Technology-Enhanced Shared Reading With Deaf and Hard-of-Hearing Children: The Role of a Fluent Signing Narrator

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Early shared reading experiences have been shown to benefit normally hearing children. It has been hypothesized that hearing parents of deaf or hard-of-hearing children may be uncomfortable or may lack adequate skills to engage in shared reading activities. A factor that may contribute to the widely cited reading difficulties seen in the majority of deaf children is a lack of early linguistic and literacy exposure that come from early shared reading experiences with an adult who is competent in the language of the child. A single-subject-design research study is described, which uses technology along with parent training in an attempt to enhance the shared reading experiences in this population of children. The results indicate that our technology-enhanced shared reading led to a greater time spent in shared reading activities and sign vocabulary acquisition. In addition, analysis of the shared reading has identified the specific aspects of the technology and the components of the parent training that were used most often.

Currently, the average deaf or hard-of-hearing student graduating from high school reads at approximately the third- or fourth-grade level (see reviews by Moores, 1996; Paul, 1998). Children with hearing loss (especially those with hearing parents) have been found to lag behind their hearing peers in measures of vocabulary (LaSasso & Davey, 1987; Paul & Gustafson, 1991; Walter, 1978), morphosyntax (Schafer & Lynch, 1980), prior knowledge (Andrews & Mason, 1991; Yamashita, 1992), and theory of mind development (Peterson & Siegel, 1995). We hypothesize that a lack of quality shared reading with deaf and hard-of-hearing children contributes to this overall poor achievement in literacy skills. We define shared reading as the interactive sharing of storybooks between an adult and a child. The mode of communication used is not critical as shared reading can occur between parents or teachers and children through the use of sign language, just as it occurs in the auditory modality through the use of speech. The term “reading aloud” may be used interchangeably so long as “aloud” is thought of as expressive language that can be either signed or spoken.

There is a need for experimental studies to assess the impact of shared reading in children who are deaf or hard of hearing. This article is an attempt to further examine ways in which the shared reading experiences can be altered or enhanced through the use of technology and parent training for deaf and hard-of-hearing children under the age of 5.

Shared Reading With Normally Hearing Children

Typically developing children and children with speech and language impairments have been found to benefit from shared reading. Snow, Burns, and Griffin (1998) identified the home literacy environment to be an important predictor of later reading success in children. Snow et al. (1998) encourage parents to talk to their children, to read and write with them, to encourage them to tell stories, to model storytelling, and to make literacy activities fun and enjoyable for their children.

Bus, van Ijzendoorn, and Pellegrini (1995) conducted a meta-analysis of several studies that examined the effect of early shared reading on the reading
outcomes of children. They found that early shared reading explained approximately 8% of the variance in reading outcome measures. The researchers concluded that shared reading contributes to the acquisition of literacy. In addition, they held that the positive effects of shared reading were found for families across socioeconomic status. Wells (1985) followed children from age 15 months to 14 years. He found that children who experienced shared reading became better readers and were more likely to have higher academic success. Those children who were read to had more knowledge of print when they entered school. This knowledge was correlated with subsequent academic achievement.

What is it about shared reading that has this effect on children? Some researchers argue that shared reading helps to familiarize children with literature and to start them on the path toward literate thought (Holdaway, 1979; Scollon & Scollon, 1981). In addition, during shared reading children are exposed to the predictive nature of story grammar. This aids in children’s comprehension of new stories and new texts. If a child is able to predict the sequence of events that occur in a story, they are more able to expend effort on other aspects of reading such as asking questions and making inferential links to their own real-life experiences (Cochran-Smith, 1984).

Written language is different from spoken language in its use of more complex syntax and vocabulary (Mason & Allen, 1986; Tannen, 1982). Hayes and Ahrens (1988) explored the diversity of vocabulary and complexity of children’s books, prime-time television shows, and college students’ conversations. The researchers found that lower frequency words were used 50% more in children’s books than in the other two settings. Shared reading exposes children to these differences and allows them to become familiar with the conventions of the written register (Mason & Allen, 1986).

Shared Reading With Children Who Are Deaf or Hard of Hearing

Mitchell and Karchmer (2004) estimate that approximately 92% of children with hearing loss are born to two hearing parents. Spencer et al. (1990, 1992) report that when the hearing status is different between mothers and children, mothers can sometimes feel a loss of control in the communicative interaction. Although the children in the Spencer studies had mild to severe hearing loss, Spencer et al. speculated that the mothers felt a need to address the visual needs of their children. For children with severe to profound deafness, a communication plan that involves only oral/aural communication will most likely not result in the development of language and speech skills commensurate with normally hearing individuals (Marschark, 1997).

Hearing parents of those children with hearing loss for whom some kind of visual input (in the form of sign language, sign codes, or cued speech) has been deemed beneficial may not have, and indeed would not be expected to have, the skills necessary to share books with their children. These skills include knowledge of a visual language, and knowledge of visual strategies to attract and maintain the attention of their deaf or hard-of-hearing children. As a result, several researchers agree that hearing parents do not read often to their children with hearing loss (Luetke-Stahlman, 1996; Marschark & Harris, 1996). In fact, a study by Ewoldt (1986) found that only 20% of elementary and middle school students with hearing loss reported that they had ever experienced shared reading with their parents. College students with hearing loss reported that when shared reading did occur, it was a disagreeable experience that they did not take pleasure in (Schleper, 1995).

Why is it that parents of deaf and hard-of-hearing children do not engage in shared reading experiences with their children? One reason may be the limited ability of most hearing parents in the use of sign language. There is no a priori expectation that hearing parents should have this ability. Before the birth of a deaf or hard-of-hearing child, there is little reason for a hearing parent to learn sign language with the exception of personal interest. If the child with hearing loss uses some form of sign language or signing code of a language, parents most likely begin to learn the language or code at the same time as their children. In addition, the child’s sign language skills are often more advanced than that of the parents’. Moeller and Luetke-Stahlman (1990) examined parental use of Signed Exact English. They found parents used...
shorter utterances than their children, and that 14%–85% of the parents’ utterances were grammatically correct. Parents’ awkwardness in the language modality of their child may cause them to shy away from shared reading experiences due to a feeling of incompetence.

In addition, a hearing parent may not be familiar with techniques related to attracting and maintaining the visual attention of their deaf or hard-of-hearing child. It has been reported that hearing parents will sometimes use strategies such as forcing a child to look where parent wishes them to look (Wood, 1989). By contrast, Deaf parents will use strategies such as a gentle tap on the child’s shoulder or maintaining eye gaze to elicit the child’s attention (Lartz & Lestina, 1995).

Research that compares the early literacy interactions of Deaf parents of children with hearing loss to hearing parents of children with hearing loss point to a common finding. Namely, the interaction styles of hearing parents with deaf or hard-of-hearing children are different from those of hearing parents of hearing children and Deaf parents of deaf or hard-of-hearing children (Lederberg & Everhart, 2000; Loots, Devise, & Jacquet, 2005; Mohay, 2000). Commonly, hearing parents of deaf or hard-of-hearing children are found to interact in a more directive manner with their children (Webster, 1992). These children with hearing loss have been found to ask fewer questions and engage their parents less in dialogue (Blum, Fields, Scharfman, & Silber, 1994; Kritzer, 2008; Nienhuys, Horsborough, & Cross, 1985).

There has been little research in the past 10 years that deals with the issue of shared reading for young deaf and hard-of-hearing children under the age of 5. Most studies focus on kindergarten or school-age children (Aram, Most, & Mayafit, 2006; Fung, Chow, & McBride-Chang, 2005; Plessow-Wolfson & Epstein, 2005). This line of research is important because the greatest amount of shared reading time occurs before a child enters first grade (Adams, 1990). In fact, it is recommended that physicians suggest to new mothers that they begin reading and sharing stories with their children when they are as young as 2 months old (Green & Palfrey, 2002). Adams also speculated that once children are in first grade, the amount of time spent sharing books with them drops dramatically and that those children who did not experience such great amounts of shared reading before this time may likely not catch up to their peers who did.

A review of the literature was conducted to identify research articles published within the past 10 years that focus on shared reading experiences between parents and their deaf or hard-of-hearing children aged 5 years or younger. The review identified only four studies. Three of these four studies were descriptive and qualitative in nature (Gioia, 2001; Stobbart & Alant, 2008; Swanwick & Watson, 2007), whereas the fourth used an experimental approach (Kaderavek & Pakulski, 2007). An additional study utilizing older children (4.2–9.5 years old) was also identified (Plessow-Wolfson & Epstein, 2005). These researchers investigated the scaffolding used by hearing mothers with their deaf children during shared reading.

