Information Technology in Childhood Education Annual (2003), 105-138

Children's E-Book Technology: Devices, Books, and Book Builder

NORSHUHADA SHIRATUDDIN
Universiti Utara Malaysia (UUM)
Malaysia
shuhada@e-web.uum.edu.my (or)
shuhada@dis.strath.ac.uk

MONICA LANDONI
University of Strathclyde
Glasgow, Scotland UK

This article describes a study of children's electronic books (e-books) technology. In particular, the focus is on devices used to access children's e-books, current available e-books and an e-book builder specifically for children. Three small case studies were conducted: two to evaluate how children accept the devices and one to test the ease of use of an existing book builder currently on the market. In addition, with the intention of finding functions that can be enhanced we also personally reviewed the book builder. A hypothesis was formed to verify the ease of use of the program. An ease of use index was constructed from the addition of four variables: (a) learning time, (b) number of questions asked during learning, (c) book building time, and (d) number of questions asked during book building. This article then concludes that children are very much at ease with e-book technology. They are able to use devices, e-books, and e-book builder without much effort.

The result of integrating classical book structure, or rather the familiar concept of a book, with features which can be provided within an electronic

environment, is referred to as an electronic book (e-book) (Landoni & Gibb, 2000). E-books are developed with the intention of overcoming the limitations of paper books. They have advantages over paper books in that they are dynamic, reactive, and able to provide the same features as well as new features such as fast hyperlinking, multimedia technology, digital annotating, digital bookmarking, and fast searching. The term is used instead of hypermedia or interactive multimedia for the reason of maintaining the paper book metaphor. Literature defines e-books to be composed of a collection of electronic reactive pages that exhibit many of the characteristic features and properties of a conventional book (Barker, 1999). Following a paper book metaphor into the design of e-book reduces the cognitive loads of users when using a new technology (Landoni & Gibb, 2000).

At present, distribution of e-books through CD-ROM and the Internet is most popular. Since 1998, another type of e-book medium was introduced to the public: readers or hand-held devices or slates. These devices act as distribution medium as well as dedicated reading devices.

HARDWARE BASED READERS

The emergence of e-book has resulted in many companies engaging in manufacturing electronic reading devices used for displaying, reading and storing electronic information. NuvoMedia Inc.[1], SoftBook Press Inc.[2], EveryBook Inc.[3], and Japanese Sony (Sanders & Sanders, 2000) are examples of manufacturers of hand-held reading devices who were initially targeting only professionals that require access to lots of reference materials (Judge, 1998). Gemstar International Group, one of the leading companies who are involved in electronic technology, however own NuvoMedia Inc. and SoftBook Press Inc. since early 2000 and has been promoting and planning to produce better reading devices. These machines (Figure 1) are produced purposely for reading downloaded electronic contents. They are lightweight devices aimed at duplicating the familiar experience of reading a paper book, yet contain electronic-age features to further enhance convenience and enjoyment (Thomson Multimedia, 2000). Examples include:

- NuvoMedia Rocket eBook (now obsolete);
- RCA REB 1100 and 1200;
- Microsoft IPM-NET Myfriend;
- Cytale Cybook.

Figure 1. REB 1100 and REB 1200 by Gemstar

O'Donnell (1998) stated that all these devices have one common function in that they are e-book only, not handheld computers or organisers. This statement is now partially inaccurate as hybrid devices (Wilson, 2001), which contain address books, diary, calculator, and personal digital organisers (PDAs) associated functions have also been used to read e-books. Additionally, this device can also be used for e-mailing, Internet surfing, word processing, and MP3 playing. For example, Franklin eBookMan (Figure 2). PDAs are rapidly becoming a common technology at schools[4] because they allow students and teachers to do essential tasks such as note taking, word processing, graphing, emailing and browsing.

Figure 2. Franklin eBookMan

Besides PDAs, Game Boy machines are also now capable of functioning as e-book reader. Pet Crowe[5] developed a program written in assembler,

to allow out-of-copyright classic book texts to be read on the Game Boy screen. It converts text files and supports many languages, colour schemes, and font sizes. The latest, still under development (as of March 2002) device, is called ReBooks from RealTimeTouch.com[6]. It will allow print, video, audio, interactive touch, and wireless communications. Another initiative is the EInk[7] project, a flexible paper-like electronic display on thin sheets of plastic. The basic idea behind electronic paper is that it is a reusable display device, allowing the storage of visual content on a "page" of plastic paper. This technology is at its early stages, but EInk has expressed the desire to create the technology to allow the development of electronic devices that work like paper books—plastic, reusable pages bound together to form a book-like device.

In contrast, Oregon Scientific[8], VTECH[9], and IQ Builders[10] are producing fun, friendly, computer-based learning laptop machines for children aged 3 - 12 years old (see Figure 6). These machines are used to distribute pre-installed activity books with many electronic drill and practice exercises and come in a variety of colourful casings and designs. Contents can be up-dated through downloading or buying storage devices designed specifically for the machines.

NuvoMedia Inc., SoftBook Press Inc., and EveryBook Inc. are pioneers in introducing the reading devices which come in various specifications and prices, along with individual advantages and disadvantages (Manes, 1999). They have important advantages over traditional paper books in that they can store tens to hundreds of titles, making them ideal for convenient, portable access to reading material from virtually any location (Thomson Multimedia, 2000). The back-lit display and font size can be adjusted to improve readability (Selvidge & Phillips, 2000) and they also include other features such as interactive dictionaries, bookmarking, searching, note taking, and cross referencing. Full descriptions on the advantages of these reading devices can be found in Williams (2000a).

Even though they have advantages over paper books, reading from these devices is reported to cause more eyestrain and glare (Williams, 2000b). The display quality is poor compared to paper and the devices are still too expensive for the average person to buy.

Contents for the readers can come from a variety of online sources such as novels, journals, newspapers, magazines, company training manuals, and professional information. Unfortunately currently contents of printed books especially textbooks remain scarce. Online books currently consist mostly of work whose copyrights have expired (Moschella, 1999). Project Gutenberg[11] has been collecting thousands of out-of-copyright titles since 1971

and offering them to the public for free. However, a new trend is emerging whereby electronic publishers such as Fatbrain[12], iUniverse[13], and 1st-Books[14] have proven to successfully produce and sell new electronic titles. Customers are drawn to books about computers and business (Carvajal, 2000) as well as romances and science fiction novels (Allen, 2000; Hawkins, 2000a). Well known writers such as Stephen King are among those interested in marketing their books in electronic format. Additionally, contents can also be downloaded from digital libraries such as Fliblibrary, The Internet Public Library Online Texts Collection, University of Virginia's E-Book Library, and Net Library.

E-BOOKS

Children's E-book Format

E-book formats for children books are similar to the adult market. Publishers who are currently selling children's e-books use HTML, EXECUTABLE (.EXE), and PDF formats. Among the popular publishers, Antelope Publishing[15] produces, publishes, and sells children's storybooks, picture books, teenage novels, and fiction/non fiction books in HTML formats. They are targeting children from preschool to young adults and books are read on web browsers. Although their books are read using web browsers, the books are stored on CD-ROM making them possible to be viewed on or offline.

VanGoach Books[16] produces fairy tales and story books in .EXE format. Books can be bought either in CD-ROM or send through e-mail to children aged 2 to 10 years old. Other publishers such as Bookmice[17], DiskUs Publishing[18], Ebook On the Net[19], Book Locker[20], and Zorba Press[21] sell children's classic books, sci-fi books, audio books, and learning books in PDF and HTML formats.

