores. For example, student A's pretest score was 9.8% on all 51 words, whereas his posttest score was 47.1%; this is an increase of 37%. Student B's pretest score was 1.96%; his posttest score was 56.9%, an increase of 54.9%. Student C's pretest score was 5.9%, and his posttest score was 35.3%, an improvement of 29.4%. Among those in the control group that did not receive the treatment, the first student's pretest score was 3.9%, and his posttest score was 9.8%, an improvement of 5.9%. The second student's pretest score was 15.7%; his posttest score was 17.7%, an improvement of 2.0%. Taken together, these results show that the students' improvement in word recognition was attributable to the vocabulary intervention.

Social Validity Data

The students who received the intervention completed a social validity survey at the end of the study to evaluate their opinions about the acceptability of the experimental procedures and their effects on learning words with multiple meanings. The researchers rated students' acceptability with four items on a Likert scale (1–4) where 1 denoted "strongly disagree" and 4 "strongly agree." For the four items, all students selected #4, "strongly agree" (see Table 4).

Discussion

The purpose of this study was to examine the effects of a vocabulary intervention to teach 24 words with multiple meanings to fourth-grade DHH students. There was a functional relation

Table 4 Likert scale for social validity

	Strongly disagree	Disagree	Agree	Strongly agree
1. I learned new multiple-meaning words	1	2	3	4
2. I liked word web activities	1	2	3	4
3. I liked engaging in the multiple-meaning word activities	1	2	3	4
4. I would like to use the multiple-meaning word activities again	1	2	3	4

between the intervention and the results. The results showed that students who received the intervention improved significantly on the dependent variables—recognition and comprehension of words with multiple meanings. In contrast, students who did not receive the intervention showed no significant improvement on the posttest.

The vocabulary intervention's effects on the students' word recognition scores varied slightly; however, all students' recognition of target words improved. Students A and B scored 91%, recognizing 22 of 24 words correctly. Interestingly, student B's score improved even more during the follow-up phase—first session, 95%; second session, 100%—whereas student A's score was 70% in both sessions. Student C showed less improvement compared to the other two students; he scored 71%, recognizing 17 of 24 words correctly, and during follow-up scored 63% in the first session and 66% in the second. Students who did not receive the treatment did not improve significantly.

The results of the intervention on the students' comprehension of words with multiple meanings were the same during the intervention and follow-up phases and showed substantial improvement. All students scored 100% during the follow-up phases, as they were able to select the two pictures among the five available alternatives that corresponded to the two meanings of the target words. Using picture cards as a tool during intervention sessions to distinguish both meanings of the targeted words may have helped the students recall these words. In particular, repeated exposures to the same pictures in addition to the instruction seem to have contributed to the students' ability to remember the target words.

This is the first study to date that has examined the effectiveness of a vocabulary intervention in enhancing the recognition and comprehension of words with multiple meanings with DHH students in Saudi Arabia. The results are similar to those of studies that demonstrated that direct vocabulary instruction increased the ability of DHH students with limited reading skills to recognize and comprehend words with multiple meanings. Direct instruction helped students learn difficult words that might interfere with reading comprehension, such as those with multiple meanings, homonyms, and homographs (National Reading Panel (2000); also, see the review in Trezek et al., 2010).

Incidental vocabulary learning varies among DHH students, and therefore, the students may need direct instruction to build their vocabulary and to facilitate the development of their reading skills (e.g., see review in Paul, Wang, & Williams, 2013). Despite the demographic variability among the participants in previous studies, including gender, language background, age, and degree of hearing loss, the findings of the present study are consistent with those of previous studies; direct instruction has a significant positive effect (Barker, 2003; Cannon, Fredrick, & Easterbrooks, 2010; Coleman, MacLauchlan, Cihak, Martin, & Wolbers, 2015; Dimling, 2010; Lund & Schuele, 2014; Massaro & Light, 2004; Trussell & Easterbrooks, 2014). In addition, delayed reading skills did not appear to be a contributing factor that pre-

vented these students from learning and comprehending new words. Direct vocabulary instruction confirmed the effectiveness of teaching new words to DHH students who vary in their reading skills and vocabulary development.