Swanwick and Watson (2007) compared parents who used only spoken English (the majority were hearing; the father of one of the children had a profound hearing loss and the mother of another child had a severe hearing loss) to parents who used British Sign Language. The six children in this study had severe to profound hearing losses. Five of the children had cochlear implants, whereas one child used hearing aids.

Stobbart and Alant (2008) investigated the home literacy experiences of children with severe to profound hearing loss, most of whom used some sort of amplification. Only hearing parents participated in this study and they reported that the most common form of communication used with their children was speech and gesture.

Only hearing parents participated in Gioia’s (2001) study and they used a variety of communication modes with their children from voice to American Sign Language (ASL) and contact sign. The three children in this study had moderate to profound hearing losses and all used hearing amplification.

The results of these three qualitative studies were similar. Swanwick and Watson (2007) and Stobbart and Alant (2008) both found that hearing parents did not engage in conversations surrounding the story but
chose instead to focus on the text of the story for the purpose of teaching their children letter names and sounds, and on the pictures for the purpose of learning labels. Conversation surrounding the story is an important part of shared reading and leads to better language outcomes (Crain-Thoreson & Dale, 1999; Heath, 1982, 1983; Hockenberger, Goldstein, & Haas, 1999). Additionally, Stobbart and Alant found that the hearing mothers in their study believed it was the responsibility of the child’s teachers and the schools to develop literacy skills in their children. Similarly, Gioia (2001) found that most of the shared reading for the children in her study occurred in the school and not at home. According to reports from the children’s caregivers, they shied away from shared reading activities “due to feelings of inability rather than lack of interest” (Gioia, 2001, p. 424). Reasons why the hearing parents felt unable were not discussed.

Kaderavek and Pakulski (2007) conducted an experimental study in which motivation and interest (termed “orientation” in the study) were assessed during shared reading with children aged 2–4 years who had hearing loss ranging from mild to profound. The children’s parents were all hearing and the communication modalities used with the children ranged from aural/oral to total communication to sign language (type not specified). The first finding indicated that repeated readings were necessary before a child’s interest in a book could be assessed. The authors found that there was a significant increase in interest ratings between those children who participated in multiple readings of the same book versus those children who were only assessed after one reading of a book. Secondly, the authors found that children showed more interest in manipulative-type books than in narrative-type books. The manipulative books had physical mechanisms such as flaps or dials for the child to play with. Manipulative books often have text and pictures but not a narrative story with a plot. Narrative books are those that have a storyline along with pictures and text. Kaderavek and Pakulski state that there is a “need to provide an opportunity for children with HI (hearing impairment) to physically interact and contribute to the book reading process” (p. 66). They further state that “manipulative books may be a logical first step or appropriate book type for the reluctant reader” (p. 67).

A common conclusion from the studies discussed is that although hearing parents of deaf or hard-of-hearing children presumably know of the importance of reading and sharing stories, there is a lack in follow through. These findings suggest that training and support for these parents is needed. However, little guidance is given regarding the type of parental training and support that would be most helpful. The qualitative studies (Gioia, 2001; Stobbart & Alant, 2008; Swanwick & Watson, 2007) show that hearing mothers of children who are deaf or hard of hearing require instruction regarding ways to create conversation surrounding the story content. Additionally, we believe it is important to make the shared reading experience easier for hearing parents to alleviate some of their feelings of “inability.”

**Technology for Deaf and Hard-of-Hearing Children**

Technology has been used in the education of deaf and hard-of-hearing children for some time (Loeterman, Paul, & Donahue, 2002). Technologies that have been used and studied with respect to deaf and hard-of-hearing children relative to literacy include the use of captioning and Internet-based approaches (Easterbrooks & Stephenson, 2006). Additionally, several signed stories are available that also specifically target literacy on video home system tape, CD-ROM, or DVD such as Rosie’s Walk Sign Language CD-ROM (Hutchins, 1996) and Paws Sign Stories (Institute for Disabilities Research and Training, 1998).

Loeterman et al. (2002) have developed a multimedia curriculum for deaf and hard-of-hearing children called the cornerstones approach. It is the goal of the approach to improve deaf and hard-of-hearing children’s ability to identify words and to increase vocabulary knowledge and story comprehension. Sample units contained captioning stories as well as a paper and a hypertext version of the stories in which children were able to click on words for further information. Additionally, videotaped stories were used in which the storyteller used only ASL or only “exact representations of English.”

The cornerstones approach was evaluated in a field test of 32 deaf and hard-of-hearing children with severe to profound hearing loss, kindergarten through
fifth grade who participated in a variety of educational settings including oral-only and signing program that used forms of manually coded English and bilingual-bicultural programs. Loeterman et al. (2002) found that the children became familiar with more vocabulary words from the units beyond those that were explicitly targeted. The use of technology also allowed for greater repetition of the material and more in-depth knowledge of story concepts than would have been provided by the teachers without the use of technology. Additionally, the signed stories were “highly valued” by the students.

Alessi and Trollip (2001) state that the use of technology may be valuable under certain circumstances such as when other methods have not been successful, when much practice is necessary to master the material or skill, and when the learner is lacking in motivation. We know from the history of deaf education that although many different philosophies and approaches have been used (oral-only, sign-only, total communication, bilingual-bicultural programming), the literacy skills of deaf and hard-of-hearing children have not significantly improved; therefore, these methods have not been successful. Ericsson and Kintsch (1995) discussed the importance of practice to become a skillful reader. Research has shown that deaf and hard-of-hearing children may not experience much shared reading in the home (Luetke-Stahlman, 1996; Marschark & Harris, 1996; Schleper, 1995); therefore, their opportunities for practice may be limited. Finally, those children who initially experience difficulties in learning to read may feel less motivated to exert the effort required to improve their reading skills. The use of technology can potentially address each of these issues to better the literacy attainments ordinarily made by children with hearing loss.

**Shared Reading Project**

In order to aid hearing parents in their shared reading experiences with their deaf or hard-of-hearing children, the Shared Reading Project developed by Gallaudet University was designed to increase the amount and quality of shared reading a child with hearing loss is exposed to. The Shared Reading Project was created by Schleper (1995) while he was a teacher at the Hawaii School for the Deaf. The ultimate goal of the Shared Reading Project is to increase the literacy skills of the deaf children enrolled in the program. The Shared Reading Project is based on the research (Akamatsu & Andrews, 1993; Andrews & Taylor, 1987; Lartz & Lestina, 1995) that identified the strategies used by Deaf mothers while sharing books with their deaf children. From that research, Schleper compiled 15 principles for reading to deaf children (see Appendix A for a list of the principles). When a family is enrolled in the Shared Reading Project, they are assigned a tutor. This person is a Deaf adult who is fluent in ASL and has received training in the Shared Reading Project approach. The tutor goes into the homes of the families and works one-on-one with the parents of the deaf child to teach them how to share books with their children. On each visit, the tutor brings with him/her a bag that contains a children’s book, a video of the book signed in ASL, and a copy of the 15 shared reading principles to remind the parents of what they are. The tutor first shares the story with the parents. This is followed by the parent sharing the story with the tutor. During this time, the tutor makes suggestions on how the parent can improve. Afterward, the child is invited into the room and the parent shares the story with the child while the tutor observes and makes further suggestions. The video of the ASL translation of the story is left and is for the parents to use after the tutor leaves in the event that the parent forgets how to sign a particular part of the story.

Delk and Weidekamp (2001) have reported on the implementation of the Shared Reading Project. Although the research on the efficacy of the Shared Reading Project is not yet complete, the developers of the program have reported successes. For example, parents who were enrolled in the Shared Reading Project report that they felt their sign language skills as well as the communication interactions with their deaf or hard-of-hearing children improved (Delk & Weidekamp, 2001). Additionally, Delk and Weidekamp report that more instances of shared reading occurred in the week after the program ended for families than in the week before the program began.

The Shared Reading Project, although groundbreaking in intention and scope, has some inherent limitations. The first relates to the availability of Deaf
adults to act as tutors. In areas where the Deaf population is small such as in smaller cities or rural areas, tutors may not be available. Secondly, the cost of implementing the Shared Reading Project may be prohibitive for some sites. We estimate that the cost for the first year of starting a Shared Reading Project program in a small town where only five families might be served is approximately $25,000.00. This would include the cost for the Shared Reading Project book bags and manuals, salary for the tutors and for the site coordinators, TV/VCR combinations to loan those families that do not have one of their own, workshops for families and tutors, and compensation for translators.