E-Book Initiatives

Good examples of e-books are reported in Landoni (1997). She discusses examples according to their types and introduced the terms "page turner books" and "scrolling books." In addition to her classification, this study reveals the presence of another type of e-book, which exhibits both "page turner plus scrolling books" features. E-books are also classified according

to their purpose as evident in Borchers (1999). There are four categories: (a) reference/documentation (e.g., dictionaries, manuals), (b) learning (e.g., textbooks, tutorials), (c) browsing (e.g., newspapers, magazines), and (d) entertainment (such as novels, comics).

E-book publishers are now adding children's titles to their list of e-books. Before 1997 most children's e-books on the net were not published by professional e-book publishers (Hardin, 2000). This has now changed and children's e-book has grown immensely. Children's e-books can be grouped into the following 3 categories, usually for the purpose of learning or story telling:

- picture books;
- audio books; and
- multimedia books.

These categories follow Barker who categorised e-books into 10 basic types (Barker, 1992; Barker, 1999) depending on the types of information embedded, the basic properties exhibited and the function to be performed: textbooks, picture books, talking books, moving picture books, multimedia books, polymedia books, hypermedia books, intelligent electronic books, telemedia books, and cyberbooks. The first five types and intelligent electronic books are easily recognised. However, the others are scarcely discussed or differentiated. Polymedia books involve the use of both electronic and nonelectronic media. Hypermedia books are very similar to multimedia except that they embed nonlinear web-liked information structures. Telemedia books make use of telecommunications facilities such as sending mail or dynamically updating their own content from remote agents and cyberbooks provide readers with virtual reality capability. A similar differentiation between multimedia and hypermedia books is outlined by Bartolome (1995). In the case of a multimedia book, the information is organised in a linear way whereby it is fragmented, structured, and several access paths are defined. In the case of hypermedia, information is divided into several chunks with multiple links connecting the chunks.

Picture books mostly include pictures only and there are no words to read. Children simply select pictures or objects that are linked to other pictures or activities. Other features include graphics that can be animated by clicking on them. These kinds of books are intended for early learners who cannot yet read. For those who can read few words, there are books which provide a first step towards reading with graphics and simple sentences, often one line per page, written in a large font size as in picture books by Antelope-Ebooks (Figure 3).

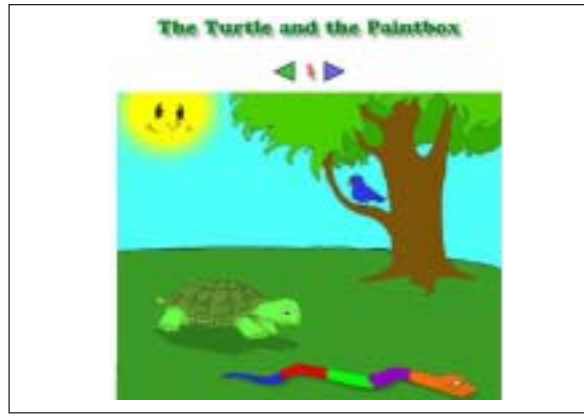

Figure 3. Example of picture book

Other examples of picture books include a project developed by Live And Learn[22] and Coloring.com[23]. Live and Learn has developed an online animated picture book ideal for beginner readers, pre-schoolers and toddlers. The animated picture book includes five pages, with the focus subject on opposites. Coloring.com provides various types of pictures that children can colour (Figure 4). The coloured pictures can then be printed, saved into users' own art gallery, which is provided or posted through e-mail to friends and families.

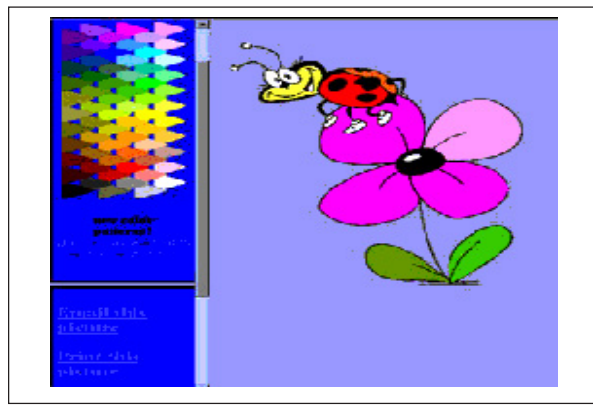

Figure 4. An example of a colouring book

Audio books are normally stored in cassettes or CD-ROM. The contents of the books are read aloud to the children and this is a particularly effective

use of technology for children with disabilities such as visually impaired or loss of motor control (NCIP Library, 1998). Features of audio books vary but include the rate at which text is read, highlighting words or phrases or sentences while reading, and types of voices (boy, girl, etc.). Fiction Works[24] produces children's audio books with titles for example by Townsend (2000).

Multimedia books incorporate text, graphics, audio, animation, and /or video in their content to provide a powerful experience for any child (NCIP Library, 1998) and if applied carefully, would improve learning, user friendliness of user interfaces, and entertainment value (Hoogeveen, 1995). Antelope-Ebooks produces and publishes many kinds of e-books including multimedia books. However, most of their books are used for the purpose of entertainment (i.e. storybooks, humour, cook books, fantasy, etc.) with limited interactivity (mainly next and previous buttons) and include only graphics, background music, and very few low quality animations. Hiyah[25], on the other hand produces multimedia books with more features, which imitate book metaphors (Figure 5). Books are read aloud and children are provided with a pause button. Options are given whether or not to start reading from the first sentence of the opened page or from where the pause button is stopped. Their books however do not include any animation or video.

Figure 5. An e-book by Hiyah.com

All the previously described examples are either stand-alone or web based e-books. To read books that require a software based reader (e.g., *Adobe Acrobat Reader*™, *Adobe Acrobat eBook Reader*™, *Microsoft Reader*™) users can visit Webs4Kids[26] and download books to be read on *Microsoft Reader*™. Webs4Kids publishes and sells e-books specifically for children aged 6 to 14. They also include free e-books for popular titles such as Aladdin and the Wonderful Lamp, Cinderella, Snow White, and The Little Mermaid.

Examples described so far are not used for learning purposes. Children's learning tools can be categorised into two types and is influenced by the theories on how children learn: edutainment; and drill and practice.

The word *edutainment* is a combination of two words: *education* and *entertainment*. Learning tools in this category are based on "constructivists" theory, which acknowledges that children know a lot before they get to school and seek to create environments for children to play in, and objects to play with (Druin & Solomon, 1996; Alexander, 1999). Emphasis is on providing tools that allow children to continue to learn new things as naturally as they are exploring their daily activities. In short, this theory adopted a strategy of teaching children by relating them to things they already know as well as a variety of games, which allow children to participate in authentic, active learning experience (Blanchette & Kanuka, 1999). Play elements enable children to stretch their young imaginations (Lopez, 1998).

Edutainment lets children enjoy what they are learning with a combination of sound, animation, video, text, and images. It offers children a way to wander through information or games at their own pace and in their own way (Druin & Solomon, 1996). Tools in this category are most commonly found on CD-ROM with diverse titles by many companies including Edmark[27], Disney Interactive[28], Educational Activities Inc.[29], and Mattel Interactive[30].

Drill and practice programs are usually the results of applying "behaviorism" theory which supports the concept of teachers as the disseminators of information (Druin & Solomon, 1996). In this type of e-books, children are taught through a series of carefully moderated exercises (usually objective type questions) at different levels of difficulty that address the same skill objective. Correct answers for questions are awarded points, however for incorrect answers, children are encouraged to try again. Although this type of e-book proves to raise children's test scores, their method of delivery is repetitious making them boring after a while (Druin & Solomon, 1996). Suppes (1969) is among the earliest renowned researchers whose work is based on this approach. Table 1 summarises children's e-books classifications and features.

