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Effectiveness of Assistive Computer Technology (ACT) for Enhancing Basic Language Skills among Students with Hearing Disabilities

Nurul Hijja Mazlan[1*], Shaffe Mohd Daud[1] and Ahmad Fauzi Ayob[2]
[1]Department of Foundations of Education,
[2]Department of Science and Technical Education,
Faculty of Educational Studies, Universiti Putra Malaysia,
43400 UPM, Serdang, Selangor, Malaysia
[*]E-mail: nour.najib@gmail.com

ABSTRACT

It is well-documented that deaf children are often delayed in language development compared to their hearing peers. However, invention of assistive computer technology (ACT) gives deaf students the opportunity to enhance their language skills and immerse on new and more interactive virtual learning environment. The purpose of this paper is to review the potential and effectiveness of ACT for improving language skills and learning outcomes among deaf students. The review is organized into two major sections which reflect the theoretical framework to date, as well as dialogic reading interventions and technology interventions on the deaf's written language. Many researchers conclude that dialogic reading interventions have yielded significant improvement on deaf students' language development and ACT has demonstrated efficacy in enhancing language skills among students with hearing disabilities. Educational considerations in planning computer-based dialogic reading intervention for students with deafness in Malaysia are deliberately discussed for future practitioners and educators.

Keywords: Effectiveness, assistive computer technology, language skills, hearing difficulties

INTRODUCTION

Language and Students with Deafness

Normal children develop most of their early linguistic skills through spoken language and they use what they hear to construct their own understanding, which includes the decoding of the words, rules governing the sentences and combining words to make meaningful sentences (Ormrod, 2006; Beaty and Pratt, 2007). Construction of the understanding tremendously influences and helps children later in their development of written language, a secondary form of literacy that revolves around understanding of printed texts and capability to produce written texts (Kajder, 2007). However, deaf children are disadvantaged on both counts due to their inaccessibility to the spoken language and less exposure to sign languages (Goldin-Meadow and Mayberry, 2001; Belson, 2003). Therefore, it is not surprisingly that deaf children are often delayed in language development compared to their hearing peers (Wauters, 2006; Kyle and Harris, 2006; Daigle and Armand, 2007; Mayer, 2007).

Geers (1994) further added that the disparity between their incomplete spoken language system and demands of reading a speech-based system is the culprit that leads to the low-literacy levels among students with hearing disabilities.

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[*]Corresponding Author

Language deficit in an early onset of linguistic acquisition can clearly be evidenced in middle-school aged where the written language is widely being used (Stoner *et al*., 2005). Advancing learning process demands highly rich literacy situation, in which reading and writing play bigger role in acquiring broader knowledge. Entering this phase, students should be able 'to read in order to learn'. In a congruent view, Piaget (1964, cited in Passig and Eden, 2000), suggested that lacking on linguistic progression hampered the cognitive development among deaf children, and thus affected the chances to be functional members in the society, i.e. the capability to enquire knowledge to be employed and to be able to communicate with the community (Ormrod, 2006; Bursuck and Damer, 2007; Gunning, 2003; Bond *et al*., 1994; Bowe, 2002).

Realizing the importance of written language as the precursor of literacy, many researchers have experimented with different types of interventions to improve basic language skills among students with hearing disabilities. Thanks to the invention of technology, special education is gaining the benefit from the application of ACT in its setting. The purpose of this paper is to review the potential and effectiveness of the ACT in improving language skills and learning outcomes among deaf students, and it specifically investigated how dialogic reading interventions could be successfully implemented through ACT. This paper is organized into two major sections which reflect the theoretical framework to date, as well as the dialogic reading interventions and technology interventions on the deaf's written language.

Reading at a Glance

The first revelation sent down to Prophet Muhammad (pbuh) was;

اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ

Read! in the name of thy Sustainer,
who has-(Quran 96:1)

The verse implies the importance of reading in human's life, with a view to understand the texts, extract the pivotal meaning and implement the knowledge gains in a beneficial ways. Reading has several definitions underpinning it. Goodman, Watson and Burke (1987, cited by Girgin, 2006) defined reading as the process of problem solving and meaning construction. Gibson and Levin (1979) defined "reading is extracting information from text." They proposed that reading involves several processes and to be able to read requires the acquisition of basic language skills. Massaro and Schmuller (in Massaro, 1975) suggest that reading process starts with the stimulation by a sequence of letters and spaces that conform to orthographic, syntactic, and semantic constraint defining the written language. Reading is a continuously developing activity as a reader grows and expands, as the child progresses through the age. Fresh experience, new vocabulary acquisition, and interaction with printed text help students enhance their language skills (Gunning, 2003; Ormrod, 2006).