Another limitation of the Shared Reading Project involves the signing skills of the parents. The tutor does not share the stories with the deaf or hard-of-hearing child. The tutor is merely there to help the parents. It is ultimately still the responsibility of the parents to provide a good language model and conversational interactions for the child in the shared reading context. Because these children and their parents are participating in the Shared Reading Project that focuses on learning to share stories in sign, it is presumed that the use of sign was predetermined to be beneficial in some way for the children. If the parents' knowledge of sign is limited, they will not be able to provide an adequate sign language model or arena for linguistic practice for their child. In addition, if the parents have limited proficiency in sign, they may be unable to comprehend comments or questions that the child poses. Likewise, the parents may find it difficult to answer questions or respond to the comments made by their child. Finally, if the parents' signing skills are limited, they may not be able to fully comprehend and follow the recommendations or suggestions of the tutor.

We feel that the use of technology can enhance the shared reading experiences of children with hearing loss and their hearing parents, aid in training hearing parents on shared reading strategies to alleviate some of the feelings of inability, and potentially make up for some of the limitations of the Shared Reading Project. Technology has been used successfully in literacy instruction for older children with hearing loss (Loeterman et al., 2002). The program used for this study is called the Iowa Signing E-Book and will be described in the next section.

**Iowa Signing E-Book**

This article describes an approach that utilizes key principles from the Shared Reading Project as well as technological support for the purpose of enhancing not only the quantity of shared reading interactions between hearing parents and their deaf or hard-of-hearing children but also the quality of those interactions. The Iowa Signing E-Book, developed by the present authors in the Assistive Devices Laboratory at the University of Iowa, provides the children and their parents with age-appropriate books in an electronic media format. The program was developed within a social constructivist framework (Derry, 1999; Vygotsky, 1978), which posits that learning occurs through social interactions. In this case, the social interactions occur through shared reading between parent and child.

The development of a working version of the Iowa Signing E-Book occurred over the span of 3 years. Guidance regarding the creation of the Iowa Signing E-Book was taken from a model for the design of multimedia technology developed by Alessi and Trollip (2001). The Iowa E-Book for populations of children with communication needs had been in development and use for several years before the Iowa Signing E-Book was created for the current study. The development involved several iterations of the Alessi and Trollip model. Testing and revisions continue to be made as a result of continuing formative evaluations (Bloom, Hastings, & Madaus, 1971; Fisch & Bernstein, 2001). These evaluations involve both observations made by the research team and feedback from end users (e.g., children and their parents).

The signing e-book (see Figure 1 for a screen shot) was developed to be a multimedia tool that creates (among other applications) electronic books with or without a video of a narrator telling the story in sign language. Since a video is made, any form of sign language can be used such as ASL, fingerspelling, Signed English, or contact sign. Essentially, it is an interactive multimedia book with a narrator that tells a story to a child, makes comments on the story, asks the child questions, and gives response-contingent feedback. The types of stories that were used for the creation of the signing e-books for the current study were authentic children’s storybooks. The children’s
book collections Adventures With Arthur (Brown, 1976–2007) and the Berenstain Bears (Berenstain & Berenstain, 1962–2004) are examples of the kinds of stories that were used and chosen for their clear storyline and appealing pictures.

Questions can be embedded within the e-book and response options can be provided in one of two ways. The first way is illustrated in Figure 2. The correct answer is some object or word somewhere within the storybook picture. Figure 3 illustrates the second option, which involves providing the response options in a multiple-choice format. The story can be told in any language or language modality that will benefit the child. For children with hearing loss who sign, the narrator would be fluent in the type of sign communication the child is familiar with. However, the Iowa E-Book is just as easily applicable for hearing children because the e-book can be designed to use a speaking narrator. The narrator can also ask the child questions of differing levels of structure/complexity (e.g., labeling to inferencing) and can give systematic and contingent feedback to the child’s responses. In every instance in this study, a sign is connected to the English text. The child is able to progress through the e-book at his/her own pace. The books are designed in an attempt to assist and simulate the shared reading experiences deemed so predictive of later academic success in hearing children. Although, ideally the e-book is to be read by both the parent and the child together providing essential parent–child interaction experiences and a language model for both the child and the parent, it can also supply the child individual time with the book to experience as many consistent repetitions of the story as the child wishes. Note that in the current study, no independent reading was allowed.

For the deaf or hard-of-hearing child, the e-book may provide a form of scaffolding support for reading growth. Initially, the e-book may provide the sign and picture support for the child who is just beginning the reading process. As the child becomes a more efficient reader, the sign and picture support can be systematically removed until the child is able to read the text alone. In addition, the e-book provides a language model for the child during the story-sharing process. If properly constructed, the e-books may be able to provide a motivating fun and entertaining activity for the child. Animations and the feeling of power and control may be a way to entice the child to interact for longer periods of time with literature. Finally, the e-book can also provide auditory support for those hard-of-hearing children that may benefit from auditory cues. Those cues can be added in the form of speaking and signing at the same time as in simultaneous communication if the child uses Signed English or other auditory cues such as animal or car noises that can be added to enhance the literacy experience.

A reading program that includes the signing e-book is an option that can be a more cost-effective
alternative, which has the potential of reaching a broader audience, especially in areas where access to Deaf adults is not abundant. The cost for the creation of a signing e-book is minimal and most of what is spent is done so in the beginning stages of the process. Included is the cost for the signing narrators and the e-book developers. However, once a signing e-book is made, it can be used over and over by an infinite number of people. The cost of a computer with which to run the e-book program should also be included. However, the cost of technology is decreasing as seen by the current reduction in price of desktop computers and small netbooks.

For the hearing parents of deaf or hard-of-hearing children, the signing e-book may provide a means for sharing books with their children despite their not feeling confident with their signing skills. In fact, the e-book may also be a means for the parents to improve their own sign skills while interacting in the story-sharing experience with their deaf or hard-of-hearing children.
An accompanying parent training e-book has also been created to provide a supplement to each of the child e-books. The parent training e-books contain the child e-book embedded within it. The parents can interact with the embedded child e-book to learn how to sign the story before sharing the story with their child (see Figure 4 for a screen capture shot). Additionally, book-specific strategies are included with the intention of giving parents ideas and suggestions regarding different ways to sign parts of the story or how to produce conversation starters. Finally, the Shared Reading Project principles are included along with video demonstrations and explanations of each principle.

The e-book attempts to provide the assurance that the signing model that is provided to the children is accurate and correct. The goal of the signing e-book is to provide the deaf or hard-of-hearing signing child with early exposure to literacy activities in order to ultimately increase their English-reading ability by linking the sign to text and to provide support to parents of deaf or hard-of-hearing children during shared reading (Hurtig & Mueller, 2007; Mueller, Hurtig, Rochdi, Downey, & Daugherty, 2005).

The research questions asked in the current study were related to the use of the signing narrator within the Iowa Signing E-Book. Without the signing narrator in the Iowa E-Book, the program runs much as a conventional book would. Parents and children turn electronic pages and it is left to the parent to tell the story to the child. The question of the effects of the signing narrator is an essential one because the narrator is an important element that makes the Iowa E-Book different from reading a conventional paper book. The research questions are as follows: (a) Is there a difference in the amount of time or frequency of e-book shared reading sessions when the e-books contain a signing narrator compared to when there is no narrator present? (b) Is there a difference in the amount of time or frequency of parent training use when the e-books contain a signing narrator compared to when there is no narrator present? (c) Are there parts of the e-books or the parent training modules that are used either most often or least often by the majority of the parents? and (d) Do children and parents learn sign vocabulary from the signing e-books and do parents learn vocabulary from the parent training modules?

The first question was asked because it is felt that it is important to know if the main element that makes the signing e-book different (the signing narrator) keeps the children focused on literacy activities for longer periods of time. Several authors have stated that by simply increasing the frequency of shared reading, a child’s language and literacy skills can be enhanced (Chomsky, 1972; Crain-Thoreson & Dale, 1999; Wells, 1985). The present authors acknowledge that it is not only the frequency but also the quality of

Figure 4  Screen capture shot of parent training e-book page.
the shared reading that has the greatest effect on the language and literacy skills of the child. Although data regarding the parent–child interactions were also collected during this study, an analysis and discussion of them is not possible in this article. Those data will be described elsewhere.

The second and third questions involving the parent training are important because they will give insight into what parents of deaf children feel is necessary in aiding them to share stories with their children. The question involving vocabulary learning was added in order to verify that learning was occurring with the use of the signing e-books.

Method

The research protocol used in this study was reviewed and approved by the University of Iowa Institutional Review Board. Families, referred to the investigators by their clinicians and/or teachers, were provided information regarding the purpose of the study and gave informed consent prior to participation in the study.