Table 1
Children's Book Classifications and Features

Purpose / Type	Leisure | Edutainment | Drill & Practice Features
Picture books	Pictures only usually storybooks or colouring books; Click objects to activate interactivity; For very young children who can not yet read;
Audio books	Contents are read aloud to children; Rate of read can be changed; Sentences are highlighted while reading; Options of different voices.
Multimedia books	Incorporate multimedia elements;Highly interactive.

HARDWARE EVALUATION

This section presents results of hardware evaluation. Two types of hardware were evaluated with children to study how well children accept the devices.

The Children's Laptop

E-book may soon deliver man from paperweight (Judge, 1998). Paperweight has long been a problem, especially to schoolchildren. This hardship is unavoidable as students are actively engaged with texts and new information. Students learning from textbook practice active reading and learning (Schilit, 1999) as opposed to passive paperback fiction reading. This hardship will soon be lessened with the coming technology of electronic reading (e-reading). E-reading uses a machine screen as its medium of display.

An electronic learning machine was used to observe children's technology preferences. It is a laptop look-alike machine with a keyboard and mouse that displays learning activities on a built-in screen, a PC-based e-book for young children. The machine, Zip the Robot Learning PC, by Oregon Scientific[31] is designed for 4-7-year-olds and has 50 game activities covering vocabulary, spelling, grammar, math, music, and games. It can be expanded with add-in smart cards. Like a real laptop, it has a QWERTY keyboard and a mouse to also introduce essential computer user skills (Figure 6). The machine is powered either by 4AA size batteries or a 9V AC adapter.

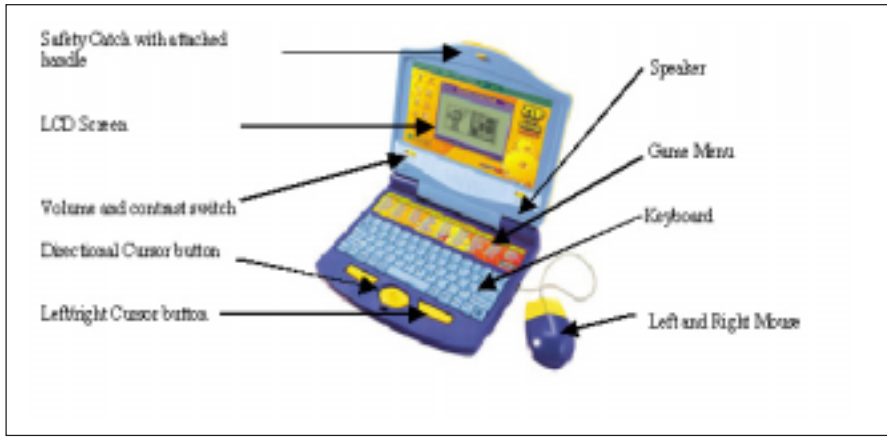

Figure 6. Physical designs of Zip the Robot e-book

The Machine Features

Game activities and questions come in groups of 10. Users will be given 3 attempts to answer each question. Points are awarded according to the number of attempts taken to answer each question correctly. Each attempt to answer a question is timed one minute for levels 1-5 and 30 seconds for level 6. If users are unable to answer in time, it is counted as incorrect attempt. Users are praised for each correct answer and prompted for action if given time is exceeded.

The score is displayed at the end of each activity and a score of 85 points or higher after a group of 10 questions will proceed to the next higher level of difficulty. A score of 60 points or below will go to the next lower level.

Fun Laptop: Observed Results

Six 5-8-year-old children were given the opportunity to play with the learning machine. All participants were considered as "moderate technology users" at their age as all have had many experiences playing with CD titles, video games, and personal computers. Moderate technology experience is essential as this study assumed the children were used to the handling of input devices. While using the machine, the children were observed for reactions

and at the end of the playing time, each child was asked to answer some questions regarding selected parameters.

This initial study attempts to observe the children's preference toward the learning device, thus, a study of display preferences by Wearden (1998) was partially adopted. He measured display preferences in six categories: (a) navigability, (b) information utility, (c) design, (d) physical format, (e) wait time and (f) overall preference. Navigability, physical format, and overall preference were selected and used as observation parameters. However, instead of observing wait time, the overall time each child took to play with the machine was measured. A major challenge for flat panel display technology is to reproduce the viewability or readability of ink on paper (Doane, 1998). Realising the importance of readability concept, this parameter was also observed in the study.

To study how the children read and feel towards the learning device, the observed parameters were further broken down into the following questions:

- Navigability—(a) how easy is it to make game choices, (b) are the input devices easy to be used and handled;
- Physical format—(a) how heavy is the machine, (b) do you like the design of the casing, screen and keyboard;
- Readability—(a) are the texts clearly displayed, (b) are the texts and graphics smoothly outlined or is it too jagged, (c) do you like the black and grey display, (d) is the audio clearly understood;
- Overall preference—(a) do you prefer learning with CD-ROM, paper, or the electronic learning machine.

The following table outlines the positive and negative feedback given by the children.

In measuring each child playing time, the timing started when he/she was familiarized with switching on the machine and selecting particular activity. Table 3 shows playing time for each child measured to the nearest minute. The average playing time was calculated to be 19.16 minutes.

Table 2
Feedback from Children

Parameter	Observation Feedback
Navigability	It was easy to select the choices of activities. The right, left and directional buttons were easy to use. The mouse movement was not smooth enough.
Physical format	It was light. The design shape was good with built-in handle. Keyboard worked well. The display screen was too small. Difficult to see the text display.
Readability	Texts and graphics looked too jagged. Displays were not colourful, only black and grey. Grey display panel too dull. Certain character was often mistaken for another character (for example, letter g and s). Audio sounds too robotic.Numbers were easy to read as com pared to letters.
Overall preference	Prefer CD titles displayed on computer monitor or video games displayed on television monitor.

Table 3
Laptop Playing Time

Child	Total Time (min)
1	24
2	18
3	19
4	22
5	15
6	17

Some of the observed results are consistent with findings from other studies:

- Doane (1998) stated that an important parameter of the e-book is its necessary weight limitation. It cannot be heavier than we normally expect a book to be. When asked about the weight of the device, the children agreed that the weight was ideal and they preferred collections of books in electronic form compared to paper books.
- Is the weight of the device really ideal? The laptop provides 50 activities, and say, if each activity were equivalent to 10 pages, the bound conventional paper book would have to have about 500 pages. These 500 pages are indeed heavier than the weight of the machine.
- Jaggies in LCD were found to be liked least in a study by Gujar, Harrison, and Fishkin (1998). The six children in this observation study also complained about the too jagged texts and graphics in the laptop. Examples of jagged characters in Zip the Robot machine:

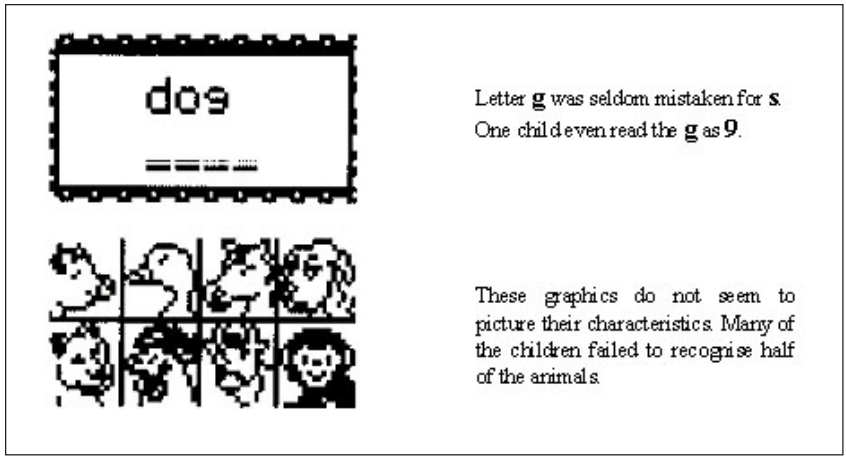

Figure 7. Examples of jagged characters here

- The readability of the laptop was observed to be low in the eyes of the children. Reasons being are low resolution black and grey displays, small display screen, dull grey display panel, and too many jagged texts and graphics. Not surprisingly, Nielsen (1998) also states in his design guidelines that low resolution monitors have poor readability. These children prefer richer colourful multimedia displays as opposed to the black and grey displays.