Limitations and Directions for Future Research

The present study had a few limitations. A single-case design was used in which only a small sample ($N = 3$) received the intervention; therefore, these results cannot be generalized to the larger DHH student population. In general, DHH students vary greatly in many domains, such as language exposure, parental hearing status, hearing loss, age at identification, age at amplification, etc. (Cannon, Guardino, Antia, & Luckner, 2016)—and this limits the generalization of the results.

There is a limitation associated with treatment integrity. Although inter-rater reliability was conducted on the students' performances on the tests, it was not conducted on treatment fidelity. We followed the protocol regarding the number of sessions, but only one person (first researcher) assessed treatment fidelity. The first researcher did ensure that the teacher was administering the intervention according to plan; however, it is recommended that future projects utilized two raters of treatment integrity.

Typically, it is recommended that at least three data points should be plotted during the baseline phase to ensure its stability prior to the intervention stage. We had decided to proceed to the intervention stage after plotting two data points, which we felt did establish stability. While we acknowledge this as a limitation, it is an open question whether the addition of a third data point would have made any significant difference for the participants in our study.

Several factors throughout the intervention were beyond the researchers' control, such as students' and teachers' absences, field trips, and weather conditions. This presented a few problems, and the intervention took longer than expected. The third limitation is associated with the fact that the intervention did not include any tangible reinforcements for students between sessions, and the first researcher observed that some students appeared bored during intervention sessions and inquired when the intervention would be finished. Future researchers may consider strategies such as incentives to address this matter. Fourth, the sample in this study included only males; future researchers should consider including female participants. Finally, the present study did not employ *generalization probes* to assess whether students could transfer their knowledge of target words from the vocabulary intervention to other content areas of the academic curriculum. Future investigators may wish to integrate *generalization probes*.

There are a few additional recommendations for future research. Further research is needed to examine the effects of this intervention with additional diverse groups of DHH students. Additional research should also address various factors, such as parental hearing status, students' abilities,

and hearing level, type of language, and other factors (e.g., see discussion Paul et al., 2013).

Dimling (2007) found that DHH students with additional disabilities had difficulty learning vocabulary taught compared to DHH students without additional disabilities, whereas Aceti and Wang (2010) found that both DHH students with and without additional disabilities achieved significant understanding of words with multiple meanings that were taught. Future research should investigate the benefits of the present study's intervention with DHH students with additional disabilities, with attention to the number of words and duration of the intervention. Aceti and Wang's success might have been attributable, in part, to the fact that their intervention taught students only seven words over 8 weeks.

The present study focused on assessing students' performance on a vocabulary picture test in isolation; therefore, future research should assess students' performance in an embedded task in which students are asked to define words used in the contexts of sentences. Finally, the intervention in the present study may have the potential to be implemented with typical literacy learners in general education, as well as with other students in special education settings.

Conclusion

The present study examined the use of a vocabulary intervention to teach 24 words with multiple meanings to fourth-grade DHH students and to determine whether such an intervention improved DHH students' word recognition and comprehension skills. The findings demonstrated that DHH students were able to recognize and distinguish both meanings of the target words correctly. In addition, follow-up tests conducted 1 week and 1 month after the intervention showed that students retained their knowledge of the target words. Direct instruction in vocabulary is crucial in helping struggling readers, such as DHH students, learn certain difficult words that may impede reading comprehension. Furthermore, the intervention of the present study incorporated many *causal elements*, including visual materials, explicit instruction, and scaffolding that facilitates learning for DHH students.

Overall, the acquisition of vocabulary knowledge for a number of DHH students is quantitatively delayed in comparison to the acquisition of their typical literacy peers. However, the acquisition of English, including vocabulary knowledge, among DHH learners is developmentally similar to that of children who are typical learners (e.g., see discussion in Williams, 2012). Paul and Lee (2010) and Paul et al. (2013) have also stated that children who are DHH acquire vocabulary knowledge and other literacy variables that are qualitatively similar to that of children with typical hearing who are native speakers of English. Consequently, it can be argued that DHH children learn vocabulary in a manner similar to that of their typical hearing peers, but at a slower speed. Because their rate of acquisition is slower and the amount of learning is less than that of typical literacy learners for a number of DHH children, these children need additional and focused instruction.