Participants

Young deaf and hard-of-hearing children and their primary care givers were targeted and recruited. Inclusionary criteria included the following:

1. Identified with prelingual hearing loss
2. Between the ages of 2 and 5
3. Exposed to some form of sign language (ASL, Signed English, or contact sign)
4. No known concomitant disorders such as autism, mental retardation, or attention deficit hyperactivity disorder
5. Parents both hearing

This age range was chosen because it has been suggested that early exposure to reading can have a significant positive effect on children (Snow et al., 1998; Trelease, 2001). In addition, Hart and Risley (1995) have shown that the time between birth and 5 years of age is critical in the development of child language and therefore literacy. That is, the cumulative effects of linguistic experiences early in life are important to a child's later cognitive growth. If intervention occurs later, the impact on a child's cognitive skills may be limited.

Four children who met the above criteria were identified and enrolled in the study. To protect their identities, we will use pseudonyms in referring to them in this article.

Participant 1. “Ivan” is 2 years 0 months old. He is an only child and was identified with a mild to moderate hearing loss at birth. At 3 months of age, he began wearing hearing aids bilaterally. Ivan receives services from a local area education agency and is visited by a teacher of the deaf weekly. Ivan's educational goals mainly involve increasing his mean length of utterance and increasing his expressive and receptive vocabulary. Ivan’s mother's goal is for him to become an oral-only speaker of English. Ivan used a combination of speech and signs to communicate in mainly one- and some two-word utterances with approximately 70% intelligibility to an unfamiliar listener. Ivan learned the few signs that he uses from the teacher of the deaf and from signing videos that he watches. His mother reported that signs are used because Ivan is “more likely to say a word when he first learns the sign for it.” At the beginning of the study, Ivan consistently used approximately 50 spoken words spontaneously and approximately 65 signs spontaneously. This signed and spoken vocabulary included the names of his family (mommy, daddy, the family dog's name), the names of his favorite toys (train, car, pumpkin), and favorite foods (hot dog, cereal).

Participant 2. “Wayne” is 4 years 8 months old. He was identified with a moderate to severe hearing loss at birth. His parents began using sign language with him at 3 months of age, and at 4 months of age, he began wearing hearing aids bilaterally. At the age of 1 year, Wayne began a day program for children with hearing loss and a Deaf role model visited him and his family once a week. He currently attends both a general education preschool and a preschool at the school for the deaf in his state. Wayne uses mainly speech to communicate but also uses sign when communicating with a conversational partner who also can use sign language. Wayne consistently had a mean length of utterance of 5–7 and was 95% intelligible to an unfamiliar listener.

Participant 3. “Nancy” is 2 years 3 months old. She passed her newborn hearing screening. At 8 months of
age, her mother became concerned due to her lack of language development. Nancy was identified with a moderate hearing loss bilaterally at 14 months of age. Nancy wears one hearing aid on her left ear and is unaided in her right ear. At the time this study was conducted, Nancy had been wearing her hearing aid for 6 months. Nancy attends group speech therapy services through a private speech–language pathology clinic twice a week. She uses a combination of single signs and vocalizations to communicate with approximately 30% intelligibility to an unfamiliar listener. Nancy independently uses approximately five words spontaneously, and approximately 15 signs spontaneously. At the time the study began, Nancy’s mother just enrolled in a sign language class. The signs Nancy knew at the outset of the study had been taught to her by her speech–language pathologist and through signing videos that her mother had purchased for her.

Participant 4. “Charlie” is 4 years 10 months old. He was referred for a hearing test at age 2 due to his lack of speech development. At that time, he was using single words but was unintelligible to an unfamiliar listener. At age 2 years 5 months, he was identified with a moderate hearing loss. Four months later, the loss had progressed to a profound level. After a hearing aid trial, he was bilaterally implanted at 4 years of age. With his cochlear implants, Charlie continues to have a mild hearing loss. Charlie’s mother reported that his speech development had not progressed as quickly as she and the professionals working with Charlie had expected. At the time of the study, Charlie had been implanted for 10 months. Charlie produces approximately two to three spoken word combinations and he is intelligible approximately 20% of the time to an unfamiliar listener. Charlie attends a neighborhood preschool twice a week where the language of instruction is spoken English. An itinerant teacher for the deaf accompanies him to the preschool for a total of 1.5 h each week. The itinerant teacher for the deaf uses simultaneous signing and speaking as the mode of instruction. Charlie also received speech therapy services through a private therapist and a government-run early intervention agency.

All four children, despite their level of hearing loss, had been exposed to some type of signing system, indicating that the use of sign either as a visual means of communicating or as a visual support was thought to be beneficial for these children. The mothers of the children are also included as participants in the study. They were all willing to participate, agreed to the requirements of the study, and provided informed consent.

Setting

Participants were seen in their homes. As best as could be done, videotaping session were planned at the times when storytelling would normally occur. However, this could not always occur due to scheduling conflicts between the researcher and the families.

The reading program that was used in this study consisted of parent- and child-supported shared reading. The Iowa Signing E-Book was utilized because of its flexibility and the ease with which it can be programmed to perform specific tasks. The story narration the e-books used in this study were signed in ASL to support the children’s interest and attention to the story as it has been found that deaf and hard-of-hearing children (even those who use a manual code of English for instruction) prefer stories told in ASL versus Signed English (Schick & Gale, 1995) and are able to understand stories told in ASL even when only exposed to Signed English (Leutke-Stahlman, 1990). Fingerspelling was also included when appropriate throughout the story narration such as when signing proper names or signs that are typically fingerspelled such as BUS and ZOO.

The signing e-books were also designed to be the kind of manipulative book that Kaderavek and Pakulski (2007) found to be interesting and motivating for deaf and hard-of-hearing children through the interactions that occur between the child and the e-books. In addition to the story on each book page being signed in ASL, each word in the text was also clickable and linked to a video clip of the sign. Because there is not a one-to-one correspondence between ASL and spoken English, short video clips of Signed English signs appeared when the individual words on a page were clicked. The purpose for giving children and parents the ability to click on individual words was not to provide decoding instruction but for two other reasons. First, the ability to click on individual words
gives parents who do not understand enough ASL the ability to at least match some individual words with their corresponding sign. Also, just as children may point to pictures in a storybook for their parent to name, they also may point to words and expect a label. Parents were supported in the shared reading process through the use of Signed English for the text of the story and embedded questions to help the parent know what was important to focus on in the story. The parent training modules were designed to give the parents extra practice with shared reading and to give them suggestions for topics of conversation related to the particular e-book stories.

All e-books were presented on a touch screen tablet PC. The mothers were instructed to use the tablet just as if it were a conventional paper book. As a result, some of the mother–child dyads sat on the floor with the tablet PC in the child’s lap, and other dyads sat at a table with the tablet PC resting upright on a stand.

Design and Experimental Conditions

The effects of the signing narrator in the e-book were evaluated in an A-B-A-B-A, single-subject, withdrawal design (Kazdin, 1982). The element that was withdrawn was the presence of the signing narrator in the children’s e-books. Children were given five new e-books every week for a total of 25 different e-books over the course of the study. During the withdrawal phases, the e-books that were presented did not contain a signing narrator but did contain all the functionality of the signing e-books (i.e., page navigation, question/response buttons, and response-contingent feedback in the form of a video reward for a right answer). The sign support was in the form of an on-screen signing narrator. The signing narrator always appeared in a box on the top left-hand corner of the screen (see Figure 1 for a screen capture shot of a typical signing e-book page).

Although five e-books were presented to the parent–child dyad during every phase, seven e-books were created for each phase. Each mother–child dyad was given a different combination of five of the seven e-books in each phase. This was done to ensure any effect seen was the result of the signing narrator in the e-books and not resulting from particular effects of a specific story or of a specific e-book. Additionally, the presentation of the e-books was counterbalanced for every participant such that no two participants received the same set of e-books in any phase of the study. This was done to ensure that any effects seen were not the result of differences between the content of the e-books used for the signing phases and those used for the nonsigning phases.

A set of 40 sign vocabulary items were chosen from the Carolina Picture Vocabulary Test (CPVT; Layton & Holmes, 1985) to serve as the target sign vocabulary for the study. The CPVT is a receptive vocabulary test that has been normed for signing deaf and hard-of-hearing children. The sign vocabulary designed by the authors of the CPVT for children aged 4.0–5.6 was used in this study. This range of words was chosen because the children in the present study presumably would not have yet learned this vocabulary prior to enrollment in the study. See Appendix B for a list of the vocabulary words. The list was divided into five groups of eight signs corresponding to the five phases/intervals of this experiment. Each group of signs was balanced for sign articulation complexity and part of speech. Each group of eight signs was targeted in each of the e-books in a certain phase of the study. For example, one group of sign vocabulary items was airplane, camera, cat, letter, mail, policeman, purse, and sit. Each of these items was pictured at least one time in each of the e-books in one phase of the study. Additionally, the written label of each of the items was used at least one time in the text of all the children’s e-books within a given phase.

