MULTIMEDIA STORYBOOKS: SUPPORTING VOCABULARY FOR STUDENTS WHO ARE DEAF/HARD-OF-HEARING

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A single case study examined the use of multimedia storybooks on the vocabulary acquisition of 7 preschool students who are deaf/hard of hearing in two classrooms at a school for the deaf in the U.S. Participants also included 3 speech-language pathologists. Students spent an average of 7.1 minutes daily working with the multimedia storybooks and results indicated that the average vocabulary words independently identified correctly in isolation and in the context of sentences doubled over the course of the study (5 weeks). Differentiated instruction was provided through the use of three levels of storybooks and 6 of the students benefited from this differentiated instruction. Results indicated that increased vocabulary development may be supported by the use of multimedia storybooks.

Early intervention for hearing children at risk for language difficulties helps many children to achieve once they reach school age. Despite early intervention, however, many children who are deaf/hard of hearing experience delayed language (Sarant, Holt, Dowell, Richards, & Blamey, 2009). The language levels of preschool children who are deaf/hard of hearing are delayed, often two to three years, behind their hearing peers (Marschark, 1997). They experience delays in developing their vocabulary knowledge, have smaller lexicons, and acquire new words at slower rates (Lederberg & Spencer, 2001). This becomes problematic in that for students who are deaf/hard of hearing, vocabulary is a strong predictor of performance in the early literacy skills of letter and word identification and passage comprehension (Easterbrooks, Lederberg, Miller, Bergeron, & Connor, 2008) and reading achievement (Connor & Zwolan, 2004). Furthermore, research suggests that explicit instruction is needed to improve their vocabulary (Lederberg & Spencer, 2009).

Vocabulary Instruction

Based on a review of effective instructional practices supported by scientifically based research with hearing students, the National Reading Panel (NRP) delineated five methods of vocabulary instruction: explicit instruction, indirect or implicit instruction, multimedia methods, capacity methods, and association methods (NRP, 2000). Multimedia instruction was described as the incorporation of *computer and multimedia technology to aid in the instruction of vocabulary words. Examples included CD-ROM, talking software, hypertext dictionary support, speech prompts, adaptive software, visual representations, and multisensory input* (p. 4-34). Schirmer and McGough (2005) conducted a review of the research on instruction as defined by the NRP and their application with students who are deaf/hard of hearing. The reviewers found a limited research base supporting the multimedia method of vocabulary instruction for students. Based on their review, the authors reported that computer technology, with the addition of speech or sign to computer-presented text, has the potential to enrich vocabulary instruction. Easterbrooks and Stephenson (2006) also conducted a survey of best practices in deaf education and examined the supporting research base. The authors identified use of technology as a highly cited literacy practice but indicated that the research base on use of technology is still developing.

Gentry, Chinn, and Moulton (2005), investigated the effectiveness of various multimedia presentations and reading comprehension with students who were deaf/hard of hearing, 9-18 years of age, using sign language as their primary mode of communication, and reading at the third or fourth grade level. Using a

repeated-measure design for single subjects within groups, stories were presented by CD-ROM in four formats: print only, print plus pictures, print plus sign language, and print plus pictures plus sign. The effectiveness of the multimedia presentation was measured by student performance on story retellings. Results indicated that comprehension was strongest when stories were presented in print plus pictures and weakest when stories were presented in print only. Statistically significant differences were found between print only and print plus pictures.

A second study with younger students who were deaf/hard of hearing, ages 3 to 8 years, was conducted by Prinz and Nelson (1985). The researchers developed an Apple computer interactive language software system, ALPHA. Results indicated significant improvement in syntax and vocabulary. A third study, conducted by Reitsma (2008), reported that students 6 to 9 years of age learned printed words (12 out of 20 words) using a multimedia program.

Several multimedia programs included sign language videos, HandsOn (Hanson & Padden, 1990), Rosie's Walk, Aesops Fables (Pollard, 1995a and b), and PAWS Sign Stories series (Institute for Disabilities Research and Training, Inc., 1998). They have received positive reviews and/or student feedback, but no research on improved reading or vocabulary has been reported to date. Thus the research on the use of multimedia technology to support and improve vocabulary and reading comprehension is developing, but limited.

Implementing Technology Based Vocabulary Instruction

Guidelines on the use of technology were published by the National Association for the Education of Young Children (NAEYC) and suggest integrating technology into daily routines (1996). They issued a position statement on technology use with children, ages 3 through 8, supported by research, that *computers supplement and do not replace highly valued early childhood activities and materials* (p. 1). Researchers in deaf education support this position and consider technology *a best practice when it is used to support the teacher's skilled explanation and discussion of the subject being taught. It is not considered a best practice when used as a primary source of instruction.* (Easterbrooks & Stephenson, 2006, p. 386).

Several studies reported benefits with just 10 minutes/day spent on computer assisted instruction. For example, first grade hearing students who received 8 to 10 minutes/day of computer assisted instruction over five months scored higher in reading achievement tests than those not receiving computer assisted instruction (Fletcher & Atkinson, 1972). Chera and Wood (2003) reported that hearing students 4 to 6 years of age increased phonological awareness with ten 10 minute sessions of computer assisted instruction. Similar studies involving students who are deaf/hard of hearing were not available.