Based on the findings of the present study, it can be argued that Saudi DHH children who speak/sign Arabic are also able to acquire vocabulary comparable to that of their typical literacy learners who are native Arabic speakers, although at a slower acquisition rate. In a similar manner, these Arabic DHH children also require additional and focused instruction to improve their vocabulary knowledge and, subsequently, their reading comprehension ability.

Conflicts of Interest
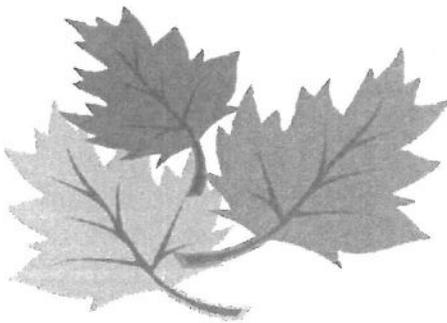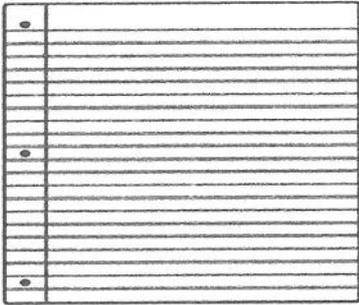
No conflicts of interest were reported.

References

Aceti, K. J., & Wang, Y. (2010). The teaching and learning of multimeaning words within a metacognitively based curriculum. *American Annals of the Deaf*, 155, 118–123. doi: 10.1353/aad.2010.0010

Antia, S. D., Guardino, C., & Cannon, J. E. (2017). Single-case design. In S. W. Cawthon & C. L. Garberoglio (Eds.), *Research in deaf education: Contexts, challenges, and considerations* (pp. 225–250). New York, NY: Oxford University Press. doi:10.1093/deafed/enx053

Barker, L. (2003). Computer-assisted vocabulary acquisition: The CSLU vocabulary tutor in oral deaf education. *Journal of Deaf Studies and Deaf Education*, 8, 187–198. doi:10.1093/deafed/eng002

Birsh, J. (2011). *Multisensory teaching of basic language skills* (3rd Ed.). Baltimore, MD: Paul H. Brooks Publishing Co.

Cannon, J. E., Fredrick, L. D., & Easterbrooks, S. R. (2010). Vocabulary instruction through books read in American Sign Language for English language learners with hearing loss. *Communication Disorders Quarterly*, 31, 98–112. doi: 10.1177/1525740109332832

Cannon, J. E., Guardino, C., Antia, S. D., & Luckner, J. L. (2016). Single-case design research: Building the evidence-base in the field of education of deaf and hard of hearing students. *American Annals of the Deaf*, 160, 440–452. doi: 10.1353/aad.2016.0007

Coleman, M. B., MacLauchlan, M. P., Cihak, D. F., Martin, M. S., & Wolbers, K. (2015). Comparing teacher-provided and computer-assisted simultaneous prompting for vocabulary development with students who are deaf or hard of hearing. *Journal of Special Education Technology*, 30, 145–156. doi: 10.1177/0162643415618913

Cooper, J., Heron, T., & Heward, W. (2007). *Applied behavior analysis* (2nd Ed.). Upper Saddle River, NJ: Prentice Hall.

Cunningham, A. E., & Stanovich, K. E. (1997). Early reading acquisition and its relation to reading experience and ability 10 years later. *Developmental Psychology*, 33, 934–945. doi: 10.1037/0012-1649.33.6.934

Curtis, M. (2006). The role of vocabulary instruction in adult basic education. *Annual Review of Adult Learning and Literacy*, 6, 43–69. Retrieved from http://www.ncsall.net/fileadmin/re sources/ann_rev/comings_ch3.pdf

Davis, F. B. (1944). Fundamental factors of comprehension in reading. *Psychometrika*, 9, 185–197.

Dimling, L. M. (2007). *Recognition, use, and comprehension of vocabulary by students who are deaf/hard of hearing: A strategic approach to vocabulary instruction*. (Doctoral dissertation). Retrieved from ProQuest Dissertations. (Order No. 3282086).