**Phase 1—Baseline (A).** Participants received five e-books that did not contain sign support. All other functional features of the e-book were present including animations and embedded questions. One book was chosen to be read, with the interaction videotaped in the experimenter’s presence. After the initial reading of the first e-book, the experimenter ensured that the mother was able to access the other parent training modules and e-books. The parents were instructed to read each of the five e-books with their children at some time during the week, and if the child requests, e-books could be reread. The parents were also instructed to interact with the parent training e-books prior to reading the child e-books with their children.
The data logging function of the Iowa E-Book software allowed for tracking of the on-screen button clicks and the responses to the questions presented in the e-books.

Phase 2—Treatment condition 1 (B). The treatment condition progressed in the same fashion as the baseline condition. The only difference being that the e-books presented to the participants contained sign support and included a different subset of the vocabulary selected for the study. The parents were given the same training and instructions.

Phase 3—Withdrawal 1 (A). Following the first treatment condition consisting of five e-books with sign support, a different set of e-books that did not contain sign support were presented in the same fashion as the previous conditions in order to determine if a return to baseline rates of responding occurred. The parents were given the same training and instructions. Just as in the other conditions, the e-books in this phase contained their own subset of the targeted sign vocabulary.

Phase 4—Treatment condition 2 (B). Five e-books that contained sign support were presented in this second treatment phase of the experiment. Again, identical instructions and training were given to the parents. The targeted sign vocabulary in this set of e-books was different from those of the other three conditions.

Phase 5—Withdrawal 2 (A). The final withdrawal phase consisted of five e-books without sign support, which were presented in the same fashion as in the previous condition to determine if a return to baseline rates of responding occurred. The parents were given the same training and instructions as in the Withdrawal 1 phase. Just as in all other phases, the e-books contained their own subset of targeted sign vocabulary.

Parent Training

Each mother was given access to parent training for each e-book, regardless of the phase of the experiment. In other words, sign training was available to the mothers regardless of whether the e-books presented contained sign support or not. All parental training materials were presented as e-books. The training materials consisted of three parts. The first part was the child’s e-book embedded in the parent training e-books. The purpose of this was to give the parent the opportunity to learn how to sign the story to their child before the storytelling session. Therefore, in all phases the parent would be able to sign some parts of the story to their child. This is similar to the Gallaudet Shared Reading Project in which the parents who participate receive a videotape of the story being signed by a native signer to practice in the event that they forget how to sign certain parts of the story. The second part of the parent training contained story-specific tips. These tips are similar to the Shared Reading Project principles in that they included hints on how the parents could use sign language to describe the pictures to their child and suggestions regarding comments that the parent could make during the shared reading experience for the purpose of extending the concepts in the story or connecting the concepts in the story to the child’s everyday life. These tips differed from the Shared Reading Project principles in that they gave specific suggestions for each particular story. For example, in the story, “Arthur Writes a Story” (Brown, 1996), Arthur daydreams about story characters. One of the tips given for that story showed how to sign a daydreamed scene in ASL. The third part of each parent training material was the same for each e-book in the study. This third part described and explained the 15 principles suggested by the Gallaudet Shared Reading Project to be important when sharing stories with deaf children. Each of the 15 principles was available as a video clip that described the principle and suggested general ways to implement it. The parents were told that they could view the parent training e-books as many times as they liked.

Dependent Measures

Time on task. Several measures regarding the length of time the children and parents spent with the child e-books and the parent trainings were taken (note that time measures were all tracked automatically by the e-book software):
1. Total time spent with e-books
2. Total time spent per e-book feature
   a. E-book page—for sign-supported e-books, this is essentially the time spent watching the signing narrator. For the nonsign-supported e-books, this was conceived of as the time the mothers spent telling the story to the children (either in sign or in spoken English).
   b. Question/response—this is the time the mother–child dyad spent engaging in the embedded questions, responding to them, getting feedback for their responses, and responding again if they choose to.
   c. Pictures—for the sign-supported e-books, this is the time spent clicking on the storybook pictures and watching the signing narrator label the picture or comment on it. For the nonsign-supported e-books, this was conceived of as the time mothers spent labeling pictures or commenting on them after the child pointed to and touched the storybook picture.
   d. Text—for the sign-supported e-books, this is the time spent clicking on the text that was placed below the storybook picture. Each word in the text was linked to a corresponding video. For the nonsign-supported e-books, this was conceived of as the time the mothers spent signing the individual words for the children after they pointed to and touched the text.

1. The total time the mothers spent with the parent training e-books
2. The time the mothers spent on each parent training feature
   a. E-book page, question/response, pictures, text—these measures are similar to those taken from the child's e-books. The difference being that these measures are taken from the embedded child e-book within the parent training, and there were no nonsign-supported e-books within the parent training. All embedded child e-books contained sign support. Tips—this is the time the mothers spent viewing the story-specific tips provided for the purpose of enhancing the conversation surrounding the specific stories, or to give mothers variations in signing different parts of the story. Three to four tips specific to the story were included in every parent training e-book.

b. SRP—this is the time the mothers spent viewing video descriptions and demonstrations of the Galaudet Shared Reading Project principles. These were provided within every parent training.

Sign vocabulary. Children’s and mother’s knowledge of the signs chosen from the CPVT was tested before and after treatment using the pictures from the CPVT. Because certain sign items were only presented in specific phases of the study, if the signs not known at pretest were known at posttest, it was assumed that they were learned during the phase of the study they were presented in.

Results

Time Spent in E-Book Readings

Length of shared reading sessions was used instead of the length of time a particular e-book was open. A measure of the length of shared reading was calculated by adding the length of times e-books were read when the readings occurred within 1 min of the last e-book reading. This was done because it was felt that this measure more closely approximates measures of storytelling times when using conventional paper books. It was found that mother–child dyads were reading several e-books in a row much in the same way that children ask for several conventional paper books one after another. For all the children, despite individual variability in reading times, we observed increased reading times during the signing phases. Figure 5 shows the reading times by sessions for each of the children. Note that there is a difference in the total number of reading sessions across the four dyads.

When the data are averaged by phase and then converted to z scores, the differences can be seen more clearly (see Figure 7). The differences between the phases are most clear for Charlie; however, his results must be interpreted differently from the other three participants. Due to technical difficulties with running
Figure 5  Time spent during e-book lap-reading sessions.
Charlie’s e-books, attempting to click on the embedded questions during the nonsigning phases (Phases 1, 3, and 5) caused the e-book program to freeze.

A microanalysis was conducted to examine the individual effects of the various e-book features. The features examined included the clickable text, clickable pictures, the question/response options, and the page-turning tabs. Figure 8 illustrates that all the children spent more time on the individual book pages and with the questions/responses than either of the other two features of the e-book (Clickable text and the clickable pictures within the storybook). For all study phases, Ivan spent more time being asked questions by the e-book and responding to them than he did turning the book pages and having the story read to him. Also for Ivan, more time was spent using the question/response feature during phases in which there was no sign support in the e-books than during phases in which there was sign support. Wayne spent slightly more time on the individual e-book pages than he did with the question/response feature, and the percentages of time were stable across all phases. Nancy made use of the clickable text and picture features of the e-book to a greater extent than did the other children. The majority of Nancy’s e-book time in Phases 1, 2, and 3 was spent engaging in question/response with some exploration of clickable text and pictures in Phases 2 and 3. In Phase 4, Nancy spent approximately 25% of her time exploring the clickable text feature, and 10% of her time was spent exploring the clickable pictures in Phase 5. Charlie’s data must again be interpreted with some care because the question/

response feature during the nonsigning Phases 1, 3, and 5 was unavailable to him and his mother.

There are no obvious patterns in the number of times e-books were read across the four children in the study (see Figure 9). However, for three of the four children (Wayne, Nancy, and Charlie), we observed that e-books were read a greater number of times in the beginning phases of the study. Wayne read the e-books given to him in Phase 1 twenty-three times. His e-book use dropped after the initial phase and then increased and stabilized at about 10 e-book readings per week. Similar to Wayne’s e-book use, Charlie also read e-books a greater number of times during the first two phases of the study. E-book use dropped during Phases 3 and 4 and then increased again during Phase 5. It seemed as though Nancy read e-books more times during phases in which no sign support was present. However, during the last phase of the study (a nonsigning phase), only two e-books were read. Ivan read the e-books more often during the signing Phases 2 and 4 of the study, than during the nonsigning phases. The phase in which the most e-books were read was Phase 4, a signing phase, in which twice as many e-books were read than in any of the other phases.