Moreover, technology has been used in various ways to individualize or differentiate instruction (Smith & Throne, 2009; Stanford, Crowe, & Flice, 2010). One way technology can differentiate instruction is to personalize the content based on the current ability level or the learning rate of the student(s) (Tomlinson, 2005). Through multimedia, the process of learning can also be differentiated to include pictures, videos, and text. Therefore, multimedia storybooks can be used to implement technology based differentiated vocabulary instruction.

Statement of the Problem

Examination of the research on use of multimedia for vocabulary instruction for students who are deaf/hard of hearing indicated that the research base is still emerging and there is a need for additional research. Based on what is known from studies involving hearing students, the present study was designed such that students who are deaf/hard of hearing would spend approximately 10 minutes/day working with multimedia storybooks that presented vocabulary coordinated with teacher vocabulary instruction.

Thus, the purpose of this study was to examine the following questions. Does the use of a PowerPoint multimedia storybook increase preschool deaf/hard of hearing students' receptive vocabulary isolated at the word level? Does the use of a PowerPoint multimedia storybook increase receptive vocabulary in context at the sentence level? Can PowerPoint multimedia storybooks effectively individualize or differentiate instruction?

Methodology

Participants

Students

All students who are deaf/hard of hearing in two preschool classrooms at a school for the deaf in the U.S. were recruited for participation and all students for whom consent was given were included in the study. Participants included 7 preschool students, two of which were identified with a concomitant disability (students 4 and 7). The mean age of students was 4 years 5 months with a range in age from 3 years 6 months to 5 years 1 month. Data on level of hearing loss were reported based on the hearing loss in the better ear (see Table 1). Data further indicated that 4 students experienced a pre-lingual hearing loss and for the remaining 3 students the onset of hearing loss was unknown. As seen in Table 1, students used various assistive listening devices and no students were implanted with a cochlear implant. Five students were reported to use American Sign Language and 2 students were reported to use sign supported speech as their primary method of communication.

Educational data indicated that the average length of time students were enrolled in the current placement was 1.1 years. Students were scheduled to attend school 7 hours per day, 5 days per week with the exception of 1 student who attended 4 days per week (student 3). Four students transitioned from early intervention programs, 2 students did not attend an early intervention program, and for 1 student early intervention services were unknown. Students received speech/language services for a mean of 50.7 minutes/week with a range of 25 to 75 minutes/week. Language assessment scores were available for 5 students and were based on the Carolina Picture Vocabulary Test (Layton & Holmes, 1985) or the Preschool Language Scale, fourth edition (Zimmerman, Steiner, & Pond, 2002) (see Table 1).

Professionals

Participants also included 3 speech-language pathologists who collected data on students during interaction with the multimedia storybooks and will be referred to as data collectors. All 3 data collectors were female, hearing, held masters degrees, and reported the use of sign supported speech as their primary method of communicating with students. The mean number of years of experience was 9 years (range of 8 to 10 years). Mean number of years working with students who are deaf/hard of hearing was 6.7 years (range of 3 to 10 years). Data collectors received no pay for participation in the study, but did receive the multimedia storybook template and multimedia storybooks upon completion of the study.

Setting & Materials

The study was conducted with two preschool classrooms at a school for the deaf in the U.S. that used a Montesorri curricular approach. The setting within the school was either the speech-language pathologists' classroom or the computer area within the preschool classrooms, whichever area was consistent with the routine setting of speech service delivery. Intervention occurred during regularly scheduled speech sessions with the speech-language pathologist(s) who typically provided speech services to the participant.

The materials and equipment included: a computer with Microsoft PowerPoint software installed along with the multimedia storybook files, student data collection forms, a clock, pencils, graphing charts, stickers or bingo markers, and folders. Preparatory material included a digital camera with video capabilities, computer cable, and shareware video conversion software.

Each multimedia storybook was designed as follows. The first slide contained the initial instructions presented in print and through a sign language video with audio. The instructions also directed the student to select an action button to advance to the next screen (positioning the cursor over the arrow and clicking the left mouse button). The multimedia storybook began by individually presenting the target vocabulary words; the printed word, a picture, and a sign/audio video of the word. Students looking at the picture, listening or watching the video, and then repeating the word in voice or sign were coded as imitating or expressing the vocabulary word independently. If the student looked at the picture, listened/watched the sign, but did not repeat the word in voice or sign until additionally prompted by the data collector, the interaction was coded as imitating or expressing the vocabulary word with prompting. If the student was distracted, looked at items around the room, or needed prompting to focus on the computer, the interaction was coded as not attending. Students used an action button to advance to the next word. This process continued for the presentation of five vocabulary words.

Receptive word identification in isolation was the second section of the multimedia storybook and directions were again provided in print and sign/audio video. The printed word and a sign/audio video of

the vocabulary word along with two pictures were presented. Students were to choose the picture which correctly matched the word. Receptive word identification in isolation was coded as correctly identified independently, correctly identified with prompting, incorrectly identified, or did not attend. After each picture selection, the multimedia storybook provided the correct reinforcement (praise for positive responses and a second presentation of the correct picture, word, and sign/audio video for incorrect responses). This process continued for the five vocabulary words.