One other issue that needs to be discussed is the average time each of the children took to play with the machine. Liu's (1996) study showed that multimedia technology with its use of video, audio and graphics could engage children at a longer period of time. However, this is not the case in this case study. All six children appeared to manage to get excited and interested for not more than 20 minutes as opposed to an average time of about 50 minutes they spent on educational games or CD titles played on personal computers. This detected time suggests that there is not enough fun for the kids in the contents, displays, and activities.

DEDICATED E-BOOKS READERS

Taking advantage of another project (E-Books On-Screen Interface: EBONI[32]) conducted by researchers at the Department of Information Science, Strathclyde University, a reader was borrowed and tested with four out of six children from the same group described earlier. The now obsolete NuvoMedia Rocket eBook (Figure 8) has the following features:

- price: USD 269 (retail price);
- size & weight: 7.1 in. by 4.8 in. by 0.8 in., 1.3 lbs;
- screen: Black and white, 3 in. by 4.5 in., 320 x 480 pixels, 108 dots per inch;
- battery life: 20 to 45 hours, depending on backlight brightness setting;
- memory: 16 MB;
- eBook reading software: Closed, proprietary system developed by *NuvoMedia*;
- connectivity: Connects to PC or Mac through cradle and serial cable;
- interactivity: Touch screen and buttons; and
- tools: Library, personalisation, adjustable text size and screen orientation and backlight setting.

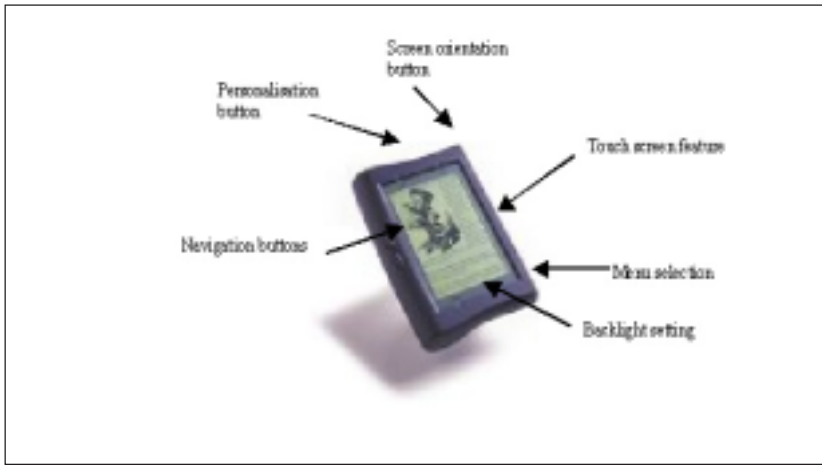

Figure 8. Nuvomedia Rocket eBook

All four children surprisingly when asked to read a few pages of *Alice in Wonderland* were at ease with the reader. They navigated without problems, were able to use all functionalities easily (with very little help), and were very happy with the touch screen feature. Table 4 outlines the results.

Table 4
Feedback from Children

Parameter	Observation Feedback
Navigability	It was easy to select the choices of activities. All buttons were easy to use. Navigation buttons (forward and backward) easily confuse when screen orientation is changed.
Physical format	Quite thick to hold. Onscreen keyboard was easy to use. Touch screen feature was very useful. The display screen size was adequate for reading.
Readability	Texts were easily read. Displays were easily recognised. Displays were not colourful, only black and grey. Grey display panel too dull.
Overall preference	Like it very much and would like to read books on it.

They were able to annotate without much difficulty, and use the free-hand feature more than the keyboard facility. As predicted, they opted for larger text size before reading a page. Other negative responses were also noted such as lack of audio and lack of activities (or in their words: games). When asked to choose between the laptop and the dedicated reader, all were not able to decide but would like to play activities (that are installed in the laptop) in the dedicated reader.

Children's playing time was not recorded here. The reason for this was that each child was asked to read few pages of a book. The reading time for each child reflects his/her own reading ability. Thus, taking reading time was not appropriate for the purpose of this observation.

Conclusions: Hardware

The existence of products such as *Zip the Robot* laptop are a promising indication of the renewed interest in technology application in education. However, there are still few points to be taken into designing future products. Although this study was performed on a small controlled scale, the opinions of these young children should not be ignored.

Children as young as kindergarten can have positive educational experiences with computer technology and educational programs (Carlson & White, 1998). There is no doubt that electronic learning devices will revolutionise the way students learn. Before the devices under investigation can become 100% successful, they should be able to not only display the pre-installed contents, but to also display pages of many types, from documents to journals, letters, newspapers, magazines, and web pages (Fidler, 1998), as well as support analytic reading and other electronic activities. These types of pages are obviously highly essential for school children. The devices should also have the ability to personalise (highlight, add notes, underline items or bookmark) the contents (Fidler, 1998) as this ability is often required by students even as young as seven years old. In addition, the machines should be an affordable technology, able to motivate and at the same time affect the currency and accuracy of the children's knowledge.

It is possible to conclude that when the cost is taken into account, the learning machine is somewhat ideal for the children even if the readability is poor. It is on sale for about £30, which is quite reasonable and affordable. In comparison, imagine the costs of buying 50 activity books with each book priced at £1 (bare in mind, nowadays, it is unlikely to find a new book at this cost), would total up to £50 (50 X £1). This is £20 more expensive than the price of the learning machine.

The dedicated reader is too expensive for parents to buy for their children. Even if parents can afford it, there are still lacks of e-books to buy for children, which contain activities as provided in the laptop. On-line publishers have yet to venture into producing or selling electronic textbooks or activity books for children. However, it is believed that it is just a question of time. More and more publishers are acknowledging the potential of e-books, especially storybooks. Additionally, prices of dedicated readers are getting lower by the year and studies seem to indicate that hybrid handheld devices are gaining popularity in school environment (e.g., Electronic School[33], The Educator's Palm[34], K12 Handhelds[35], British Educational Communications and Technology Agency[36]). These devices are becoming smaller, cheaper, better in performance, and more connected (i.e., able to browse Internet and transfer data).

Demand for dedicated e-book readers in adult consumers is still low (Molina, 1998). This may be because of the comfort factors that are said to play a significant role in making paper based reading preferred (Munyan, 1998). Although the printed book is a familiar companion, lightweight and portable, it offers readers only text that is forever immutable (Chartier, 1998). Furthermore, it falls apart over time (Rothman, 1996) especially when young children are involved.

In conclusion, the learning machine is another of the newest evolution of learning devices. It is an addition to the learning devices list, which includes paper based, television, radio, videotape player, computer, videodisc player, and the Internet. The choice "to use or not to use" these learning devices is in the hands of each individual. However, it is wise to bear in mind that the most significant influence on education is not the technical development of more powerful devices, but the professional development of wise designers, teachers and learners.