DIALOGIC READING (DR)

For normal children, development of vocabulary is highly related to their communicative input and environments (Carney and Moeller, 1998; Ormrod, 2006; Silverman, 2005; Schunk, 2004). Vocabulary knowledge provides foundation to decode and comprehend text and deficit in this area will clearly interrupt the process of becoming a mature reader (Beatty and Pratt, 2007, Bursuck and Damer, 2007; Nagy, Berninger and Abbott, 2006). Moeller, Osberger and Eccarius (1986) found that there was a lack of improvement in deaf students' language skills with age, i.e. with a delay in vocabulary development at 4-9 years compared to hearing children. Thus, limited or no access to oral language potentially hinders the process of vocabulary development in deaf student's linguistic milestone.

Many researchers have conducted various types of vocabulary intervention to help young children and children with language delays enhance their vocabulary acquiring process

(Silverman, 2005; Van Otterloo, Van der Leij and Veldkamp, 2006). One of the prominent vocabulary intervention is a dialogic reading, which is a research-based technique invented by Whitehurst and his colleagues during the 80's at the State University of New York at Stony Brook Reading and Language Project, with the ultimate goal to enrich vocabulary of the children (Arnold, 2005). It is an interactive shared picture book reading practice designed to enhance young children's language and literacy skills. Vygotsky's Zone of Proximal Development and scaffolding concept are applied in this intervention (Vygotsky, 1978), which was evidenced during the shared reading practice. The adult and the child switch roles so that the child will learn to become the storyteller with the assistance of the adult who functions as an active listener and questioner. Three simple steps are involved in the process: (a) asking 'wh' questions that have specific answer, (b) increasing open-ended questions, and (c) expanding appropriately on the children's attempt to answer those questions (Whitehurst *et al.*, 1988; Zevenbergen and Whitehurst, 2003). For adult as a facilitator, DR prompts (i.e. CROWD, PEER) were prepared to help them memorize the DR strategies which should be used during the process of intervention (*see* Table 1).

A REVIEW TO SUPPORT THE USE OF DR

Whitehurst *et al.* (1988: 1994a: 1994b), Wasik and Bond (2001) and Zevenbergen *et al.* (2003) conducted several studies to investigate the usage of DR in different settings and subjects.

Whitehurst *et al.* (1988) included 29 children from 21 to 35 months of age with normal development and language level, and from sub-urban Long Island, New York in their study, to investigate the impact of home-based dialogic reading intervention in enhancing children's linguistic skills. The treatment groups received designated instruction which altered the frequency and various aspects of their child-directed verbalization during the reading procedure. Meanwhile, the controlled groups were directed to the accustomed reading procedure with no additional behaviour. Whitehurst and colleagues found that the children from experimental groups (M=29.4 months-old) scored significantly higher than the children in the controlled group (M=27.9 months-old) on the standardized post-test expressive language ability, possessed a higher mean length of utterance (MLU), higher usage of phrases and lower frequency of single words occurrence. The results were maintained at 9 months follow-up assessment.

Whitehurst *et al.* (1994a) selected different samples of 67 children (M=3.46 years-old) from low-income families in New York in five subsidized day-care centres. They were randomly assigned to three different conditions: (a) DR both at school and home, (b) DR in school, and (c) a control condition in which children engaged in play activities under the supervision of their teachers. The outcomes showed significant

TABLE 1
DR prompts (WWC Intervention Report, 2006)

Prompts	Description
Completion	Child fills in blank at the end of a sentence
Recall	Adult asks questions about a book the child has read
Open-ended	Adult encourages child to tell what is happening in a picture
Wh-	Adult asks "wh-" questions about the pictures in books
Distancing	Adult relates pictures and words in the book to children's own experiences outside of the book

differences in expressive language produced by children from the condition involved the implementation of DR during the procedure.