Time Spent With Parent Training Modules
There is no clear pattern of results across the four mothers regarding the amount of time they used the parent training modules; however, two of the four did show
discernible patterns (see Figure 10). Ivan’s mother used them very infrequently despite being reminded of the goals and objectives of the experiment. She used the parent training e-books only twice in each of the first two phases and then not again. The other mothers in the study did comply with the experimental protocol and used each of the parent training e-books at least one time, with the exception of Wayne’s mother who used only four of the five parent training e-books in Phase 4 of the study. Nancy’s mother and Wayne’s mother both used the parent training e-books for longer periods of time during the phases in which there was no sign support in the child’s e-books. The difference between the amount of time parent training e-books were used during signing and nonsigning phases was greater for Nancy’s mother than for Wayne’s mother. As for Charlie’s mother, she used all the parent training e-books at least one time throughout the study for approximately the same amount of time in every phase.

With the data averaged by phase and converted to z scores, it is apparent that for all four mothers the use of the parent training e-books dropped over the course of the study (see Figure 11). With the data in this form, the patterns of use by Wayne’s and Nancy’s mother are more clearly seen.

The percentage of time the mothers’ spent using each parent training feature was calculated and is shown in Figure 12. “Pages,” “Ques/Resp,” “Pictures,” and “Text” refer to the storybook elements in the embedded child e-book in the parent training e-books. Recall that the embedded child e-book looks and functions exactly as the e-book used by the mother–child dyad. “Tips” refers to the story-specific tips and suggestions given to the mothers in an attempt to offer guidance regarding which aspects of the story could be focused on, ways to expand on the story, or topics of conversation regarding the story. “SRP” refers to the definitions and examples of the Shared Reading Project principles that were included in every parent training e-book.

Nancy’s mother spent her time with the parent training in a more diverse manner than the other mothers in the study. In Phases 1, 3, and 5, approximately half of the time she spent with the parent training e-books was spent viewing the narration of the embedded child e-book pages, whereas the other half of her time was shared between the other features of the parent training. Nancy’s mother also spent a greater percentage of her time on the question/responses, pictures, and text within the embedded child e-book than did the other three mothers.

For the other three mothers in the study, their time with the parent training was spent viewing the story narration on the pages of the embedded child e-book and on the story-specific tips. Of interest is the lack of time spent by any of the mothers with the SRP principles. Wayne’s mother in the first phase and Nancy’s mother in the last phase were the only two mothers who showed any discernible interest in the SRP principles as evidenced by the percentage of time spent on them.

Vocabulary

The signed vocabulary data were obtained from the results of the pre- and posttest of the CPVT. All the children and all the mothers learned new signs throughout the 5-weeklong study (see Tables 1 and 2).

There was no effect of the presence of a signing narrator in the e-book on Ivan’s knowledge of sign vocabulary. Ivan initially knew 14 of the 40 targeted signs before the study began. At posttest, Ivan demonstrated that he knew a total of 19 signs, the 14 he knew at pretest and 5 additional signs. Ivan learned no new targeted signs during the first two phases of the study. He learned two signs in Phases 3 and 4, respectively, and one new sign in Phase 5. In other words, Ivan learned the same proportion of signs in the signing (13%) and the nonsigning (13%) phases of the study. At pretest, Ivan’s mother knew the same 14 signs that Ivan knew at pretest. At posttest, Ivan’s mother knew the 14 signs she initially knew and 16 more; learning over twice as many signs as Ivan in the 5-week period. In the signing Phases 2 and 4, Ivan’s mother learned five and four targeted signs, respectively (56% of the total targeted signs presented in the signing phases). In the nonsigning Phases 1, 3, and 5, Ivan’s mother learned two, four, and one sign, respectively (29% of the total targeted signs presented in the nonsigning phases). Ivan’s mother learned a greater proportion of signs during the phases in which the child e-books contained sign support compared to
Figure 8  Microanalysis of time spent with e-book features.
Figure 9  Total number of e-books read per phase.
Figure 10  Time spent during e-book parent training modules.
the phases in which the child e-books did not contain sign support.

There was no effect of the presence of a signing narrator in the e-book on Wayne’s knowledge of sign vocabulary. Wayne knew all but six of the targeted sign items at the beginning of the study. At posttest he demonstrated knowledge of all but one of them. The sign that Wayne did not demonstrate knowledge of was SANDWICH. Wayne knew a different regional variation of this sign and chose to use the variation he preferred at the posttesting even when asked if he knew another sign for “sandwich.” Because Wayne knew nearly all the targeted signs at pretest, there was not a great opportunity for him to learn new signs. Wayne’s mother knew 30 of the 40 signs at pretesting. At posttesting, she had learned the remaining 10 sign items.

Nancy knew 8 of the 40 targeted sign items at pretest. At posttest, Nancy knew a total of 31 signs, the 8 she knew previously and 23 of the other targeted signs. In the signing phases (2 and 4), she learned 75% of the total targeted signs. In the nonsigning phases (1, 3, and 5) she learned 46% of the total targeted signs. Overall, Nancy learned approximately 30% more signs from the e-books in the signing phases than those in the nonsigning phases. The presence of sign support in the child e-books did affect Nancy’s mother’s acquisition of the targeted sign vocabulary. Nancy’s mother knew nine signs at pretest. At posttest, Nancy’s mother knew the 9 signs she initially

knew and 30 more. In the signing phases (2 and 4), Nancy’s mother learned 69% of the total targeted signs. In the nonsigning phases (1, 3, and 5), Nancy’s mother learned 79% of the total targeted signs.

At pretest, Charlie knew 11 of the 40 targeted signs. At posttest, Charlie knew the 11 signs he knew at pretest and 23 more of the targeted signs. In the signed phases (2 and 4), Charlie learned 50% of the total targeted signs presented. In the nonsigning phases (1, 3, and 5), Charlie learned 63% of the total targeted signs. He learned a greater proportion of signs in the nonsigning phases than in the signing phases of the study. At pretest Charlie’s mother knew 26 of the 40 targeted signs. At posttest, Charlie’s mother demonstrated that she had learned the remaining 14 signs. The presence of sign support in the child e-books did not have an effect on the number of signs Charlie’s mother learned throughout the study. In the signing phases (2 and 4), Charlie’s mother learned 38% of the total targeted signs presented in the signing phases). In the nonsigning phases (1, 3, and 5), Charlie’s mother learned 33% of the total targeted signs.

Mother’s Comments

The mother in the study were asked to reflect upon the experience, the usefulness of the signing e-books, and the parent training e-books. All mothers reported that the time spent reading the nonsigning e-books seemed roughly equivalent to the time the mother–child dyads spent reading conventional paper books either before the study began or during their participation in the study.

Recall that Ivan had a mild sloping to moderate hearing loss and had been exposed to signed communication only from his itinerant teacher of the deaf who visited once a week and from the signing videotapes. Ivan’s mother stated that she felt the e-books were too advanced for Ivan. When probed further regarding this matter, Ivan’s mother related that she believed Ivan did not have a hearing loss at all and that he could hear and understand her when she spoke. She believed that Ivan was not interested in the signing narrator in the e-book and that it was difficult to keep him on task for this reason.
Figure 12  Microanalysis of time spent with e-book parent training features.
after the first two phases of the study, Ivan’s mother reported that she did not believe Ivan was “right” for this type of study. She was assured that the purpose of the study was to determine the efficacy and usefulness of the e-book program and the parent training modules when used in a natural environment, and after giving her the opportunity to withdraw from the study, she decided to continue. When asked about the use of the parent training materials, Ivan’s mother reported that she did not find them helpful, but she could understand why other mothers would find them useful. She understood that one aim of the parent training materials was increasing parents’ signing skills. Further probing revealed that Ivan’s mother was not interested in learning sign language.

Wayne’s educational experience was very different from that of Ivan’s. Wayne’s parents both began learning ASL immediately after Wayne was diagnosed at birth with a hearing loss. Wayne had been exposed to ASL as the language of instruction in the school setting and to fluent signers in the form of Deaf tutors in his home. Wayne’s mother stated that she enjoyed the nonsigning phases better than the signing phases because she was given the opportunity to use the signing skills she learned from the parent training with Wayne during storytelling and that she felt she was only a passive observer during the signing phases. Wayne’s mother stated that she enjoyed the book-specific tips and that they helped her to extend the story content and relate the story to Wayne and his everyday life. As for Wayne, he stated that he enjoyed both the signing and the nonsigning e-books equally. His only complaint was that the e-book stories were not long enough.