E-BOOK BUILDER

This section presents the results of allowing children using an existing children's e-book builder (i.e., the authoring program that enables children to build e-books). However, before the evaluation was conducted, the program was reviewed with the intention of finding the usefulness of system functionality and determining which functions might be enhanced.

By maintaining the same book model on screen, users access to electronic information can be facilitated (Landoni & Gibb, 2000). In view of this, Software Production Associates (SPAsoft) developed an authoring tool that allows users, especially children, to create e-books. The software is

called *Book Builder* and enables children of all ages to put together multimedia books containing text, pictures, sounds, and videos in the easiest possible way. When the book is completed, other children can view, use, and hear it with the simplest possible navigation controls. In addition, books can also be saved in HTML format.

To build a book, children start by choosing the format of each page from a number of simple choices: just text, pictures and text, or a video. Then they add content using the built-in text editor. Text colour, size, and font can easily be changed. For more complicated effects, children can load up their favourite word processor from within *Book Builder*. Teachers can set what word processor is loaded, so there is no need for children to learn how to use yet another piece of software.

Pictures can be copied and pasted straight into *Book Builder*. However if children want to make new pictures, they can load their favourite picture program and use that to create and paint without leaving *Book Builder*. On top of this, users can easily record a sound track or insert a video to go with each page without leaving *Book Builder*.

Book Builder also supports collaborative works between children. One book can be inserted into another. So, for example, pairs of children can each work on a page or two, and then the whole class's pages can be combined into one book. The finished books (Figure 9) can be locked so the content of the books cannot be changed by an unauthorised person.

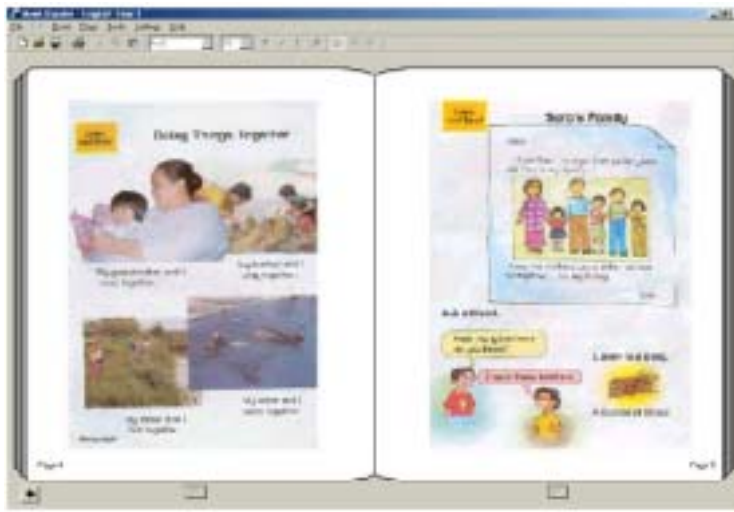

Figure 9. Example of completed book

Review Method

At first glance *Book Builder* functions seem adequate. However, when reviewed thoroughly by adopting co-operative inquiry (Druin, 1999) approach, the tool can be further modified and enhanced to meet users' needs.

Since it is seen as the most appropriate technique (Druin, 1999) with the children, co-operative inquiry technique was used to gather data from them. Co-operative inquiry is a unique research approach to creating new technologies for children, with children (i.e., children have a voice throughout the technology development process). In this approach Druin (1999) includes three crucial steps:

- partnership with children in order to understand what is needed;
- performing field research to study children's activities; and
- developing iterative low-tech prototyping where children use crayons, clay, string, and so forth, to present what they want.

However, in this study, instead of the definition by Druin (1999), co-operative inquiry is adapted and defined as a data collection technique for use with children in their environment. The researchers became participant observers, talking naturally to the children as they were using *Book Builder*, and answering any question asked during the session while at the same time extracting required data. For this initial review only 15 children (aged 7-9) were used as samples. In addition to co-operative enquiry, review was also based on published literature and their results are presented in the next section.

Results: *Book Builder*

Results of the initial reviews are divided into two parts: (a) children's reaction and (b) evaluation based on collected literature on e-book technology. Firstly, the results of evaluating the e-book builder based on existing literature are discussed, then children's reactions are reported.

Based on the literature, *Book Builder* was reviewed for the purpose of finding what features are provided and not provided. Only the additional functions that were believed should be available in *Book Builder* are listed here (Tables 5 and 6). For full descriptions of existing functions refer to the *Book Builder* user manual (SPAsoft, 2000). Functionality is divided into two categories: Book Create Mode (mode in which users create their books) and Book Read Mode (mode which is used to read the finished book).

Table 5
Additional Tools for Book Create Mode

Tool	Description
Export as HTML Book	When exporting maintain book metaphor.
Save as .exe	Allow the book to be saved in executable format so that it can be used without *Book Builder*.
Hyperlink	Make hyperlinking of texts and objects possible.
Read aloud icon	Make this feature easily visible to children. Currently, this function can only be activated by clicking right mouse button.
No page number on cover page	Include an option of not wanting page number on cover page.
Insert cover page	Include template for book cover page.
Insert verso page	Include template for verso page.
Insert TOC (Table of Contents) page	Include template for TOC page.
Insert background	Provide option to easily insert background for each page.
Animation tool	Tool for users to create animation.
3D tool	Tool for users to build 3D images.

In addition to these descriptions, icons for first page, previous page, next page, last page, TOC, annotate, notes, bookmark, zoom, search, read aloud, open book, and exit book should also be made available.

Table 6
Additional Tools for Book Read Mode

Tool	Description
Read in HTML mode	Allow book to be read in HTML mode without having to go back to create mode.
Print book	Currently this function is only available in create mode.
Insert annotation	Allow users to annotate.
Insert notes	Allow users to write.
Bookmark	Allow users to bookmark one or more pages at one time. Currently, this function is only available in create mode, which lets users to bookmark only one page at a time.
Zoom	For children to enlarge page.
Go to TOC	Go to table of contents.
Search	Let users search for texts.
Read aloud icon	Make this feature easily visible to children. Currently, this function can only be activated by clicking right mouse button.

Children's Reaction

Observation form was used to note down the results of observation and it was divided into "Background" and "*Book Builder* Usage" sections. Items in *Book Builder* Usage section were concerned with how well children learned and then used the program to build a 5-page book. While interaction took place, each child's learning time in minutes (LEARNT), numbers of questions asked during learning (QLEARN), number of questions asked during book building (QBUILD) and building time in minutes (BUILDT) were noted. In addition, their ability to complete a task successfully, their own perception of the ease of use, and finally their interest in using such program if given a chance were also recorded.

There were eight male and seven female children. Five were seven years old, three were eight years old and seven were nine years old. Six had no computer experience and nine had some experience with mostly using

CD titles and playing games. In short, the samples did represent different gender, age groups, and computer experiences.

All children were very excited and enthusiastic when using the *Book Builder* to create their own storybooks. One of the children, who was recognised by his teacher as having the least interest in writing and spelling, showed a very high interest in making his own sentences to create his story. This is evident when he did not cease working even though he failed to spell many words.

From observation, inserting graphic and audio, editing pictures and texts, and read aloud their written texts are the most used tools. It could also be deduced that the interface of *Book Builder* could be improved. *Book Builder* uses standard icons as appear in all Windows-based software (Figure 10). On one hand, this is a good idea, introducing standard icons early in their experience. However, on the other, these standard icons are too small and quite hard for young children to point the mouse cursor to.