In a related study by Whitehurst *et al*. (1994b), 167 four years old at-risk children were selected. Oral language, phonological processing, print knowledge, and early written language outcomes were studied. They found significant differences in four out of five domains tested; where phonological processing showed no statistically significant result. A follow-up study conducted by Zevenbergen *et al*. (2003) was replicating Whitehurst *et al*., (1994b), with additional domains, and narration understanding. The findings showed that positive effects continued to demonstrate, including the outcomes from the additional features.

A hundred and twenty one children (M=4.3 years old) participated in a study by Wasik and Bond (2001). The study was aimed at examining the effects of DR plus extension activities to reinforce usage of target vocabulary in the book on children's activities. Two groups were assigned different reading tasks, namely DR with targeted vocabulary reinforcement and usual reading. The outcomes showed that significant differences in terms of expressive language produced by the children treated with DR strategies. The outcomes are parallel with those by Hargrave and Senechal (2000) and Mol *et al*. (2008). In Mol *et al*. (2008), the researchers further suggested that dialogic reading has potential to foster rich literacy experience for family with 2-3 years old children, but less likely for older children, families with at-risk children or children with language impairments.

DR has also been shown to be efficient in other languages (Jimenez *et al*., 2006; Chow *et al*, 2008; Aram, 2006; Korat *et al*., 2006).

Jimenez *et al*. (2006) repeated Whitehurst *et al*. (1988) with linguistic minority children selected as sample. 16 primarily Spanish-speaking Hispanic American caregivers and their 7- to 8-years-old children participated in a home-based reading intervention in the families' primary language. Results of their study showed that DR had boosted the verbal participation of the parents and children, parents' reading approaches and children's production of language.

In Aram (2006), children from low-socioeconomic strata (SES) township in Jaffa, Israel were selected to take part in the research which was aimed to examine the different impacts of three intervention programmes, namely shared reading, alphabetical skills, and combination of shared reading and alphabetical skills conducted by teachers in preschools and investigate whether age reciprocally related to the outcomes of those proposed interventions. Therefore, in order to fulfil the objectives, 156 Hebrew speaking children were randomly assigned to one of the three interventions and comparison groups at the two age groups (3-4 years old and 4-5 years old), respectively. The effects of intervention programmes were separately analyzed and storybook reading was found to be productive in promoting name writing, letter knowledge, phonological awareness, and, marginally, receptive vocabulary, as compared to the comparison group. The unexpected finding found was that the storybook reading programme, which focused on language, did not enhance receptive vocabulary more than the other intervention programmes, and this is in line with the finding by Whitehurst *et al*. (1994a). In relation to age-related objective, very few differences emerged between the progress of the younger children and that of their older counterparts. Nevertheless, no differences were demonstrated between the progress of the younger and older children on the manipulated dependent variables in any of the programmes, except for receptive vocabulary which documented younger children outdid the older ones in all the programmes.

In a related study by Chow *et al*. (2008) 148 kindergartners (M=63.8) from Cantonese-speaking parents were used as sample to investigate the effects of parent-child shared book reading and metalinguistic training on their language and literacy skills. Children were randomly assigned to one of four conditions: the dialogic reading with morphology training

(DRMT), dialogic reading (DR), typical reading, or controlled condition. The findings showed that DR yielded highly improved receptive vocabulary production in Chinese students, and DRMT tremendously enhanced character recognition and morphological awareness. Both interventions were proven to be capable of inducing the children's interest on reading.

Korat *et al*. (2006) investigated the role of maternal reading mediation and family home literacy environment (HLE) in children's emergent literacy (EL) level and the differences on these variables with regard to SES level. A total of 94 5-6 years old Hebrew-speaking children and their mothers took part in this study. They were evenly distributed into two different social status-stratified groups, namely low-SES (LSES) and high-SES (HSES). Mother-children interactions while reading an unfamiliar book were videotaped and their verbal interactions were also recorded. The findings showed that HSES children demonstrated higher EL levels and had a richer literacy environment. Turning to the maternal mediation level and SES, the researchers found that LSES mothers paraphrased texts more often, whereas HSES mothers discussed the written systems and made connection beyond text. It was concluded that maternal mediation level and HLE mutually existed in the HSES group, whereas no such relationship existed in the LSES group.