Dimling, L. M. (2010). Conceptually-based vocabulary intervention: Second graders' development of vocabulary words. *American Annals of the Deaf*, 155, 425–448. doi: 10.1353/aad.2010.0040

Durlak, J. A. (2009). How to select, calculate, and interpret effect sizes. *Journal of Pediatric Psychology*, 34, 917–928. doi: 10.1093/jpepsy/jsp004

Easterbrooks, S. R. (2005). *Review of literacy in literacy development and instruction in students who are deaf and hard of hearing*. Retrieved May 5, 2015, from http:// www.deafed.net/activities/jointogether/obj2_2litrevliteracy.doc

Gage, N. A., & Lewis, T. J. (2013). Analysis of effect for single-case design research. *Journal of Applied Sport Psychology, 25*, 46–60. doi:10.1080/10413200.2012.660673

Horner, R. H., Carr, E. G., Halle, J., McGee, G., Odom, S. L., & Wolery, M. (2005). The use of single-subject research to identify evidence-based practices in special education. *Exceptional Children, 71*, 165–179. doi:10.1177/001440290507100203

Hamm, L. D. (2010). *We can read and write: Critical characteristics of highly literate deaf and hard of hearing students and their families (Doctoral dissertation)*. Retrieved from http://digitallibrary.usc.edu/assetserver/controller/item/etd-Hamm-36 Individuals with Disabilities Education Act of 2004, P.L. 108–446.

Johns, J. (2005). *Basic reading inventory: Pre-primer through grade twelve and early literacy assessments*. Dubuque, IA: Kendall Hunt.

Kazdin, A. E. (2011). *Single-case research designs: Methods for clinical and applied settings* (2nd Ed.). Oxford, NY: Oxford University Press. doi:10.1016/0005-7916(83)90018-6

Kahng, S. W., Chung, K. M., Gutshall, K., Pitts, S. C., Kao, J., & Girolami, K. (2010). Consistent visual analyses of intrasubject data. *Journal of Applied Behavior Analysis., 43*, 35–45. doi: 10.1901/jaba.2010.43-35

Kratochwill, T. R., Hitchcock, J., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M., & Shadish, W. R. (2010). *Single-case designs technical documentation*. Retrieved from What Works Clearinghouse website http://ies.ed.gov/ncee/wwc/pdf/wwc_scd.pdf

Luckner, J., Sebald, A., Cooney, J., Young, J., & Muir, S. (2005/2006). An examination of the evidence-based literacy research in deaf education. *American Annals of the Deaf, 150*, 443–456. doi:10.1353/aad.2006.0008

Luckner, J., & Handley, C. (2008). A summary of the reading comprehension research undertaken with students who are deaf or hard of hearing. *American Annals of the Deaf, 153*, 6–36. doi:10.1353/aad.0.0006

Luckner, J., & Cooke, C. (2010). A summary of the vocabulary research with students who are deaf or hard of hearing. *American Annals of the Deaf, 155*, 38–67. doi: 10.1353/aad.0.0129

Lund, E., & Schuele, C. M. (2014). Effects of a word-learning training on children with cochlear implants. *Journal of Deaf Studies and Deaf Education, 19*, 68–84. doi:10.1093/deafed/ent036

Massaro, D. W., & Light, J. L. (2004). Improving the vocabulary of children with hearing loss. *Volta Review, 104*, 141–174.

Mayer, C., & Trezek, B. J. (2018). Literacy outcomes in deaf students with cochlear implants: Current state of the knowledge. *Journal of Deaf Studies and Deaf Education, 23*, 1–16. doi: 10.1093/deafed/enx043

McKeown, M. G., & Beck, I. L. (1988). Learning vocabulary: Different ways for different goals. *Remedial and Special Education, 9*, 42–46. doi:10.1177/074193258800900108

National Reading Panel (U.S.) & National Institute of Child Health and Human Development (U.S.) (2000). *Report of the National Reading Panel: Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction: Reports of the subgroups*. Washington, D.C.: National Institute of Child Health and Human Development, National Institutes of Health.

Nagy, W. (2005). Why vocabulary instruction needs to be long-term and comprehensive. In E. H. Hiebert & M. L. Kamil (Eds.), *Teaching and learning vocabulary: Bringing research to practice* (pp. 27–44). Mahwah, NJ: Lawrence Erlbaum Associates, Inc. doi:10.4324/9781410612922

No Child Left Behind Act of. (2002). Education. Intergovernmental relations. 20 USC 6301 note.