The multimedia storybook then presented directions for the receptive word identification in context section. A video was presented in sign and voice of a sentence containing the target vocabulary word with accompanying text of the sentence. Students were to select the picture, from a set of two, which correctly matched the targeted word in the sentence. Receptive word identification in context was coded using the same guidelines as identification in isolation. The multimedia storybook again provided the appropriate reinforcement after each sentence. This process continued for five sentences which were sequenced to present a short story. At the completion of the multimedia storybook, the text *Great work! Finished*. with an accompanying picture and sign/audio video were presented.

Multimedia storybooks had four themes: Shapes, Playing in the Snow, Clothes, and Winter Activities. The present study differentiated vocabulary instruction for students by the use of three levels of multimedia storybooks for each theme or week (levels one, two, and three). Storybook level one consisted of five vocabulary words, typically including one word describing the theme or category, for example clothes, jacket, boots, sweater, and mittens. The next levels consisted of new vocabulary words and the category word, for example, clothes, scarf, hat, glove, and winter. Through the levels of each storybook, students had the possibility of exposure to a total of 36 vocabulary words.

Differentiated vocabulary instruction was provided based on student baseline scores and data collection scores throughout the week. Baseline data collection began at level one for each student. Students scoring a 4 or above independently correct in both the receptive word in isolation and context advanced to a level two storybook. Then baseline procedures were repeated. Differentiated instruction was also provided based on students' scores while working on the multimedia storybooks throughout the week. Students scoring 100% independently correct in both receptive word identification in isolation and context, moved onto the next storybook level. If, however, a student was absent on the day immediately following the 100%, the story level was presented again in order to ensure student achieved at 100% following absence.

Design

A single case design was used to examine the use of multimedia storybooks on vocabulary acquisition of preschool students who are deaf/hard of hearing. Single case design allows for the examination of the impact of the intervention on student functioning while making changes during evaluation to improve the intervention without the constraints of large samples, random assignment, and control conditions (Kennedy, 2005; Cooper, Heron, & Heward, 2007). An interview with the speech-language pathologists and a review of students' school records were conducted to collect demographic data. Also, the speech-language pathologists completed an exit survey, for social validation purposes, at the completion of all interventions. Results were graphed for visual comparison and data were analyzed to compare the pre- or baseline and post intervention means.

Procedures

Training

Researchers trained the speech-language pathologists to serve as data collectors through one formal training session which included verbal directions with accompanying documentation and computer presented storybooks. Data collectors observed the researchers coding student responses during baseline data collection. Then researchers observed data collectors coding during baseline data collection. Finally, researchers provided additional training, including systematic prompting procedures.

Data Collection

The data collector selected the student folder and accompanying data collection and graphing charts, turned on the computer, selected the PowerPoint program, opened the assigned multimedia storybook file, and began the slide show. Students entered the computer area and the data collector sat directly beside them. This seating arrangement provided optimal auditory and visual access to the computer screen and student communication. When researchers collected data for procedural and inter-rater reliability, they were also seated within direct visual view of student, data collector, and computer. The

data collector marked the beginning time and the student proceeded through the storybook with the data collector recording vocabulary responses. Upon completion, the data collector marked the ending time and totaled the responses for each section on the data collection form.

Baseline: Researchers and data collectors collected baseline data for each student and each of the four multimedia storybook themes following the procedures listed above (thus four baselines per participant).

Intervention: Five times a week, students spent time with one multimedia storybook theme. The following week, students were given a second multimedia storybook theme and the intervention procedures were repeated. This continued for a total of four storybook themes over a period of four weeks. If a student was absent for one day during the week, only four days of data were collected. In one instance a student was absent for an entire week and that week of data was made up when he/she returned to school.

Students graphed their correct responses on a graphing chart using stickers or bingo markers (self-graphing is a recommended practice of the NRP, 2000). Data were recorded on three graphs per storybook (imitative or expressive vocabulary, receptive word identification in isolation, and receptive word identification in the context of a sentence) with the x axis representing the day of intervention (Monday through Friday) and the y axis representing the number of vocabulary words correct (with prompting plus independently correct).

Each week at the completion of the multimedia storybook, social validity data were collected from students. Data collectors asked, in voice and sign, and showed the accompanying text *Talking storybooks make me feel*. Students were presented with three response choices, ☺ 😐 ☹, and asked to circle one response.

Retention: Retention data were collected during the fifth week of the study using the same procedures as baseline and intervention. Retention data on storybook theme one were taken on Monday, retention measures on storybook theme two were taken on Tuesday, etc. until retention data were collected on all storybook themes.

Procedural Reliability

Procedural reliability was defined as the ability of the data collectors to follow the agreed upon instructional intervention. The researchers collected procedural reliability for each data collector and each student. Data collectors were given a list of procedures during their training and for those steps in which they followed the guidelines the inter-rater marked a checkmark on the procedures. For those steps not observed by the inter-rater, a minus sign (–) was marked. Overall procedural reliability data was 96.1%. Procedural reliability for each data collector was 96.4%, 96.6%, and 95%. Procedural reliability by student ranged from 90% to 100%.