DR IN SPECIAL EDUCATION SETTINGS

Low literacy level among special students attracted many researchers to propose strategies and literacy intervention to alleviate the deficiency in the department. Easterbrooks and Stephenson (2006), in their theoretical review on best practices to use in improving literacy among deaf students, listed DR as one of the 10 most used practices in the deaf education field. However, in relation to the status of deafness, as a low-incidence disability, only a handful research on DR usage among students with deafness was documented. Language enhancement and vocabulary enrichment were the testimonials of the effective DR intervention among students with hearing disabilities (Fung *et al*., 2005; Gillespie and Twardorsz, 1997) and DR has also demonstrated its efficacy in augmenting language level among children with language impairments (Justice *et al*., 2005; Crain-Thoreson and Dale, 1999).

Gillespie and Twardosz (1997) selected 18 deaf children aged between 4-11 years old in their study. Nine children were assigned to the experimental group which received story. The nine children in the experimental group cottages participated in the group storybook reading twice a week for the consecutive period of five months. Each storybook-reading consisted of three to six target children, a high school student as their reader, other non-target elementary school-aged deaf students and someone (often counsellor or a child) who were assisting by holding the book. The reader read the story/ book and involved the children in the discussion. On the contrary for the controlled group, the instructors only read the book for them. The outcome proved that the children in the DR group were highly engaged during the reading sessions. It was clearly evidenced when the readers used an interactive reading approach. Moreover, children in the treatment group also performed more independently on emergent reading task and their counsellors identified them to demonstrate enjoyment (positive) behaviour towards reading.

The findings from Gillespie and Twardosz (1997) were extended by the outcomes from Fung *et al*. (2005). Twenty-eight children from Cantonese-speaking families in Hong Kong, with moderate to severe hearing loss, were included in the study. These children's age ranged from 5 years 2 months and 9 years 1 month, and they were attending kindergarten, first, or second grade in local primary schools. All the participants were randomly assigned to one of the three conditions, namely dialogic reading group, typical reading group or control group. DR was adapted to accommodate the needs of the deaf children. Picture cards were given to the parents and used as materials to support prompt questions. For example, parents were asking the children the prompt questions

based on the content of the storybook and the answers were given in the picture cards. The outcome proved that the dialogic reading group produced the largest improvements in receptive vocabulary learning among the three groups.

In a different study conducted in a language impairment field, Justice *et al*. (2005) evaluated the outcome of a parent-implemented phonological awareness (PA) intervention using DR for young children with specific language impairment. Twenty-two children (M=5 years 2 months) were assigned into two conditions, namely PA intervention and vocabulary production intervention. During the intervention, the treatment groups were exposed to the PA tasks, e.g. "Can you find me a word that rhymes with this (referring to the card with a picture of a corn)?" The outcomes showed the differences in rhymes produced in pre-test and post-test but not in alliteration. Justice *et al*. (2005) also evidenced the age-factor and level of impairments influenced the outcomes of PA intervention.

Thirty-three children (M=51.6 months) with language delays participated in the study by Crain-Thoreson and Dale (1999) and 22 were randomly assigned into one of the two conditions, namely teacher-conducted DR and parents-conducted DR. The findings favoured the intervention groups in expressive vocabulary, receptive vocabulary, and number of word utterances. It was concluded that DR interventions delivered positive results in terms of vocabulary enrichment among children with language delays.

WHAT IS ASSISTIVE COMPUTER TECHNOLOGY (ACT)?

In this section, the author segments the review into two sub-components, as follows:

- A review to support the use of ACT to improve language learning in special education settings; and,
- Electronic books and their impact on the language development of children.

The integration of education and technology has sparked a new experience of learning and benefited most of the students and educators. In a closer context of teaching and learning process in special education settings, Assistive Technology (AT) which demonstrated benefit in enhancing life is defined as any technology that allows an increase, maintenance or improvement of the functional capabilities of an individual with a disability (Morrison, 2007). In a different definition of AT but serving the same objective, Lewis (1998, cited in Jeffs *et al.*, 2006) described that "First, it can augment an individual strengths so that his or her abilities counterbalance the efforts of any disabilities. Second, technology can provide an alternate mode of performing a task so that disabilities are compensated for or bypass entirely." In a nutshell, AT provides someone with disabilities the opportunity to perform and complete task efficiently and independently.