Nancy’s mother’s initial comment regarding the e-book program was that she was looking forward to learning more sign language in order to teach Nancy. She reported that the parent training e-books were very helpful. She also reported that she preferred the e-books that contained sign support over those that did not because she could click on the text during e-book readings and learn the signs for each word in the story. During the videotaping sessions, Nancy’s mother often faced difficulty keeping Nancy focused on the e-books. She stated that they usually read them together in the evening before bedtime and that Nancy would request them by pointing to the tablet PC. With regard to specific items in the parent training materials, Nancy’s mother reported that she enjoyed the book-specific tips but that she did not believe her signing skills were advanced enough to implement them. However, she believed that the more often she used the e-books, the better her signing skills would become, and so the e-books she was given could grow with her. She believed that eventually she would be able to implement the story-specific tips. Finally, Nancy’s mother reported that family matters had precluded much reading of the e-books during the last phase of the study.

<table>
<thead>
<tr>
<th>Participant</th>
<th>No. of initial signs known</th>
<th>Phase 1 signs acquired</th>
<th>Phase 2 signs acquired</th>
<th>Phase 3 signs acquired</th>
<th>Phase 4 signs acquired</th>
<th>Phase 5 signs acquired</th>
<th>Total signs acquired</th>
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<tbody>
<tr>
<td>Ivan</td>
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<td>0</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
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<td>0</td>
<td>1</td>
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<td>5</td>
</tr>
<tr>
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<td>5</td>
<td>5</td>
<td>5</td>
<td>7</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
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<td>7</td>
<td>7</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>23</td>
</tr>
</tbody>
</table>

### Table 2  Sign vocabulary acquired by mothers

<table>
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<th>Participant</th>
<th>No. of initial signs known</th>
<th>Phase 1 signs acquired</th>
<th>Phase 2 signs acquired</th>
<th>Phase 3 signs acquired</th>
<th>Phase 4 signs acquired</th>
<th>Phase 5 signs acquired</th>
<th>Total signs acquired</th>
</tr>
</thead>
<tbody>
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<td>5</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
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<td>2</td>
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<td>10</td>
</tr>
<tr>
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<td>5</td>
<td>4</td>
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<td>7</td>
<td>30</td>
</tr>
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<td>Charlie’s mother</td>
<td>26</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>14</td>
</tr>
</tbody>
</table>
Charlie’s mother had technical difficulty with some of the “e-book functions and so was unable to take advantage of all the e-book features. Even so she believed that Charlie benefited from the use of the e-books. He enjoyed reading each of them as many as five to seven times, but after those repetitions, he lost interest in them. Charlie’s mother related that she thought the book-specific tips and the SRP principles were a good resource and should remain in the program. However, she felt that being a teacher herself, she did not need the tips but that other mothers may find them helpful. Charlie’s mother stated that she enjoyed the signing e-books more than the nonsigning e-books, and she believed that Charlie did also. When asked if she felt this way only because the nonsigning e-books did not work as they were supposed to, she answered in the negative. She stated that she enjoyed watching another person sign the stories so that she could learn different ways to sign the same content.

Discussion

In the following discussion, we interpret our findings in terms of the four questions we attempted to address in this study.

1. Is there a difference in the amount of time or frequency of e-book shared reading sessions when the e-books contain a signing narrator compared to when there is no narrator present?

Although there was a difference in the amount of time children and mothers spent reading e-books that contained sign support versus the time spent reading e-books that did not contain sign support, the difference was small for most children. For Ivan and Nancy, the greatest average difference between reading the signing e-books versus the nonsigning e-books occurred between Phases 4 and 5. An average of 3 min more reading per week may not be an amount of time that would make a difference in the learning of an older child or a child that often experiences shared reading sessions that last 30 min or an hour. In this case, the nonsigning e-books were read for an average of 5 min each week. Both Ivan and Nancy’s parents state that the amount of time they spent reading the e-books during the study was roughly equivalent to

the amount of time they spent reading conventional paper books. Two more minutes of reading per week creates an increase of 60% more reading with the signing e-books than with the nonsigning e-books. For Wayne, the average difference in the time he and his mother spent in shared reading sessions was approximately 4 min (9 min spent with the nonsigning e-books and 13 min spent with the signing e-books). This is an increase of 30%. The result showing longer e-book readings and longer shared reading sessions is not a trivial one. Longer exposure to text, stories, and interactions with parents is a positive result that the literature has suggested can have a significant impact on language and literacy development.

2. Is there a difference in the amount of time or frequency of parent training use when the e-books contain a signing narrator compared to when there is no narrator present?

We observed a mixed pattern of results regarding the time mother’s spent with the parent training e-books. Wayne’s mother and Nancy’s mother both spent more time using the parent training e-books during weeks when the child’s e-book did not contain sign support than when the e-books did contain sign support. The reasons this occurred are clear and were supplied by the mothers themselves. First, both mothers enjoyed learning sign language. Nancy’s mother stated matter-of-factly that the e-books would be a way for her to learn sign language. Wayne’s mother expressed her preference for the child e-books that did not contain sign support because it allowed her the opportunity to practice signing with her son. The reasons the other mothers did not show similar patterns of use may be inferred. Ivan’s mother did not accept his hearing loss and so perhaps did not feel as though learning sign was a necessity. Therefore, she may have viewed using of the parent training e-books as a waste of time. Charlie’s mother’s use of the parent training e-books stayed fairly constant over the course of the study. Charlie’s mother was an educator who stated that the parent training e-books were not necessary for her, but she understood how they might be helpful for other mothers who did not have experience reading stories to their children. Charlie’s mother was also a proficient signer who knew the signs targeted in
the e-books we provided. This would account for the lack of variation in her use of the parent training e-books. Charlie’s mother only used them to comply with our instructions.

3. Are there parts of the e-books or parent training modules that are used either most often or least often by the majority of the children and parents?

A great deal of effort was put into producing the parent training e-books. Based on the results of this study, some of that effort could have been avoided. Specifically, the mothers in the study did not make much use of the explanations and demonstrations of the Shared Reading Project principles. This is surprising given the apparent success of training sessions with the Deaf tutors who are involved with the Shared Reading Project (Delk & Weidekamp, 2001). The SRP training suggests focusing on only a few principles at each visit with the parents due to the complexity of the principles and the time needed to perfect their use. We cannot rule out either that the mothers in our study did not need the repeated explanations and demonstrations or that the mothers felt that the principles were not helpful to them and their children.

Possibly, a separate single Shared Reading Project training e-book would have sufficed, and it would not have been necessary to include that material in each of the parent training e-books keyed to the children’s e-book. Alternatively, a few Shared Reading Project principles could have been included in each parent training e-book focused on book-specific information. The information presented in this way may have had greater appeal to the mothers because the principles would be more contextualized. Additionally, three of the four mothers interacted with the book-specific tips. Only Nancy’s mother spent a much greater proportion of her time viewing the signs for pictures and text and interacting with the questions and responses in the embedded child e-book in the parent training e-books. Nancy’s mother’s behavior can be best explained in terms of the reports by Stobbart and Alant (2008) and Swanwick and Watson’s (2007). Much like their hearing mothers, Nancy’s mother focused her shared reading sessions on teaching Nancy sign vocabulary and not on comprehending the story. Nancy’s mother focused on the text within the story and did not focus much attention on the pictures and having a conversation with Nancy about the story content.

4. Do children and parents learn sign vocabulary from the signing e-books or from the parent training modules?

We had hypothesized that sign vocabulary acquisition would be enhanced with the use of signing e-books. That was not the case. For all children and all mothers, we observed acquisition of signs regardless of which phase in the study the signs were presented in. This result may be explained by the presence of sign support in the parent training materials regardless of the sign support present in the children’s e-books. In fact, what we have called the nonsigning phases were not intended to be totally devoid of signing. The mothers in the study all had access to the story narration in sign throughout with the parent training. This fact most likely accounts for the sign growth seen in the mother’s sign vocabulary. There was a greater growth in the mother’s knowledge of sign vocabulary than in their children’s. Wayne’s, Nancy’s, and Charlie’s mothers all reached ceiling level on our sign vocabulary test. In other words, they learned all the signs tested during the study. Although Ivan’s mother did not learn all the targeted signs, she more than doubled the number of signs she was able to recognize from pretest to posttest. Additionally, Ivan’s mother was the only mother in the study who was noncompliant in her use of parent training, which may explain why a greater proportion of the signs she acquired were from the signing phases than from the nonsigning phases. She was only exposed to the signs through the e-books she shared with Ivan.

Limitations

General limitations of single-subject research apply. Due to the small number of participants, the results cannot be generalized to the entire population of deaf and hard-of-hearing children. However, we feel the power of this type of design is in the detailed description of the participants. Consumers of this research...
who are seeking help for a specific child may be able to
decide for themselves if the child they have in mind is
similar to the children described in this study. Large
group designs do not lend themselves to this type of
detailed comparison.