Ministry of Education (2010). *My beautiful language*. Riyadh, KSA: King Fahd National Library. 25, 313–324. doi: 10.1080/01443410420003012238

Parker, R. I., Hagan-Burke, S., & Vannest, K. (2007). Percentage of all non-overlapping data (PAND): An alternative to PND. *Journal of Special Education, 40*, 194–204. doi: 10.1177/00224669070400040101

Paul, P. V. (1989). Depth of vocabulary knowledge and reading. *Intervention in School and Clinic, 25*, 13–24.

Paul, P. V., Stallman, A. C., & O'Rourke, J. P. (1990). *Using three test formats to assess, good and poor readers' word knowledge* (Technical Report No. 509). Urbana, IL: Center for the Study of Reading.

Paul, P. V., & Gustafson, G. (1991). Comprehension of high-frequency multimeaning words by students with hearing impairment. *Remedial and Special Education, 12*, 52–62. doi: 10.1177/074193259101200408

Paul, P. V. (1996). Reading vocabulary knowledge and deafness. *Journal of Deaf Studies and Deaf Education, 1*, 3–15. doi: 10.1093/oxfordjournals.deafed.a014279

Paul, P. V. (1998). *Literacy and deafness: The development of reading, writing, and literate thought*. Boston, MA: Allyn and Bacon.

Paul, P. V. (2003). Processes and components of reading. In M. Marschark & P. Spencer (Eds.), *Handbook of deaf studies, language, and education* (pp. 97–109). New York, NY: Oxford University Press.

Paul, P. V. (2009). *Language and deafness* (4th Ed.). Sudbury, MA: Jones and Bartlett Publishers, LLC.

Paul, P. V., & Lee, C. (2010). The qualitative similarity hypothesis. *American Annals of the Deaf, 154*, 456–462. doi: 10.1353/aad.0.0125

Paul, P. V., Wang, Y., & Williams, C. (2013). *Deaf students and the qualitative similarity hypothesis: Understanding language and literacy development*. Washington, DC: Gallaudet University Press.

Qian, D. (1999). Assessing the role of depth and breadth of vocabulary knowledge in reading comprehension. *The Canadian Modern Language Review, 56*, 282–308. doi: 10.3138/cmlr.56.2.282

Reitsma, P. (2009). Computer-based exercises for learning to read and spell by deaf children. *Journal of Deaf Studies & Deaf Education, 14*, 178–189. doi: 10.1093/deafed/enn031

Rosenshine, B. (1987). Explicit teaching and teacher training. *Journal of Teacher Education, 38*, 34–36. doi: 10.1177/002248718703800308

Scruggs, T. E., & Mastropieri, M. A. (2013). PND at 25: Past, present, and future trends in summarizing single-subject research. *Remedial and Special Education, 34*, 9–19. doi: 10.1177/0741932512440730

Stahl, S. A. (1991). Defining the role of prior knowledge and vocabulary in reading comprehension. *Journal of Reading Behavior, 23*, 487–508. doi: 10.1080/10862969109547755

Stahl, S., & Nagy, W. (2006). *Teaching word meanings*. Mahwah, NJ: Erlbaum. doi:10.4324/9781410615381

Tabors, P. O., Snow, C. E., & Dickinson, D. K. (2001). Homes and schools together: Supporting language and literacy development. In D. K. Dickinson & P. O. Tabors (Eds.). *Beginning literacy with language: Young children learning at home and school* (pp. 313–334). Baltimore, MD: Paul H. Brookes Publishing Co. doi:10.1097/00004703-200206000-00013
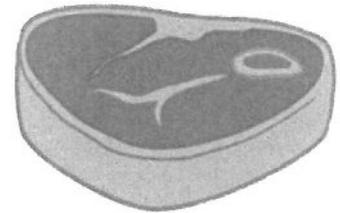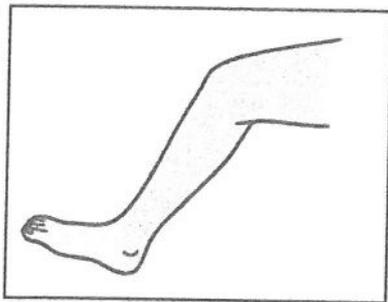
Trezek, B. J., Wang, Y., & Paul, P. V. (2010). *Reading and deafness: Theory, research, and practice*. Clifton Park, NY: Delmar/Cengage Learning.