On the other hand, Assistive Computer Technology (ACT) is functional in the same manner as an assistive device, but it requires access to electronic technology, specifically computer technology and is used to address students' learning problems. ACT, Computer-Based Learning (CBL) and Computer-Assisted Learning (CAL) are different lexicons sharing similarity in performing the function to facilitate learning through computer technology.

A Review to Support the Use of ACT to Improve Language Learning in Special Education Settings

Many researchers concluded that technology invention has sparked benefit in enhancing language learning among students with disabilities (e.g. Gentry *et al*., 2005; Barker, 2003; Massaro, 2006 in Miesenberger *et al*., 2006; Noraini *et al.*, 2006; Mioduser *et al*., 2001; Lee and Vail, 2005; Yang and Lay, 2005) across the modalities.

Noraini *et al*. (2006) conducted a survey to assess the impact of MyGfL on its users. MyGfL is a web-based learning portal owned by the Malaysian government through the Ministry

of Education to cater for the learners' needs in Malaysia. A section for the non-hearing students was developed with additional sign-language captioning. The portal is also accessible for the public who wish to learn the sign language. The research on the feasibility of Malaysian Grid for Learning (MyGfL) in assisting hearing disability students in their learning yielded positive perceptions from both the students and teachers. Children with hearing needs and their teachers agreed that the contents in MyGfL have helped these children far better in learning.

Barker (2003) conducted a study to evaluate the effectiveness of a computer-based vocabulary tutor in an elementary auditory/oral programme. Nineteen children with hearing disability took part in the study. The vocabulary tutor displayed line drawings or photographs of the words to be learned while the computer generated avatar of a 'talking head' provided synthesized audiovisual speech from the text. In general, children memorized 70 new words from everyday objects and after four weeks, they were found to retain 39 words at the most. Through the process, children memorized 218 new words for everyday household items. After four weeks, the vocabulary production was tested and most of the participants retained half of the total number of the words. In a conclusive ending, Barker stated the effectiveness of the computer-based vocabulary tutor had been demonstrated.

The findings are consistent with the ones by Massaro (cited in Miesenberger *et al*., 2006). Massaro conducted a study to evaluate the efficacy of vocabulary instruction using an embodied conversational agent as the instructor name, Baldi®. It is a 3-D computer-animated talking head. Baldi provides a realistic visible speech that is almost as accurate as a natural speaker. Eight children with hearing loss participated in this study. The researcher developed a set of lessons with a collection of vocabulary items which was individually composed for each student. Each collection of items comprised of 24 items, and they were broken down into three categories of eight items each. Three lessons with eight items each were provided for each child. Images of the vocabulary items were presented on the screen next to Baldi as he spoke. Assessment was carried out on all of the items at the beginning of each lesson. This included identifying and producing the vocabulary items without feedback. The outcomes showed that identification accuracy was higher than production accuracy. In addition, a reassessment test was carried out about four weeks after the completion of the experiment revealed that the students retained the items that they had learned.

In Mioduser *et al*. (2001), 46 children aged 5-6 years old at high risk of learning disabilities (LD) participated in a study to examine the

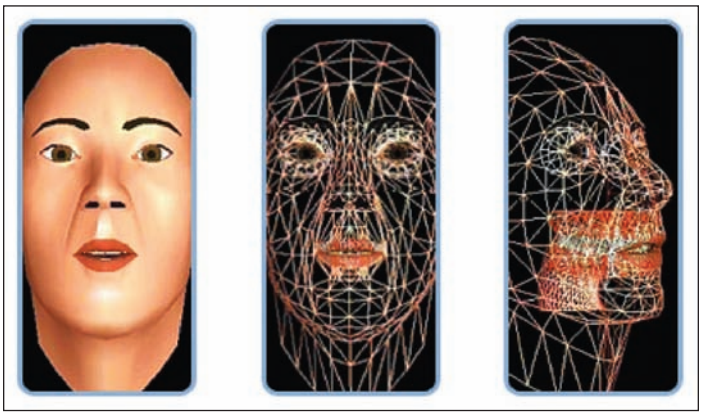

Fig. 1: Baldi ® (Massaro in Miesenberger et al., 2006)

effect of computer-based instruction compared to conventional modes of instructions in early reading skills acquisition. The children were randomly assigned to one of the three groups: Group 1 (n=16) received reading instruction which included both printed and computer-based materials, Group 2 (n=15) given printed materials reading instruction, and Group 3 (n=15) served as a controlled group which received regular special education instruction without specific reading instruction. The findings indicated that children who received the reading intervention in the forms of both printed and computer–based materials significantly improved their phonological awareness, word recognition and alphabetical knowledge relative to their peers who received the other two conditions.