Target Behaviors

The independent variables were the use of a multimedia storybook and the use of differentiated instruction. The dependent variable was the number of vocabulary words correctly identified. The researchers collaborated among speech-language pathologists to identify 36 target vocabulary words. Targeted vocabulary words presented in the multimedia storybooks would supplement classroom language instruction occurring during the five week study period. The dependent variable, vocabulary, was measured in three areas: imitative/expressive vocabulary, receptive word identification in isolation, and receptive word identification in the context of a sentence. Assessment of the dependent variables was embedded as part of the intervention.

Inter-rater Reliability

The present study was conducted using the speech-language pathologists as data collectors with the two researchers conducting inter-rater reliability checks. Both researchers are certified deaf education teachers, skilled in sign language, and each has 15 years or more of teaching experience. Inter-rater reliability checks were conducted in 10% of data collections and were taken on all student responses. Overall inter-rater percentage agreement was 96.3%. Inter-rater for each of the data collectors was 94.6%, 100%, and 100%. Inter-rater agreement by student ranged from 89.3% to 100%.

Social Validation

In order to assess if the learned behavior, vocabulary, and the use of the multimedia storybooks, were valuable for the students, two measures of social validity were collected (Wolf, 1978). Students completed social validity checks during the four weeks of intervention and one week of retention data collection, 26 out of 35 possible occurrences (74%). Of these, 81% indicated that they liked using the multimedia storybooks. Two students circled sad faces once each; one student found the level of the storybook challenging and the second student circled a sad face when returning from an absence due to illness. On three occasions all three faces were circled and on these occasions, the students were having difficulties with behavior in general.

At the completion of the study, the speech-language pathologists, data collectors, were asked to complete a questionnaire indicating the degree to which they agreed/disagreed with several statements on a five-point Likert scale. There was an additional section for open-ended comments. All data collectors strongly agreed (5) that the multimedia storybooks were valuable tools to reinforce student vocabulary development and strongly agreed (5) that vocabulary development increased as a result of using the storybooks. One data collector responded that *the rate of learning has been incredible, especially for students who typically move around a lot.* An open-ended question asked respondents to provide any evidence that students had generalized vocabulary. Data collectors indicated that students used the vocabulary to participate in classroom discussion which had not previously been observed; students increased labeling objects through pointing and signing; and for one student when the materials were presented in a class activity, *the student wanted to answer all of the questions and signed everything perfectly!*

Results

Time Spent with Intervention

Students spent an average of 7.1 minutes/day on the multimedia storybooks. Time spent working on the storybooks ranged from 4 minutes to 11.5 minutes. The student spending the longest time to complete a storybook (student 7) was the least skilled using a computer and had difficulties making choices. In general, the time needed to complete a given storybook decreased from baseline to retention. For most students, the time needed to complete a storybook also decreased as they progressed from Monday to Friday within a storybook.

Vocabulary

At baseline, the mean vocabulary words in isolation identified independently was 13.8 words (range of 0 to 26 words). The mean vocabulary words identified independently in the context of sentences was 14 words (range of 0 to 25 words). The mean vocabulary words identified correctly in both isolation and context was 9.9 words (range of 0 to 20 words). Baseline stability was established for all students, except student 1, with stability defined as 80% of data within 20% of the median (Neuman & McCormick, 1995). Those students with above average language skills (students 1, 3, and 5) had higher number of words identified independently at baseline than those students with below average language skills or those with no available language scores.

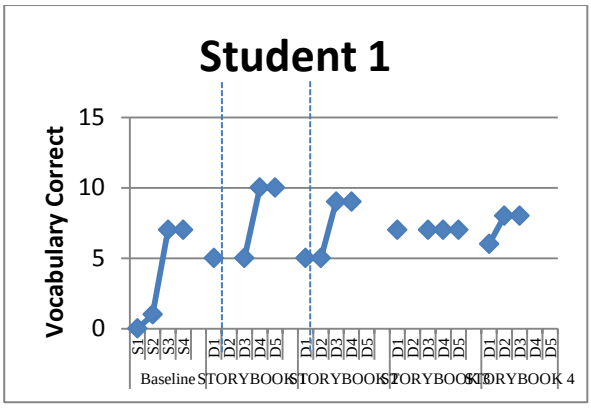
Results obtained during data collection indicated that all students showed gains in vocabulary development. The average words identified independently in isolation was 28 words (with a range of 13 to 36 words) and the average words identified independently in the context of sentences was 26.6 words (range of 9 to 35 words). The mean vocabulary words identified correctly in both isolation and context was 25.4 words (range of 7 to 35 words). Vocabulary gains did not appear to be correlated with language levels; the two students with below average language levels (students 2 and 4) made substantial gains in vocabulary development (achieving a gain of 17 and 14 words identified in isolation and 15 and 20 words identified in context). A paired sample t-test indicated a significant difference in baseline vocabulary (identified correctly in both isolation and context) and post vocabulary, $t(6)=-6.41$, $p=.001$. These results suggest that multimedia storybooks significantly increased the vocabulary of preschool students who are deaf/hard of hearing. On average, these students gained 3.9 words per week, see Table 1 for detailed vocabulary data by individual student.