Trezek, B. J., Wang, Y., & Paul, P. V. (2011). Processes and components of reading. In M. Marschark & P. Spencer (Eds.), *Handbook of deaf studies, language, and education (Vol. 1; Part II)* (pp. 99–114). New York, NY: Oxford University Press.

Trussell, J. W., & Easterbrooks, S. R. (2014). The effect of enhanced storybook interaction on signing deaf children's vocabulary. *Journal of Deaf Studies and Deaf Education*, 19, 319–332. doi: 10.1093/deafed/ent055

Wauters, L., Knoors, H., Vervloed, M., & Aarnoutse, C. (2001). Sign facilitation in word recognition. *Journal of Special Education*, 35, 31–41. doi:10.1177/002246690103500104

Williams, C. (2012). Promoting vocabulary learning in young children who are deaf and hard of hearing: Translating research into practice. *American Annals of the Deaf*, 156, 501–508. doi: 10.1353/aad.2012.1597

Appendix A: Vocabulary picture test

ورق

ساق

Appendix B:

<div align="center">قائمة المفردات ذات المعاني المتعددة</div>

الكلمة Word	المعنى الأولى First Meaning	المعاني الثاني Second Meaning
1. قص Telling a story	قص القصة للأطفال Telling a story	قص الورق بالمقص Cut something
2. تناول Take	تناول الشيء، أي اخذه Take something	تناول طعام الغداء Eat
3. ساق Leg	ما بين الركبة والقدم Leg (lower limb)	ساق الشجرة Tree trunk
4. سد Dam	البناء في مجرى الماء ليحجزه Dam	الحاجز بين الشيئين Filling a hole
5. غَار Grotto	الكهف (غار حراء) Grotto	غار الأخ على اخته Jealous
6. دار Home	البيت Home (house)	عاد إلى الموضع الذي ابتدأ منه Turn around
7. ساعد Wrist	ما بين المرفق والكتف Wrist	ساعده أي عاونه (المساعدة) Help
8. جار Neighbor	المجاور في المسكن Neighbor	ظالم Unjust
9. شوكة Fork	من أدوات المائدة Fork	أشواك الأشجار Thorn
10. ظرف Envelope	وضع الرسالة في الظرف Envelope	عذر Circumstance
11. قال Talking	تحدث بشيء Talking	نام في الظهيرة Take a nap
12. صف Classroom	الفصل المدرسي Classroom	صف الناس بشكل غير مستقيم Line
13. مال Money	نقود Money	مال عن الطريق الصحيح Take another direction

‫سلم موظف البريد الصندوق‬ Deliver	‫سلم المعلم على الطلاب‬ Greeting	‫14. سلم‬ Greeting
‫عربة تجرها الخيل‬ Horse-drawn cart	‫سيارة‬ Car	‫15. عربة‬ Car
‫مزق الورق‬ Torn	‫صعب عليه الأمر‬ Difficult	‫16. شق‬ Difficult
‫احتفال‬ Celebration (Eid)	‫تكرار‬ Repeating	‫17. عيد‬ Repeating
‫وثيقة سفر‬ Passport	‫جاز الشيء أصبح جوازاً‬ Allowable	‫18. جواز‬ Allowable
‫المنازل متقاربة بعضها لبعض‬ Neighborhood	‫على قيد الحياة عكس ميت‬ Alive	‫19. حي‬ Alive
‫اسنان الانسان‬ Teeth	‫عمر الإنسان‬ Age	‫20. سن‬ Age
‫جمع حبوب (حب القمح)‬ Seed	‫محبه‬ Love	‫21. حب‬ Love
‫الورق من الشجر‬ Leaves	‫ما يكتب فيه او يطبع عليه‬ Paper	‫22. ورق‬ Paper
‫ضرب الأرقام وحصل على الناتج‬ Multiplying	‫ضرب الطالب زميلاه‬ Hit	‫23. ضرب‬ Hit
‫ما ينبع من الأرض ويجري‬ An oasis	‫عضو الإبصار للإنسان‬ Eye	‫24. عين‬ Eye
‫أي: يختار ما يشاء‬ Options	‫نوع من أنواع الخضروات‬ Cucumber	‫25. خيار‬ Cucumber
‫قَلب الطالب الصفحة‬ Turn the page	‫عضو عضلي داخل الجسم‬ Heart	‫26. قَلب‬ Heart
‫جهل القراءة والكتابة‬ Illiterate	‫من الأم‬ Mother	‫27. أمي‬ Mother
‫غرفة الدراسة بالمدرسة‬ Classroom	‫فصول السنة/فصل الصيف‬ Seasons	‫28. فصل‬ Classroom
‫جاء، قدم الطالب للمدرسة‬ Came	‫عضو من أعضاء الجسم‬ Foot	‫29. قدم‬ Foot
‫ذهب، أي مضى‬ Go/Went	‫معدن ثمين‬ Gold	‫30. ذهب‬ Gold