In their study, Lee and Vail (2005) investigated the effect of computer-based word recognition intervention in four selected children with developmental disabilities. The intervention programme was developed through a formative evaluation process and embedded a constant-time-delay procedure which involved sounds, video, texts, and animations. The percentage of correct responses was measured. The programme consisted of among others, direction page, video segment with verbal description, and task directions. Findings indicated that all the participants acquired the targeted words. They gained incidental information presented through antecedent procedure and sight word recognition.

Yang and Lay (2005) developed a computer-aided Mandarin phonemes training (CAMPT) system and evaluated its effectiveness in enhancing phonemes among deaf students in high schools. The system analyses the spoken Mandarin phonemes of a hearing-impaired person, compares it with the phonemes database, and shows the results on the computer monitor. The analysis showed that the system could help the students with hearing disabilities in learning Mandarin phonemes.

DR via Electronic Books and Its Impact on Language Development of Children

In a previous review, using a printed materials, DR has been demonstrated to be effectiveness in augmenting language level of children including among children with disabilities (Whitehurst

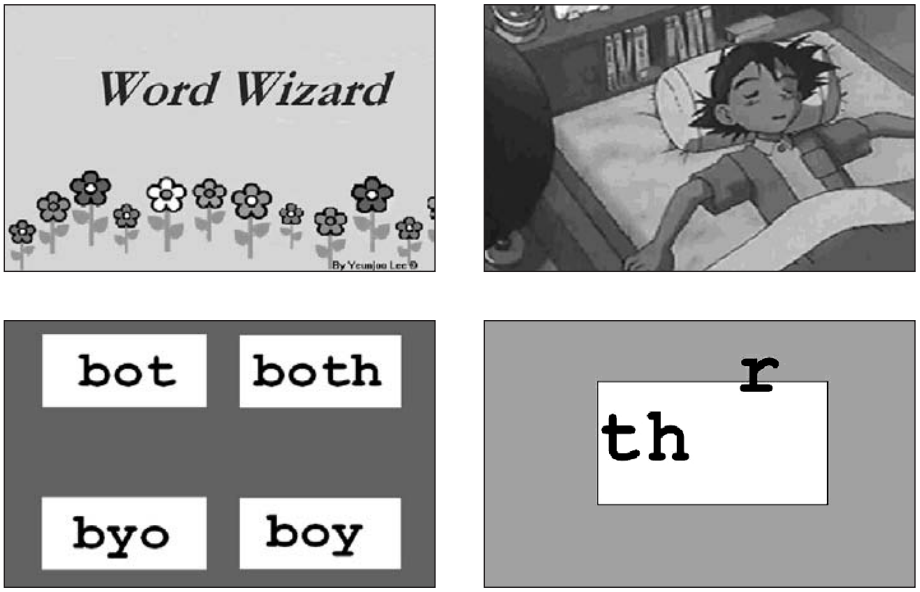

Fig. 2: Screenshot from the computer-based language programme in Lee and Vail (2005)

et al., 1988: 1994a: 1994b; Wasik and Bond, 2001; Zevenbergen *et al*., 2003; Walsh and Blewitt, 2006; Jimenez *et al*., 2006; Chow *et al*., 2008; Aram, 2006; Korat *et al*., 2006; Fung *et al*., 2005; Gillespie and Twardorsz, 1997; Justice *et al*., 2005; Crain-Thoreson and Dale, 1999). Advances in information and technology communication have brought new dimension of learning, which evidences the influx of technology-embedded learning. DR too, has gone through the evolution of technology when the conventional method of conducting the face-to-face session is substituted with the computer-based intervention programme. The new idea of computer-based DR procedure has attracted a few researchers to investigate the efficacy of e-DR in enhancing language skills of normal students (Korat and Shamir, 2007) and students with disabilities' (Kennedy, 2004; Gentry *et al*., 2005).