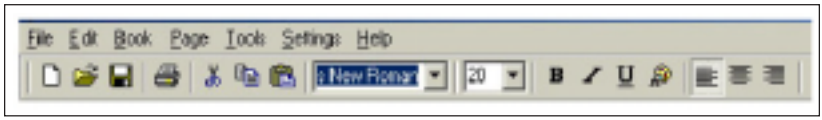

Figure 10. *Book Builder* Tools

For children of younger ages to be able to use the interface effectively, a larger icon based menu should be made available for all functions. It was quite difficult for all the children to use the pull down menu mainly for the reason that they cannot yet read well especially when the size and font of the text used is small.

Proving of Hypothesis

In addition to observing children's reaction, the following main hypothesis was also formed with the aim of verifying the ease of use of *Book Builder*. We are predicting that regardless of children's gender, age, and computer experiences, they are able to use the program without much effort.

H1: There is no significant difference between children's gender, age and computer experience ease of use of Book Builder.

In making inferences, One way Analysis of Variance (ANOVA) was used to compare means of a single variable between two or more groups

(e.g., between different age groups, between different computer experience groups). Alpha was set at 0.05.

Interaction with children started with training them how to use the program. Those who have no computer experience were first introduced to how to handle the input devices. *Book Builder* learning time (LEARNT) ranged from 15 to 60 minutes, with an average of about 37 minutes. During learning process, the number of questions (QLEARN) asked ranged from 0 to 28, giving and average of about 9 questions. When asked to build a book independently (BUILDT), time taken ranged from 10 to 40 minutes. On average, about 12 questions (QBUILD) were asked during the book building process (Table 7)

Table 7
Statistics for LEARNT, QLEARN, QBUILD, and BUILDT

	Learning Time (minutes)	Questions during learning	Building Time (minutes)	Questions during building
N Valid	15	15	15	15
Mean	36.53	8.73	26.00	12.07
Minimum	15.00	0.00	10.00	2.00
Maximum	60.00	28.00	40.00	28.00

Ease of use index (EASECHIL) was constructed from the summation of learning time (LEARNT), questions during learning (QLEARN), questions during building (BUILDT) and building time (QBUILD). It was assumed that the lower the value of EASECHIL (i.e. lesser time and questions asked), the easier the program was. EASECHIL ranged from 9.25 to 33.25, with an average of about 21 (Table 8).

Table 8
Descriptive Statistics for Children's Ease-of-Use

	N	Minimum	Maximum	Mean	Std. Dev
EASECHIL	15	9.25	33.25	20.83	8.46

COMPARING MEANS EASE OF USE

(a) EASECHIL * Gender

$H_0 : \mu_{male} = \mu_{female}$ (i.e., there is no significant difference between children's gender). *p* value in table 9 is rather large ($p = 0.463$) indicating that there is not enough evidence to reject H_0 ($p > 0.05$). Thus male and female children used *Book Builder* easily.

Table 9

Descriptive Statistics for Ease of Use and Children's Gender

Gender	Mean	Std. Dev	N
Male	22.41	7.89	8
Female	19.04	9.39	7

ANOVA results for ease-of-use and children's gender

ANOVA Table		Sum of squares	df	Mean Square	F	Sig.
EASECHIL * Gender	Between Groups (Combined)	42.41	1	42.41	0.57	0.46
	Within Groups	965.55	13	74.27		

(b) EASECHIL * Age Group

$H_0 : \mu_1 = \mu_2 \ldots = \mu_k$ (i.e., there is no significant difference between age groups). *P* value is 0.120 (Table 10) indicating not enough evidence to reject H_0 ($p > 0.05$). Hence, there is no significant difference between children's age groups. Children's of all ages (7 - 9) found *Book Builder* easy.

Table 10
Descriptive Statistics for Ease-of-Use and Children's Age

EASECHIL

Age	Mean	Std. Dev	N
7 years	23.20	5.49	5
8 years	27.42	5.88	3
9 years	16.32	9.29	7

ANOVA results for ease-of-use and children's age

ANOVA Table		Sum of squares	df	Mean Square	F	Sig.
EASECHIL * Age	Between Groups (Combined)	300.53	2	150.27	2.55	0.12
	Within Groups	707.43	12	58.95		

(c) EASECHIL * Computer Experience Group

$H_0 : \mu_1 = \mu_2 \ldots = \mu_k$ (i.e. there is no significant difference between computer experience groups). *P* value is found to be significant (see Table 11) indicating enough evidence to reject H_0. Hence, there is significant difference among means. Those who have no computer experience found *Book Builder* not easy to use.

Table 11
Descriptive Statistics for Ease-of-Use and Children's Computer Experience

EASECHIL

Computer Exp.	Mean	Std. Dev	N
No	29.67	2.33	6
Yes	14.94	5.01	9

ANOVA results for ease-of-use and children's computer experience

		Sum of squares	df	Mean Square	F	Sig.
Ease-of-use (child) * Comp. Exp.	Between Groups (Combined)	780.28	1	780.28	44.56	.000
	Within Groups	227.68	13	17.51		

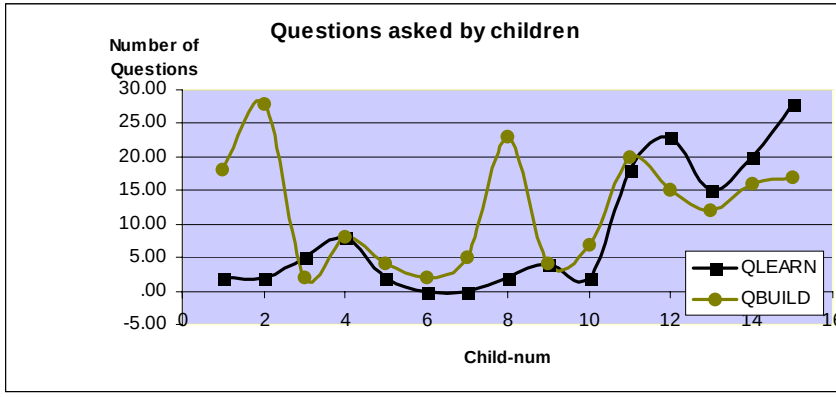

Figure 11. Plot for questions asked by children

From the plot in Figure 11, it can be seen that more questions were asked during book building time than training time. Possible reasons for this could be:

- children need hands-on experience in order to learn. Therefore, while building the actual books, they progressively gain the understanding of using the e-book builder;

- by the time they were building their own books, they felt more at ease with the evaluator, thus able to speak up and make more conversation.

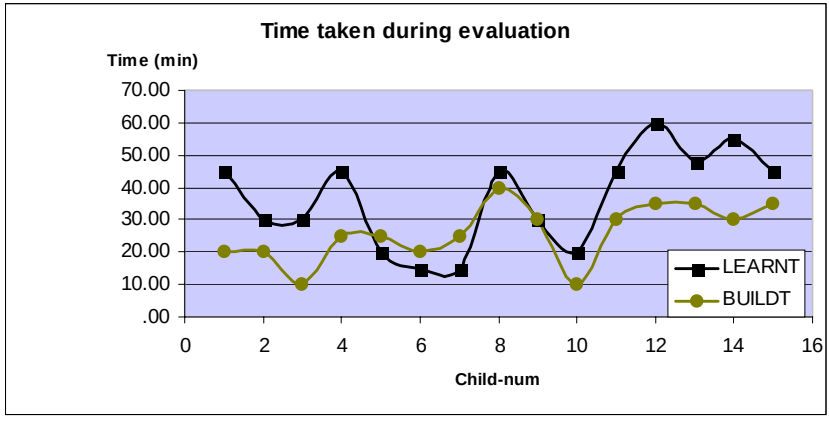

Figure 12. Plot for time taken during children's evaluation

The plot in Figure 12 shows that for most of the children, time taken to build their books is less than the training time. This could be interpreted as a positive indication to show that the children could easily understand how to use the program. After just one training session that lasted less than 60 minutes, children were able to build books within 40 minutes.