Limitations of the type of single-subject research
design used (withdrawal design) also apply. It is com-
monly the purpose of any kind of therapy to produce
a lasting change in an individual. When a return to
baseline measures is obtained within the context of
a withdrawal design, the implication is that the treat-
ment is necessary for the behavior to continue. We do
not intend that every storybook a child who is deaf or
hard of hearing is exposed to be a signing e-book. We
would like these children and their parents to eventu-
ally make a transition to the use of conventional paper
books.

Related to this idea is research that demonstrates
that the excitement and allure of technology wanes over
time (Kulik, Bangert, & Williams, 1983; McKinnon,
Nolan, & Sinclair, 2000). Indeed, we have seen anec-
dotal evidence of this phenomenon during pilot test-
ing of the e-book software to the benefit of the
children. There are no data yet to support this claim,
but there is anecdotal evidence that some children,
who initially disliked storybooks and were exposed to
the e-book software, eventually lost interest in the
e-books but developed newfound appreciations and
interests in conventional paper books.

Although it is known that it is not only the quan-
tity of the shared reading experiences that occur but
also the quality of those interactions that are of benefit
to children (Heath, 1982, 1983), only information on
the quantity of shared reading was described in this
publication. As was stated previously, qualitative in-
formation is forthcoming regarding the specific inter-
actions that occurred between the children and their
mothers.

Suggestions for Future Research

This study allowed us to collect a great deal of data on
shared reading with e-books. Additional data were
collected and analyzed regarding the quality of the
shared reading interactions; however, a great many
additional analyses of the data are possible. For exam-
ple, more qualitative analyses can be conducted on the
specific behaviors exhibited by the mothers that en-
couraged or discouraged their children from interact-
ing with the e-books. One could conduct analyses of
both the children’s and the mothers’ utterances look-
at both complexity of the semantics and the syntax
used, and length of utterance in terms of time and
mean length of utterance. This may help shed some
light on the results regarding the length of time each
mother–child dyad spent in e-book readings and dur-
ing shared reading sessions. Such analyses would also
allow us to resolve the issue of whether increased
shared reading times were due to differences between
speaking and signing articulation rates.

A microanalysis of the button clicks in the child e-
books coordinated with the videotaped sessions would
give greater insight as to how the mother’s behavior
affected the child’s interaction with the e-book. In
order to better assess the impact of using the parent
training e-books, the type of book-specific tips that the
mothers viewed should be analyzed and compared to
the language that the mothers used during the e-book
readings. This would allow us to answer the question,
“Did the mothers make use of the tips and did they
use them in the shared reading sessions?”

Finally, because there were a number of features
that were incorporated in both the child and the par-
ent training e-books (signing narrator, question but-
tons, clickable pictures, clickable text, book-specific
tips and explanations, and demonstrations of the Shared
Reading Project principles), it is difficult to be certain
what features or combination of features had the most
significant impact. In order to aid future development of
signing e-books, it may be worthwhile to try to deter-
mine the specific influence of each feature. If this is
done, a better picture may emerge regarding what e-
book features will be most beneficial to children and
mothers with certain traits and characteristics.

Regarding future studies, an analysis of the eye
gaze of children using e-books with or without sign
support would be interesting. This would also help
determine what aspects of the e-book are more or less
engaging for the children. Eye-tracking data might
provide an indirect measure of how well the children
understand the story being told to them by either their
mothers or the signing narrator. An examination of the
fixation patterns should reveal where the children look while the story is being told.

Because the e-book program is only an editor that can be used to create any number of educational materials, studies that involve other populations are necessary. There are many children who may not experience shared reading to a great degree (Snow et al., 1998). For example, children with autism, children with cerebral palsy, and children whose parents do not speak the dominant language of a culture may potentially benefit from the use of this technology to enhance their shared reading interactions. The flexibility of the e-book program also makes it possible to create e-books in other signing systems such as Signed English, Simultaneous Communication (signed and spoken at the same time), or Cued Speech.

Implications for Practice

We view the Iowa Signing E-Book and the accompanying parent training e-books as a tool that, combined with other early intervention techniques and programs, could possibly affect the literacy achievements attained by deaf and hard-of-hearing children in a positive way. The use of technology with these children has the potential to make significant changes in their language and literacy skills. It is the responsibility of those who create such technology to ensure it is beneficial and is being used in the most efficient and productive manner. The need for efficacy studies is of immense importance because it is a great disservice to children and their parents to use technology just for the sake of using technology.

Summary

The research cited earlier (Gioia, 2001; Kaderavek & Pakulski, 2007; Stobbart & Alant, 2008; Swanwick & Watson, 2007) indicated that hearing parents did not engage in conversation about storybooks as much as Deaf parents did, and that hearing parents shied away from shared reading possibly due to feelings of incompetence. The development of the Iowa Signing E-Book is an attempt to aid hearing parents in overcoming the obstacles to shared reading caused by these feelings of incompetence. These feelings may be the underlying cause of the lack of conversations about storybooks with their children. The sign support in the parent training materials and the e-books themselves may give hearing mothers confidence to practice their signing abilities, knowing that the correct sign narration is close at hand. Two of the four mothers in the study felt they benefited from the sign narration in the parent training as evidenced by the greater use of the parent training e-books during the nonsigning phases. These two mothers also stated they preferred to learn to sign the stories themselves from the parent training. With the support of the signing narrator in the parent training e-books, it is possible that hearing mothers will be able to actively seek out help in overcoming the feeling of incompetence surrounding shared reading with their children with hearing loss.

The book-specific tips in the parent training e-books represented an attempt to give hearing mothers signing suggestions and ideas regarding topics of conversation about the story, as well as variations in signing particular parts of the story in ASL. Of importance to the current discussion is the fact that the tips were provided to the mothers. Three of four of our hearing mothers have shown some level of interest in these tips. Whether these tips were actually implemented in the shared reading sessions is a topic that will be addressed in a subsequent publication.

Kaderavek and Pakulski (2007) found that manipulative-type books were more motivating for the children with hearing loss in their study. A difficulty that arises with the use of most manipulative-type books is that they typically do not present authentic narrative stories and so children reading only these types of books would not be exposed to story structure and the varied and more complex syntax and semantics known to be present in children’s stories (Hayes & Ahrens, 1988; Mason & Allen, 1986; Tannen, 1982). For these reasons, the signing e-books have been designed to provide manipulative-type books that incorporate authentic children’s stories.

The signing e-books we developed appear to have been a useful addition to the shared reading experiences of young children with hearing loss in this study. Based on the mothers’ reports, the e-books were used
at least as long as and at times longer than the conventional paper books that their children had prior experience with. Additionally, the signing e-books were also used as long as and sometimes longer than the nonsigning e-books.

The signing narrator in the signing e-books and in the embedded e-books in the parent training e-books provided sign support to parents during shared reading situations, possibly alleviating feelings of incompetence in story sharing in sign language. It remains to be seen how effective giving parents tips regarding conversational starters helps hearing parents converse with their children about the story in a way similar to the way Deaf parents attempt conversations about stories with their children. In the end, it is essential that we explore all approaches to ensure that children with hearing loss begin experiencing shared reading as early as possible before starting grade school in order to be competitive with hearing children who have received possibly hundreds of hours of shared reading before entering first grade. Our findings suggest that, to varying degrees, a program that includes signing e-books can facilitate hearing parent’s ability to provide their children with hearing loss those invaluable shared reading experiences.

Appendix A  Shared Reading Project 15 principles
Deaf readers translate stories using American Sign Language (ASL)
Deaf readers keep both languages visible (ASL and English)
Deaf readers are not constrained by the text
Deaf readers reread stories on a storytelling to story reading continuum
Deaf readers follow the child’s lead
Deaf readers make what is implied explicit
Deaf readers adjust sign placement to fit the story
Deaf readers adjust signing style to fit the story
Deaf readers connect concepts in the story to the real world
Deaf readers use attention maintenance strategies
Deaf readers use eye gaze to elicit participation
Deaf readers engage in role play to extend concepts
Deaf readers use ASL variations to sign repetitive English phrases
Deaf readers provide a positive and reinforcing environment
Deaf readers expect the child to become literate

Appendix B  Vocabulary words used from the Carolina Picture Vocabulary Test
Hat
Insect
Airplane
House
Chicken
Cold
Camera
Tree
Paper
Eat
Light
Barn
Pig
Butter
Cat
Ugly
Pen
Wash
Sandwich
Sit
Walk
Handkerchief
Anger
Perfume
Box
Towel
Mail
Laugh
Witch
Letter
Write
Hamburger
Purse
Dirty
Policeman
Bottle
Snail
Arrow
Sad

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