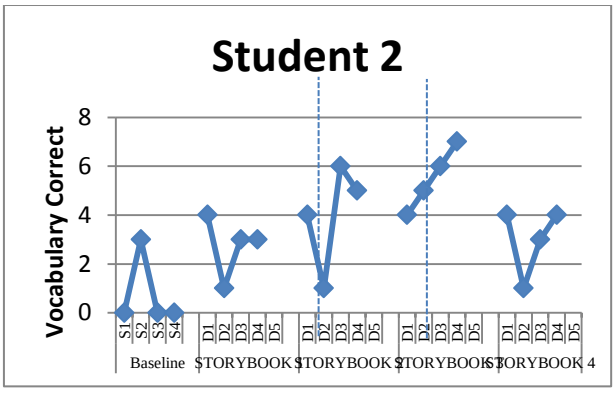
Table 1. Individual Student Data

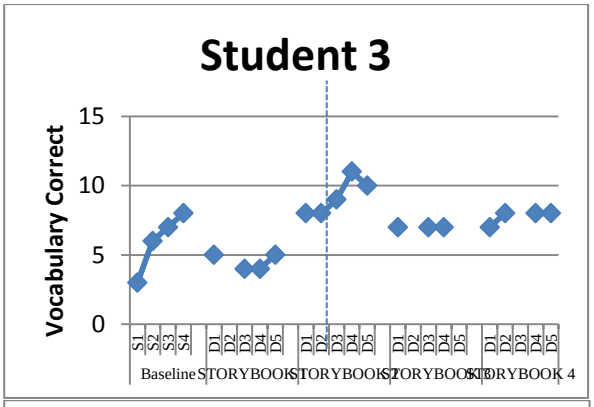
Student	Gender	Level of Hearing Loss	Auditory Equipment Reportedly Used	Language Level	Baseline Vocabulary n	Words Taught or Exposed to in Storybooks	Post Vocabulary n	Gain in Vocabulary n	Retention %
1	F	Profound	None	Above average	11	35	35	24	91.3
2	F	Mild-moderate	Classroom FM	Below average	2	26	17	15	85
3	F	Moderate-severe	Hearing Aids	Above average	20	31	29	9	100
4	M	Moderate-severe	Hearing Aids	Below average	12	36	35	23	100
5	F	Profound	None	Above average	20	36	34	14	95.3
6	F	Severe-profound	Hearing Aids and Classroom FM	-	4	26	21	17	85
7	M	Profound	None	-	0	20	7	7	60
Mean					9.9	30	25.4	15.6	88.1

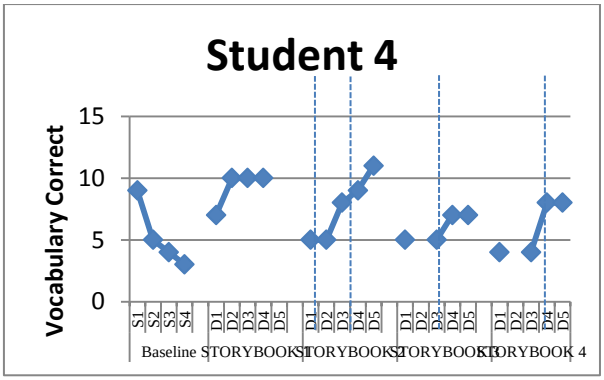
Note. Vocabulary responses independently identified correct in both isolation and context

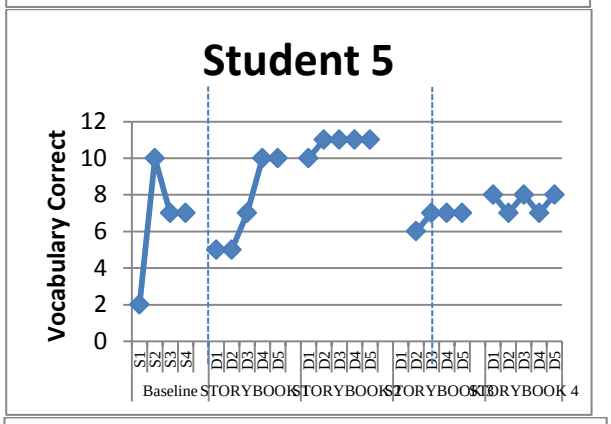
Figures 1 and 2 graphically represent data on individual students. Researchers suggest that a minimum of three data points in the same direction are needed to establish a trend (Wolery, Dunlap, & Ledford, 2011; Gast, 2010). Graphic representation of data shows at least one ascending trend line for students 2-7 indicating a gain in vocabulary development. A closer examination of variability in student graphs indicated that for students 3 and 4, vocabulary scores after student absences varied. In addition, student 2 attended school four days/week, thus data were collected four times a week. Student 7 demonstrated inattentive behavior on academic tasks in general and this was seen during intervention as well. The student displayed difficulty making choices and needed prompting to scan all choices. As with other academic tasks, the student initially required hand-over-hand prompting to complete the storybook. As experience working with the storybook increased, the level of prompting decreased. In addition, anecdotal notes documented the spontaneous language of student 7 while working with the storybooks (asking for spelling, repeating vocabulary words, and identifying signers in the video). Although not specifically a research question, it should be noted that overall participant level of prompting provided by the data collectors decreased from baseline to day five of data collection while the level of total correct responses increased. Specifically, as the level of prompting decreased, the level of student independence attained in number of correct vocabulary words increased.