There were three children whose training time was lesser than building time. Further analysis showed that these children were nine years old and had at least one year of computer experience. Because they were capable, they used more time in building their books to include more than two media (i.e., they added graphics, audio, and video). They were also the ones who asked the least questions during training and building time.

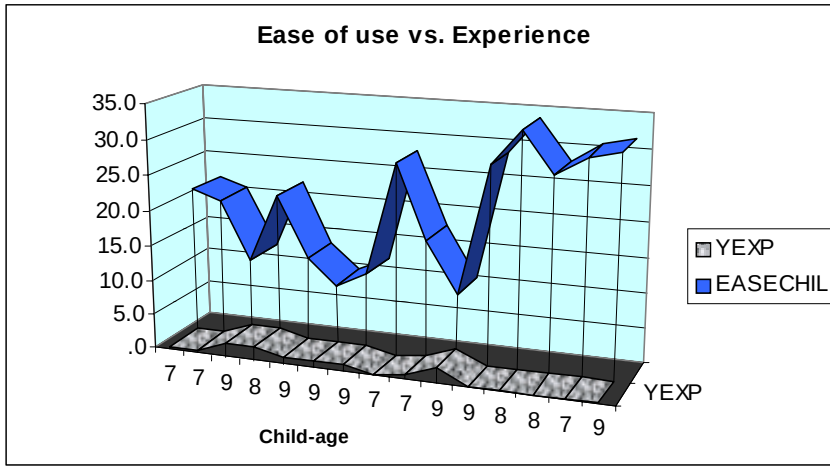

Figure 13. Plot for children's ease of use versus experience

From the plot in Figure 13, the three lowest values of ease of use index (i.e., less than 15) are from children with at least one year computer experience. This indicates that experienced children find the e-book builder easy to use.

The Figure 13 plot also shows that when children are older, and have at least one year computer experience, they will probably find the e-book builder easy to use. In addition, the plot implies that for children without any computer experience (the most extreme case), the e-book builder is at most four times harder.

Children's Ability

All children managed to build the five-page book. Sixty percent produced a good book (i.e., contained five pages, with at least two different types of media and used at least one tool, such as the drawing package). Forty percent produced a very good book (i.e., contained five pages, with at least three different types of media, used at least one tool, such as the drawing package, formatted text to different sizes and colours, built cover and back pages, and used functionality such as bookmark and read aloud).

Children's Perception

When asked whether they found *Book Builder* to be easy, very easy or difficult, 93% said it was easy.

Children's Interest

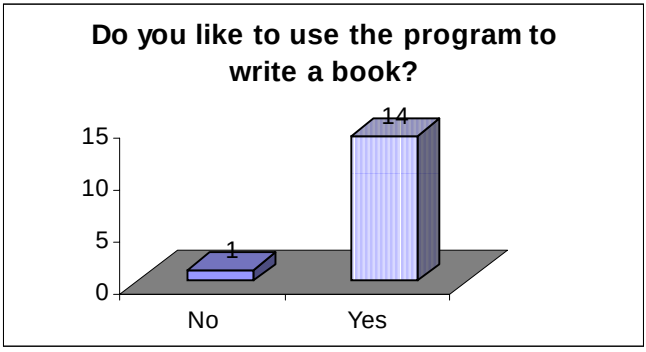

Figure 14. Bar chart children's interest

Fourteen children also said if given a chance they were interested in using such software to write books or stories.

CONCLUSIONS

Some problems were encountered during interaction with children. First, in addition to the training and building time, time was also allocated

for "get to know" sessions. The children had to be made "comfortable" with the researcher before they could gain confidence on a "friend-child level" as opposed to "teacher-student or stranger-child levels." No valuable data could be collected when the child was not at ease with the researcher. Second, they were easily distracted even with a faint sound from outside the evaluation room. Language was another barrier, most of the menu or pop-up instructions had to be translated. In addition, those who had no computer experience had to be familiarised with the input devices first. Mouse movement, left/right mouse buttons, and keyboard characters positions were areas which needed most practice. Right and left click mouse buttons to activate certain functions such as read aloud and options of voices added difficulty to the evaluation process.

In spite of the problems, the results were encouraging. Children were able to perform tasks required while using e-book devices. They were also able to tell which features they liked and do not like. Knowing they could use the devices to read and play activities confidently, another test was conducted to study how well they learned to use an e-book builder to build a storybook. Again results were promising. Hypotheses testing showed that regardless of gender and age group, *Book Builder* by SPAsoft was used easily, without much effort to build a five-page book with limited features. Learning time ranged from 15 to 60 minutes, with an average of about 37 minutes. Analysis however showed that having computer experience could make a difference in the ease of use of *Book Builder*. Result indicated that children without computer experience found *Book Builder* harder.

References

Alexander, J. (1999). Collaborative design, constructivist learning, information technology immersion & electronic communities: A case study, *Interpersonal Computing and Technology*, *7*(1-2). Retrieved March 3, 2000 from: http://jan.ucc.nau.edu/~ipct-j/1999/n1-2/alexander.html

Allen, M. (2000). E-publishing FAQ, *Inkspot.* Retrieved February 12, 2000 from: http://www.inkspot.com/epublish/ articles/epublishfaq.html

Barker, P. (1992). An object oriented approach to hypermedia authoring, *Interactive multimedia learning environments: Human factors and technical considerations on design issues*, NATO ASI Series, pp. 132-152. New York: Springer-Verlag.

Barker, P. (1999). Electronic libraries of the future, *Encyclopaedia of Microcomputers*, *23*(2), 121-152.

Bartolome, A. (1995). Designing multimedia educational programs, *New Currents*, 2.1. Retrieved June 23, 2000 from: http://www.ucalgary.ca/pubs/Newsletters/Currents/Vol2.1/bartolome.htm

Blanchette, J., & Kanuka, H. (1999). Applying constructivist learning principles in the virtual classroom. *Proceedings of the World Conference on Educational Multimedia, Hypermedia and Telecommunications, ED-MEDIA 99*, Seattle, pp. 434-439. Charlottesville, VA: Association for the Advancement of Computing in Education.

Borchers, J.O. (1999) Electronic books: Definition, genres, interaction design patterns. *Conference on Human Factors in Computing Systems, CHI99 Workshop: Designing Electronic Books*, ACM. Retrieved January 11, 2000 from: http://www.fxpal.com/ConferencesWorkshops/chi99deb/borchers.pdf

Carlson, S., & White, S. (1998). The effectiveness of a computer program in helping kindergarten students learn the concepts of left and right, *Journal of Computing in Childhood Education, 9*(2), 133-148.

Carvajal, D. (2000). Digital publishing: From Arthur C. Clarke to psoriasis tales, *The New York Times*, February 7.

Chartier, R (1998). The transformation of written culture: What is the future of the book in the digital era? *DNP*. Retrieved July 21, 2000 from: http://www.honco.net/9809/roundtable.html

Doane, W (1998). A comparison of display technologies suitable for e-book, *Future Print*. Retrieved March 12, 2000 from: http://www.jmc.kent.edu/futureprint/1998fall/christie.htm

Druin, A. (1999). Cooperative inquiry: Developing new technologies for children with children, *Proceedings of CHI'99—Human Factors in Computing Systems*, ACM Press. Retrieved June 24, 2000 from: ftp://ftp.cs.umd.edu/pub/hcil/Reports-Abstracts-Bibliography/99-14html/99-14.html

Druin, A., & Solomon, C. (1996). *Designing multimedia environments for children*, New York: John Wiley & Sons.