الحرية، فلان حُر أي إطلاق سراحه Freedom	الجو شديد الحرارة the weather is hot	46.حر Hot
عظم الشيء أصبح عظيماً Glory	العظم الذي عليه اللحم Bone	47. عظم Bone
عكس خطأ Correct or (Valid)	صحة في البدن Health	48.صحة Health
رأي يتخذه المرء نحو قضية معينة Opinion about something	موضع تقف فيه السيارة Parking	49.موقف Parking
سنة/عام ١٣٠٠ Year	ملك للجميع Public	50. عام Public
زجر وشتم Rebuff	مجرى مائي River	51.نهر River

Appendix C:

<div dir="rtl">

قائمة المفردات ذات المعاني المتعددة

</div>

المعاني الثاني Second Meaning	المعنى الأولي First Meaning	الكلمة Word
قص الورق بالمقص Cut something	قص القصة للأطفال Telling a story	1. قص Telling a story
تناول طعام الغداء Eat	تناول الشيء، أي اخذه Take something	2. تناول Take
ساق الشجرة Tree trunk	ما بين الركبة والقدم Leg (lower limb)	3. ساق Leg
الحاجز بين الشيئين Filling a hole	البناء في مجرى الماء ليحجزه Dam	4. سد Dam
غار الأخ على اخته Jealous	الكهف (غار حراء) Grotto	5. غار Grotto
عاد إلى الموضع الذي ابتدأ منه Turn around	البيت Home (house)	6. دار Home
ساعده أي عاونه (المساعدة) Help	ما بين المرفق والكتف Wrist	7. ساعد Wrist
ظالم Unjust	المجاور في المسكن Neighbor	8. جار Neighbor
أشواك الأشجار Thorn	من أدوات المائدة Fork	9. شوكة Fork
عذر Circumstance	وضع الرسالة في الظرف Envelope	10. ظرف Envelope
نام في الظهيرة Take a nap	تحدث بشيء Talking	11. قال Talking
صف الناس بشكل غير مستقيم Line	الفصل المدرسي Classroom	12. صف Classroom
مال عن الطريق الصحيح Take another direction	نقود Money	13. مال Money
سلم موظف البريد الصندوق Deliver	سلم المعلم على الطلاب Greeting	14. سلم Greeting

عربة تجرها الخيل Horse-drawn cart	سيارة Car	15. عربة Car
مزق الورق Torn	صعب عليه الأمر Difficult	16. شق Difficult
احتفال Celebration (Eid)	تكرار Repeating	17. عيد Repeating
وثيقة سفر Passport	جاز الشيء أصبح جوازاً Allowable	18. جواز Allowable
المنازل متقاربة بعضها لبعض Neighborhood	على قيد الحياة عكس ميت Alive	19. حي Alive
اسنان الانسان Teeth	عمر الإنسان Age	20. سن Age
جمع حبوب (حب القمح) Seed	محبه Love	21. حب Love
الورق من الشجر Leaves	ما يكتب فيه او يطبع عليه Paper	22. ورق Paper
ضرب الأرقام وحصل على الناتج Multiplying	ضرب الطالب زميلاه Hit	23. ضرب Hit
ما ينبع من الأرض ويجري An oasis	عضو الإبصار للإنسان Eye	24. عين Eye

Appendix D: Social validity.

	Strongly disagree	Disagree	Agree	Strongly agree
1. I learned new multiple meaning words	1	2	3	4
2. I liked word web activities	1	2	3	4
3. I liked engaging in the multiple meaning words activities	1	2	3	4
4. I would like to use the multiple meaning words activities again	1	2	3	4