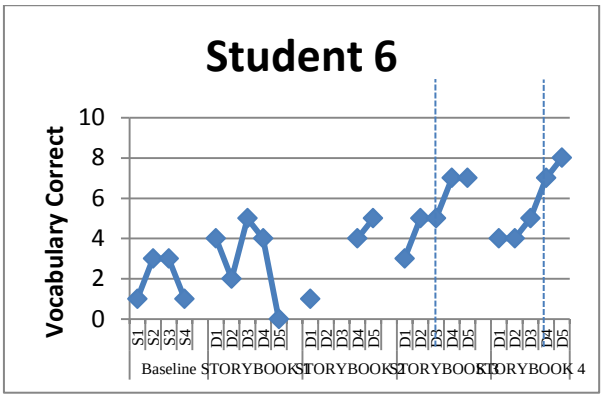


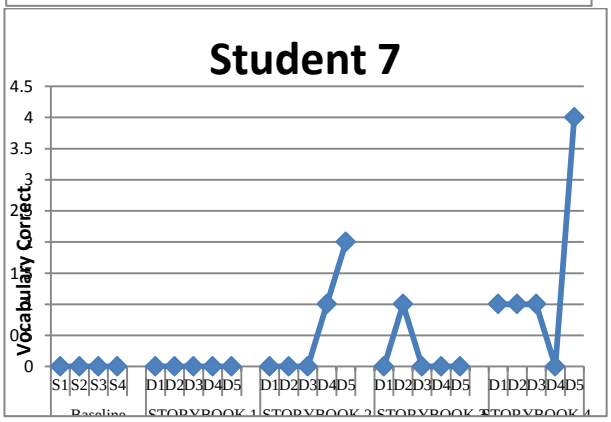






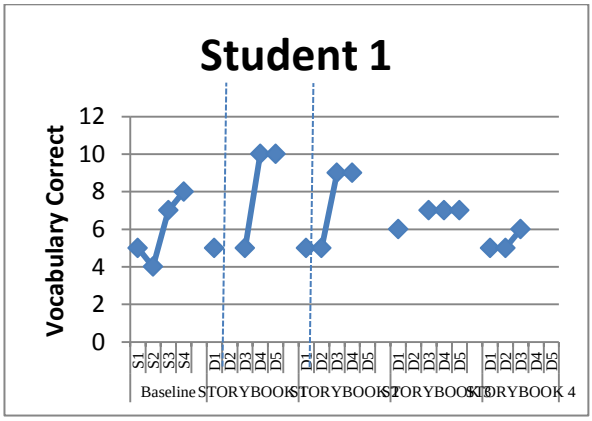


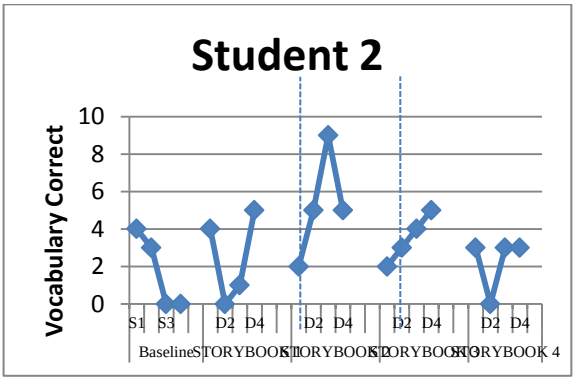




Notes: S=storybook; D=day
Break in data line indicates an absence from school

Figure1. Vocabulary Words Identified Correctly in Isolation





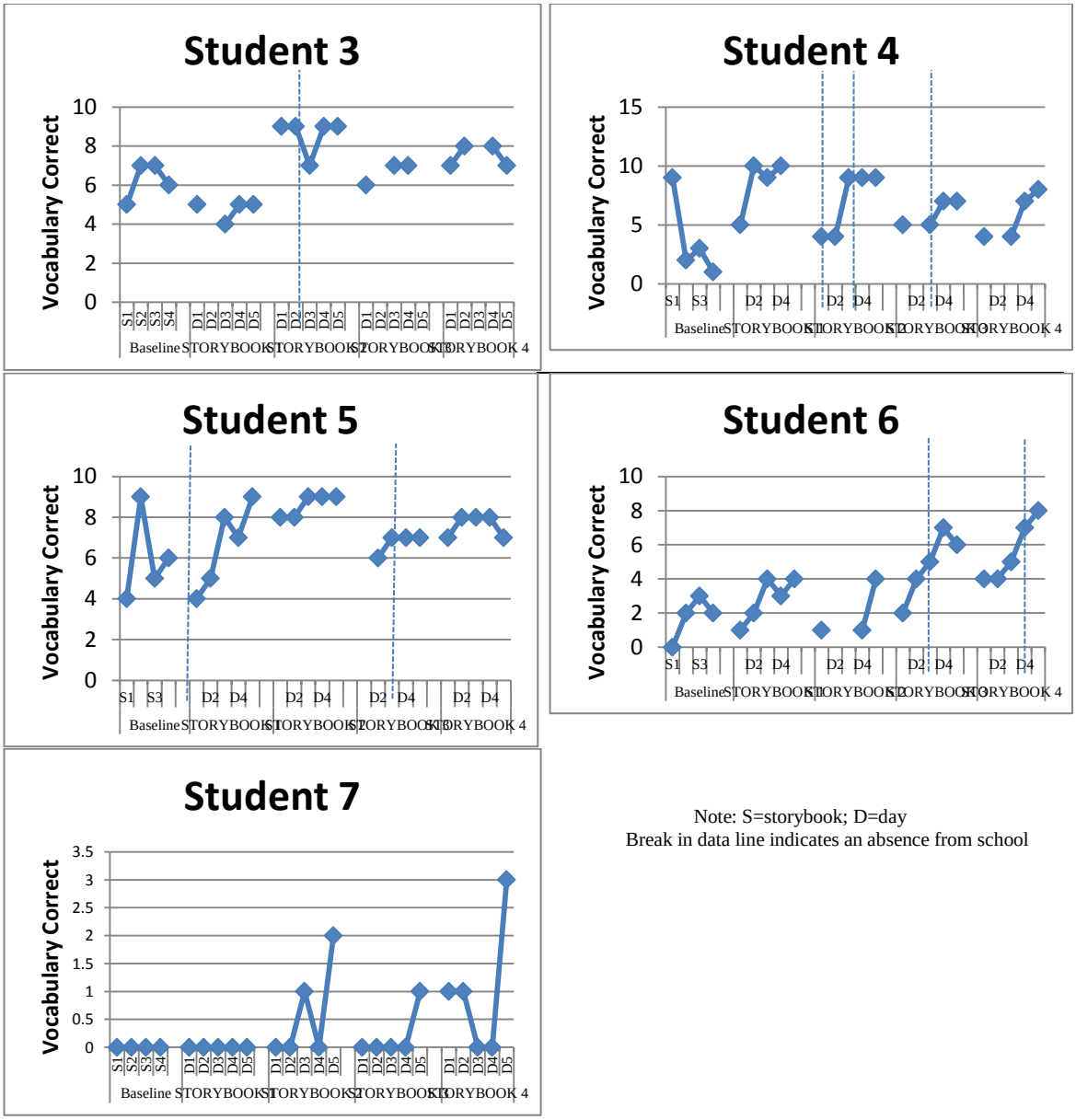


Figure 2. Vocabulary Words Identified Correctly in Context

Retention data were collected as described in the procedures section. Table 1 provides retention data for individual students. Average percentage of words retained for all students was 88.1% (range of 60% to 100%). During storybook one, student 7 could not remain on task to finish the book, however, on retention measures he was able to finish the storybook and score 5 out of 5 correct on receptive word identification in isolation so clearly he was learning some vocabulary and appropriate on-task behaviors during the intervention. Students 3 and 4 achieved 100% retention in both receptive words identified independently in isolation and in context for all weeks. In addition, all students achieved 100% retention of words identified independently in isolation and in context for at least one week.

Differentiated Instruction

The present study differentiated vocabulary instruction for students by the use of three levels of multimedia storybooks for each theme or week. Table 2 reports the advancement through storybook levels by student. At baseline, students were placed in a level one storybook 19 times (67.9%). Differentiated instruction was provided in 32.1% of the baselines with students placing in a level two storybook 5 times and in a level three storybook 4 times. Of the total 7 students, 4 students (students 1, 3, 4, and 5) placed in a level beyond level one during baseline thus were able to benefit from differentiated instruction at baseline.