Fidler, R. (1998). Electronic books: A good idea waiting for the right technology. *Future Print*. Retrieved March 12, 2000 from: http://www.jmc.kent.edu/futureprint/1998fall/Fidler.htm

Gujar, A., Harrison, B., & Fishkin, K. (1998). A comparative evaluation of display technologies for reading. *Proceedings of HFES'*, pp. 527-531.

Hardin, V. (2000). E-publishing: Children's ebooks of the future, *RestStop Writers Newsletter*, *2*(2). Retrieved October 18, 2000 from: http://www.geocities.com/SoHo/Village/2115/hardin.html

Hawkins, D. (2000). Electronic books: A major publishing revolution, Part 1. *Online*, 15-28.

Hoogeveen, M. (1995) Towards a new multimedia paradigm: Is multimedia assisted instruction really effective? *Proceedings of the World Conference of Multimedia, Hypermedia and Telecommunications, ED-MEDIA 95*. Retrieved June 12, 2000 from: http://www.takeitnow.nl/store/ref.cgi?ref=6744

Judge, P.C. (1998, November 5). E-books: A library on your lap. *Business Week*. Retrieved January 9, 2000 from: http:// www.businessweek.com/1998/46/b3604010.htm

Landoni, M. (1997*). The visual book system: A study of the use of visual rhetoric in the design of electronic books.* Unpublished doctoral dissertation, University of Strathclyde: Glasgow.

Landoni, M., & Gibb. F. (2000). The role of visual rhetoric in the design and production of electronic books: The visual book. *The Electronic Library*, *18*(3), 190-201.

Liu, M. (1996). An exploratory study of how pre-kindergarten children use the interactive multimedia technology: Applications for multimedia software design. *Journal of Computing in Childhood Education, 7*(1/2), 71-92.

Lopez, K. (1998). Nurturing emergent literacy through technology, *Proceedings of HTML 98*. Retrieved January 9, 2000 from: http:// www.coe.uh.edu/insite/elec_pub/HTML1998/yc-kimb.htm

Manes, S. (1999, February). Gutenberg need not worry yet. *Forbes*. Retrieved January 24, 2000 from: http://www.forbes.com/forbes/99/ 0208 /6303106a.htm

Molina, A (1998). The European community's newsPAD Project. *Future Print*. Retrieved March 9, 2000 from: http://www.jmc.kent.edu/futureprint/1998summer/Molina.htm

Moschella, D. (1999, April 23). Electronic books are poised to become a key medium. *CNN*. Retrieved July 18, 2000 from: http:// www.cnn.com/TECH/computing/9904/23/ebooks.idg

Munyan, D. (1998). EveryBook Inc: Developing the e-book in relation to publishing standards. *Future Print*. Retrieved January 9, 2000 from: http://www.jmc.kent.edu/futureprint/1998fall/Munyan.htm

NCIP Library (1998). Storybooks on computers: An overview. *National Center to Improve Practice in Special Education Through Technology, Media and Materials*. Retrieved March 9, 2000 from: http:// www2.edc.org/NCIP/library/ec/Storybks.htm

Nielsen, J. (1998, July 26). *Electronic books—A bad idea*. Retrieved January 20, 2000 from: http:// www.useit.com/papers/webwriting

O'Donnell, B. (1998, July 6). Is the world ready for the digital books? *Info World Media*. Retrieved January 20, 2000 from: http:// www.infoworld.com/cgi-bin/displayNwe.pl?/adonnell/

Oregon Scientific (2000). *User manual*, Oregon Scientific Inc.

Rothman, D. (1996). TeleRead: A virtual central database without big brother. *Scholarly Publishing, The Electronic Frontier*, pp. 313-339. Cambridge, MA: MIT Press.

Sanders, Y., Sanders, G. (2000). eBooks in Japan, Part 1 of a special report, *eBookNet.com*. Retrieved June 27, 2000 from: http:// www.ebooknet.com/story.jsp?id=2431

Schilit, B. (1999). Why e-read? Finding opportunities in the merger of paper and computer.“ *Future Print*. Retrieved January 9, 2000 from: http://www.jmc.kent.edu/futureprint/1999Spring/barnard.htm

Selvidge, P. & Phillips, C. (2000) E-books: Are we going paperless? *Usability News*, Usability Research Laboratory, Wichita State University. Retrieved June 19, 2001 from: http://wsupsy.psy.twsu.edu/surl/usabilitynews/volume2_winter/ebook.htm

SPAsoft (2000). *Book Builder*. Tewkesbury, UK: Software Production.

Suppes, P. (1969). Computer assisted instruction: A book of readings. In R. Atkinson & H. Wilson (Eds.) *Computer technology and the future of education*, pp.41-47. New York: Academic Press.

Thomson Multimedia (2000). Thomson will mass-produce next generation rocket eBook, softBook, *eBookNet.com*. Retrieved June 29, 2000 from: http://www.ebooknet.com/ story.jsp?id=1514

Townsend, B. (2000). *Freightliner and friends*. Fiction Works. Retrieved October 23, 2000 from: http://www.fictionworks.com/children.htm

Wearden, S. (1998). Landscape vs. portrait formats: Assessing consumer preferences. *Future Print.* Retrieved March 12, 2000 from: http:// www.jmc.kent.edu/futureprint/1998summer/Wearden.htm

Williams, G. (2000a). Where reading devices make sense. *eBookNet.com*. Retrieved June 22, 2000 from: http://www.ebooknet.com/story.jsp?id=2232

Williams, G. (2000b). A few things that absolutely must change in the eBook industry. *eBookNet.com*. Retrieved June 22, 2000 from: http:// www.ebooknet.com/story.jsp?id=2232

Wilson, R. (2001). Evolution of portable electronic books. *Ariadne*, 29. Retrieved November 22, 2001 from: http://www.ariadne.ac.uk/issue29/ wilson/intro.html

Notes

1. Refer http://www.nuvomedia.com
2. Refer http:// www.softbook.com
3 Refer http://www.everybook.net
4. See articles in http:www.becta.org.uk, http://publishing.about.com, http://www.eschoolnews.org and http://eduscapes.com
5. http://www.mqp.com/fun/gb.htm
6. http://@realtimetouch.com/rtt.html
7. http://www.eink.com
8. Refer http://www.oregonscientific.co.uk
9. Refer http://www.vtech.com
10. Refer http://www.iqbuilders.co.uk
11. Refer http://www.gutenberg.net
12. Refer http://www.fatbrain.com
13. Refer http:// www.iuniverse.com

14. Refer http://www.Istbooks.com
15. Refer http://www.antelope-ebooks.com
16. Refer http://www.vangoachbooks.com/children.html
17. Refer http://www.bookmice.com/ morekidbooks.htm
18. Go to http://www.Diskus publishing.com/children.htm
19. Refer http://www.ebooksonthe.net/youth.html
20. Refer http://www.booklocker.com
21. Refer http://www.cpsweb. com/youthtopia
22. Refer http://www.liveandlearn.com/animate.html
23. See http://www.coloring.com/
24. Refer http://www.fictionworks.com/children.htm
25. Go to http://www.hiyah.com
26. http://www.webs4kids.com
27. http://www.edmark.com
28. http://www.cd romshop.com/cdshop/ mac/pub/disney_interactive.htm
29. http://www.edact.com
30. http://www.mattelinteractive.com/aDefault.htm
31. http://www.oregonscientific.co.uk
32. EBONI at http://eboni.cdlr.strath.ac.uk/
33. http://www.electronic-school.com/2001/06/0601handhelds.html
34. http://www.educatorspalm.org
35. http://k12handhelds.com/casestudy
36. http://www.becta.org.uk/technology/infosheets/html/handheld.html