Korat and Shamir (2007) conducted a study to examine the effects of electronic storybooks on the emergent literacy relative to the conventional method, being read the same storybook in its printed version by adult. A sample of 128 children aged 5-6 years old was stratified according to their socio-economic status (SES), namely low (LSES), and middle (MSES). Then, the children in each group were randomly assigned to one of the three conditions. The two intervention groups included three book reading sessions each; children in one group individually read the electronic book; in the second group or served as a control, received the regular kindergarten programme. Vocabulary, word recognition and phonological awareness were also measured. The children's vocabulary scores in both intervention groups were found to improve and they also showed a similarly good level of story comprehension. In both the SES groups, the children's phonological awareness and word recognition did not improve following the two reading interventions compared to the control group.

Kennedy (2004) investigated acquisition of word recognition and word knowledge using Thinking Reader among students with hearing disabilities. It is a digital book with reading comprehension support embedded, facilitated word comprehension using multimedia which include videos in American Sign Language that correspond directly with the reading material. The study was implemented using deaf middle school, or grades 6, 7, 8, students whose average reading ability was at the first and second grade levels. The goal of the study was to observe the process and gain insight into the decisions and interactions students made to enhance their vocabulary with Thinking Reader, a computer-mediated environment. The findings of this study suggested that the students benefited from the multimedia features of Thinking Reader. The multimedia features support students' word recognition, word knowledge, and encourage independence. In addition, the use of technology to present text bilingually, in both American Sign Language and English, had an impact on the students' motivation. The students reported that the decoding view was the most successful in motivating them to recognize words.

In a study conducted by Gentry *et al*. (2005), technology has again done its magnificent job. The results suggested that presenting a story on CD ROM with multiple modes of reading cues, such as pictures, print and sign language could be an enjoyable and interesting supplement compared to the conventional reading practices. A sample of N=28 deaf students were chosen to participate in the study. Using the repeated measures design, they were given four different reading treatments in a CD ROM: (a) print only, (b) print and pictures, (c) print and digital videos of sign language, and (d) print, pictures and digital video of sign language. Surprisingly, the level of comprehension was shown to be the highest for stories presented with print and pictures. The least conducive treatment was presenting the story via print only. They further suggested that the use of multimedia application is significantly more effective in reading comprehension than using print-only material.

DISCUSSION

Students with hearing disabilities have different needs in education relative to their normal peers.

Planning an adapted DR into computer-based intervention, with regards to the deaf students as users, involves several factors that should be taken into consideration by the educators and practitioners. Understanding the factors which highly contribute to the success of the aforementioned programmes is therefore crucial.

NEEDS OF THE DEAF CHILDREN

First, the Computer-Based Dialogic Reading (CBDR) should be able to address the physical needs of the deaf. For a deaf or hard of hearing person, computer software applications are generally accessible and usable in respect to the visually oriented and text based application. To be more precise, Belson (2003) elaborated the criteria for evaluating the software for the deaf and hard of hearing students by citing the guideline provided by Gallaudet University's Laurent Clerc National Deaf Education Centre. The guidelines are stated below:

> *If deaf or hard of hearing evaluators/ users cannot understand what the software is about (without the ability to hear the sound accompanying the programme, then the importance (of sound in its use) would be major. If some portions of the product can be understood despite the fact that audio information cannot be heard, then its importance is moderate. If the sound is not critical to using the product successfully, then it is minor. If you are a hearing reviewer, please be sure to evaluate the product with the speakers turned off (Gallaudet University's Laurent Clerc National Deaf Education Centre).*

The author adapted De Jong and Bus (2003)'s specific guidelines to evaluate the appropriateness of the software for students with deafness (refer to Table 2).

FAMILY MEDIATION

Second, several studies showed that family mediation is an influencing factor in determining the effectiveness of a reading intervention (Whitehurst *et al*., 1994a; Mol *et al*., 2008; Korat *et al*., 2006). Thus, family should give support and participate in any intervention programme provided by the schools. Family mediation encourages more verbalization and interaction among children. In utilizing computer-assisted learning, family mediation is very helpful in helping students with disabilities to be in contact with the software. Parents can help in operating the software and discussing the learning.