Differentiated instruction was also achieved when data supported student achievement on vocabulary scores throughout the week. This occurred 12 times (42.9%) with 1 student (student 4) moving up two levels during one week of data collection. In these instances, students worked on the storybook an average of 2.2 times or days before moving to the next level. There was 1 student who was incorrectly advanced to a storybook level without mastery in both isolation and context (student 2, storybook 2). Only 1 student (student 7) did not advance in storybook level during data collection, the remaining 6 students were able to benefit from individualized instruction based on data collection (see Table 2).

Table 2. Differentiated Instruction

	Week 1 Shapes			Week 2 Playing in Snow			Week 3 Clothes			Week 4 Winter Activities		
	Level			Level			Level			Level		
Student	1	2	3	1	2	3	1	2	3	1	2	3
1	B	DC		B	DC				B			B
2	B			B	DC		B	DC		B		
3	B				B	DC		B				B
4		B		B		DC	B	DC		B	DC	
5	B	DC				B		B	DC		B	
6	B			B			B	DC		B	DC	
7	B			B			B			B		

Note. B represents baseline level; DC represents level achieved during data collection throughout the week

Examining factors when students did not move through levels during data collection revealed that in seven instances, students were already working with a storybook at a level two (3 students) or level three (4 students) based on their baseline scores. For the 4 students at a level three, these students could have advanced to a level four storybook but the study was only designed to provide three levels of differentiation. Only 1 student (student 7) did not advance beyond a level one during either baseline or data collection. Although the student did not move within levels of the storybooks, the student did increase in vocabulary words identified correctly and spontaneous language was recorded.