THE USE OF VISUAL CUES AND ANIMATIONS

Third, the use of visual cues has been proven to be beneficial for language learning among students with hearing disabilities (Gentry *et al*., 2005; Fung *et al*., 2005; Johnston *et al*., 2008). Pictorial books and pictorial reading materials tremendously assist the deaf children especially those with severe to profound hearing loss during the language acquisition period (Bond *et al*., 1994). Deficiency in auditory forces the deaf students to utilize visual cues bridge signs and printed text. However, several added considerations should be carefully used to guide the implementation of visual cues in computer-based intervention. Kim *et al*. (2007) found that for younger age deaf students, animation is deemed as the most enjoyable features which are relatively in contrast with students of older age who prefer self-paced navigation on the animation provided. Albeit one should be concerned of not overdoing it which may result in shifted learning objective. Too many animations will distract the students from extracting learning from the software (Kim *et al*., 2007; Kim and Gilman, 2008). In addition, the embedded multimedia components should be presented as a choice for deaf users. It is documented that simultaneously playing ASL video, printed text, and pictures produced lower comprehension and word recognition

TABLE 2
The adaptation of De Jong and Bus (2003) coding system for the content analysis of e-books

Coding variable	Analysis criteria
Book processing	1. Introduction screen: option are explained 2. A forward and back button to load the next or previous screen 3. Overview screen shows all screens in small format
Multimedia in pictures	4. Dynamic visuals to dramatize the story 5. What is dramatized; details, fragments or complete story scenes? 6. Availability of an oral/sign reading
Multimedia connected to printed or gestural text	7. Print that changes while it is being narrated by highlighting, colouring and the like 8. Availability of games: (i) as a separate page; (ii) integrated in the story 9. Hotspots: (i) availability; (ii) integrated in the story
Interactivity of the story	10. Interactivity of illustrations accompanying the story: (i) no interactivity; (ii) realized by the availability of games and hotspots; (iii) realized by the availability of games and; (iv) realized by the availability of hotspots
Interactive legibility	11. Option to start, restart and interrupt the sign reading 12. Availability of print 13. Hotspot in the text to activate pronunciation of phrases or separate words 14. A dictionary to explain words in the story

among deaf students. The causal might be traced to the overloaded cognition provided by simultaneously playing various multimedia components (Gentry *et al*., 2005).

INTERACTIONS

Meanwhile, in discussing about animations and interactions, Schery and O'Connor (1997) stated the appropriateness of stimuli and responds indicating that the programme features, including accessing the type of stimuli, the requirements for responding and the reinforcement provided, need to be carefully examined so as to determine if they will provide a positive learning experience for students. Interaction which consists of stimuli and responses are much akin to the prompt of Wh- in the face-to-face shared reading programme. Thus, stimuli presented must be provided in the much similar way as humans and the reinforcements should be administered to boost the motivation. The suitability of using animation and interaction in the software is therefore crucial in order to avoid bored experiences, frustration and de-motivation.

SUITABILITY OF THE READING MATERIALS

The next factor that should be taken into consideration during the planning process is the suitability of the storybooks or reading materials chosen for the audience. Delays in languages could cause deaf students to be left years behind

the chronology age. Thus, storybooks which suit normal children may not be appropriate for deaf children in a plateau age. Inappropriate reading materials, irrelative of the reading level, will result in an inefficacy of the intervention (Girgin, 2006). In addition, prior knowledge also plays a big role in determining the appropriateness of the storybooks to be included in the reading inventories. Prior knowledge gives students insight experiences to comprehend the stories and provides clues in word recognition (Girgin, 2006). Besides, children get attracted to the characters revolving around their family, animals, and fairy tales (Massaro, 1975).

CONCLUSIONS

To sum up, computer-assisted learning in accelerating language learning among children with or without disabilities is promising. The adaptation of the traditional language learning method into the digital material with embedded interactivity could constitute a good source for young children's language development, particularly children with disability and at-risk. Entering a new world of technology-based learning, where the processes are equally emphasized as much as tools, incorporating the analysis of needs, theory of learning and linguistic theoretical frameworks is crucial in planning the instructional design of computer-assisted language learning. The multimedia combination offers advantages and helps compensating the deficiency in the department of auditory among children with hearing disabilities. Enhancement of visual graphics and interactive media are promising attributes to motivate the joy of language learning among them. Since children with disabilities generally composed a rather low span of attention, technology can do wonder in retaining their focus. However, technology abandonment is on edge if the educational software is developed without concerning the needs of these children. By understanding several factors included in this study, the efficacy of the computer-assisted learning can therefore be enhanced.

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