Overall, 3 students advanced through levels for all four multimedia storybooks (students 1, 4, and 5). These 3 students also demonstrated the largest number of words independently identified correctly in isolation. In summary, 6 of the 7 students were able to benefit from the use of multimedia storybooks to differentiate vocabulary instruction.

Anecdotal Notes

Computer Usage

Between baseline measures, data collection, and retention, the multimedia storybooks were run a total of 210 times throughout the course of the study. Technical difficulties were experienced three times (in one instance a video froze and the computer had to be rebooted; in a second incident, the audio was set to mute and the data collector changed the setting after beginning the program, and on the third incidence a technical difficulty was indicated but no notes provided on the problem). Overall, few technical difficulties were experienced.

Notes on computer usage indicated that 3 students consistently experienced difficulty navigating a mouse and needed assistance from the data collector. All students, at some point, chose to replay a video by selecting the video. One student liked the sentence *my mug is cool* and clicked on it six times to view and sign with the video. Many students, recognizing the signer on the incorrect response screen, tried to advance the slide very quickly. Students were able to successfully navigate to previous slides and repeat a sign video.

Language

Anecdotal notes also indicated that the use of the multimedia storybooks prompted spontaneous language from the students. Two students spontaneously signed or fingerspelled the reinforcement words *good job*, *wonderful*, and *uh-oh*. Additional sentences spontaneously signed by students were directed toward action on the screen, such as *sign it again*, *fingerspell it again*, *I want to go back and see if I missed one*, *fingerspell 'q' or 'p'?*, and *finished* or *bye*. Students would often sign the words for the two picture choices. Additional spontaneous sentences while watching the videos included *I like marshmallows*,

name of the signer?, *signer not here*, *darn*, and *more*. In addition, many students copied the signed sentences after watching the videos.

Summary and Discussion

Students indicated that they liked using the multimedia storybooks and spent an average of 7.1 minutes/day on the storybooks. These results were consistent with previous research with hearing students (Fletcher & Atkinson, 1972; Chera & Wood, 2003) in that students who were deaf/hard of hearing also benefited from as little as 10 minutes/day of computer instruction. Student vocabulary levels, trends, and variability were reported throughout the text, tables, and figures by storybook and participant. For research question one, does the use of Powerpoint multimedia storybooks increase receptive vocabulary at the word level, results indicated that they do. Baseline data revealed the average words independently identified correctly in isolation was 13.8 words and through interaction with the multimedia storybooks, the average words independently identified correctly in isolation was 28 words. Furthermore, baseline data reported the average vocabulary in the context of a sentence was 14 words and with intervention the average vocabulary identified in the context of a sentence was 26.6 words. Thus research question two, does the use of multimedia storybooks increase receptive vocabulary at the sentence level, the results indicated yes. In reference to research question three, can multimedia storybooks individualize or differentiate vocabulary instruction, results indicated that students were able to work with storybooks until mastery of vocabulary or proceed to work with new storybooks and new vocabulary. Through interaction with the multimedia storybooks, vocabulary identified correctly in both isolation and context more than doubled (mean was 25.4 words) and results were significant. In addition, retention was good. When working with the multimedia storybooks, prompting decreased, while correct responses increased. Also, exit survey data indicated that vocabulary increased as a result of using the storybooks, that the storybooks were a valuable tool, and that students generalized vocabulary.

Limitations

One of the limitations of the present study was the small sample size, which limits generalizing of the results. Small sample sizes are not unusual in research in deaf education or in single case designs. A second limitation may be that the increase in vocabulary may have been limited due to student exposure to only three levels of differentiation; we believe this is true for students 1 and 4. The vocabulary selected for storybooks was based on the collaborative efforts between researchers, speech-language pathologists, and the classroom teacher and was designed to coordinate with classroom instruction planned for the length of the present study. This benefit was determined by the researchers to outweigh any possible limitations.

A final limitation was discovered during data analysis. For computer usage, 3 students needed assistance with the mouse. The intervention procedures did not have protocol in place to address additional training for students' use of a mouse and a touch screen was not available at the school. Data collectors did not provide additional training in this area. This limitation was deemed minor as the tracking of computer knowledge was not one of the measures of the study design, however, additional computer training for students should be addressed in future investigations.

Implications for Teaching Practice and Future Research

Results of the study indicated that multimedia holds promise as a tool in vocabulary instruction for preschool students who are deaf/hard of hearing. More long-term and expanded research is needed to generalize these results. As this study used commercially available software, PowerPoint, this study could definitely be replicated. Multimedia storybooks could easily be created by teachers as all 3 speech-language pathologists were trained in the use of the template and at the completion of the study 1 speech-language pathologist created their own multimedia storybook.

Using multimedia storybooks provided differentiated, individualized instruction matching student needs and expanded these preschool students' vocabulary knowledge. Also, this study can add to the emerging research on the possibilities of technology enhancing vocabulary instruction for students who are deaf/hard of hearing. Given the language delays of preschool students who are deaf/hard of hearing (Marschark, 1997) and the influence of vocabulary on reading achievement (Connor & Zwolan, 2004), these findings are important.

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