



# **Innovative Features of E-Books and E-Book Builders: Potential Learning and Authoring Tools for the Malaysian Smart School Environment**

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## Abstract

The potential of electronic books (e-books) particularly the electronic version of textbooks for the education of young children in a Smart School environment was investigated. The principal objective was to propose suitable features for children's e-books based on the familiar concept of a book (using Requirements Engineering approach from Software Engineering perspective). These include traditional textbook features, as well as features that are perceived to be useful in catering for the diversity of children's learning styles; these were defined in the form of a conceptual model. Emphasis was placed on incorporating appropriate interactive educational activities based on a learning style theory most suited to children to enrich the content of the currently opened book page. For this purpose, the e-book model was named "InterActivity (Interactive + Activity) Book".

Additionally, innovative features for an e-book builder (i.e. the program that allows users to build e-books) were also specified. The ability to build interactive activities by means of "builders within the e-book builder environment" and different types of book, including graphic books, talking books, multimedia books, hypermedia books and web books, are among the desired features. Furthermore, teachers' and e-book experts' perceptions on the features were analysed. There was significant evidence to show that teachers and experts were in agreement on the usefulness of the suggested features. Children's interaction with e-books on portable devices, interactive activities and an e-book builder were also investigated, and positive and significant indications of the interaction were noted.

The findings also indicated that e-books and e-book builder technology were widely accepted by both teachers and children. In particular, teachers perceived them to be easy to use and useful in assisting their classroom teaching tasks. Teachers confirmed that e-books containing interactive educational activities along with multimedia presentations were more useful than those without. Generally, although there were some readability problems with one of the portable devices, children were able to interact with e-books on portable devices (especially the dedicated e-book reader) comfortably. Children could also successfully use the e-book builder; however, it was harder for children without computer experience. It was also found that children had good e-book building ability particularly those who have experience in interacting with CD-ROM titles and computer games.

The limitations of this study are described in the final chapter. However, for each limitation future possible research topics are also proposed. For example, there is an immediate need for the development of e-books and an e-book builder that incorporates the features proposed in this study. A crucial study would be an investigation into the effectiveness of electronic textbooks in terms of children's comprehension and learning gains. The utilisation of e-books on portable devices during children's in-class activities ought also to be carried out if traditional book practice were to be fully and successfully emulated. The impacts on health and behaviour if children were encouraged to use e-books also call for further research.

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## List of Abbreviations

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2D: Two-dimensional  
3D: Three-dimensional  
ASCII: American Standard Code for Information Interchange  
AVI: Audio Video Interleaved  
BMP: Bitmap  
BNF: Backus-Naus-Form  
CAI: Computer-Assisted Instruction  
CAL: Computer-Added Learning  
CBL: Computer-Based Learning  
CD-I: Compact Disc - Interactive  
CD-ROM: Compact Disc - Read-Only-Memory  
CPU: Central Processing Unit  
DCD: Distance Collaborative Design  
DFD: Data Flow Diagram  
DVD: Digital Versatile Disc  
E-Book: Electronic Book  
E-Publishing: Electronic Publishing  
ERD: Entity Relationship Diagram  
ETHICS: Effective Technical and Human Implementation of Computer System  
GIF: Graphics Interchange Format  
GOMS: Goals, Operators, Methods and Strategies  
HTA: Hierarchical Task Analysis  
HTML: HyperText Markup Language  
IMM: Interactive Multimedia  
ISBN: International Standard Book Number  
JPEG: Joint Photographic Experts Group  
LCD: Liquid Crystal Display  
LIT: Literature  
MI: Multiple Intelligences  
MID: Midi  
MPC: Multimedia Personal Computer  
MPEG: Motion Picture Experts Group  
MP3: Media Player 3  
OCR: Optical Character Recognition  
OMT: Object Modelling Technique  
OOA: Object Oriented Analysis  
OEBPS: Open eBook Publication Structure Standard  
OSTA: Open System Task Analysis  
PC: Personal Computer  
PD: Participatory Design  
PDA: Personal Digital Assistant  
PDF: Portable Document Format  
RA: Real Audio  
RE: Requirements Engineering  
RTF: Rich Text Format  
SADT: System Analysis and Design Technique  
SGML: Standard Generalised Markup Language

**T/L: Teaching and Learning**  
**TAG: Task-Action Grammar**  
**TIFF: Tagged Image File Format**  
**TK3: Tool Kit 3**  
**TLB: Top, Left, Bottom**  
**TOC: Table of Contents**  
**UCD: User Centred Design**  
**UML: Unified Modelling Language**  
**URL: Uniform Resource Locator**  
**USMT: User Skills and Task Match**  
**WAV: Windows Audio**  
**WWW: World Wide Web**  
**WYSIWYG: What You See Is What You Get**  
**XML: eXtensible Markup Language**

# Chapter 1

## Introduction

### 1.1 Project Rationale

Different types of electronic teaching and learning technologies are available nowadays. These include Computer-Aided Learning (CAL), Computer-Assisted Instruction (CAI), Interactive Multimedia (IMM), hypermedia systems and electronic books (e-books). When applied in an educational context all these terms, although differing in definition, are generally concerned with similar concepts. Normally, CAL and CAI are designed for drill and practice purposes or interacting with students in a tutor-like fashion (Steinberg, 1991). IMM and hypermedia systems are less structured than the previous two, contain more interactivity and exhibit active screen objects (Bork, 1992). They are popularly



used in edutainment<sup>1</sup> products and information delivery systems (Oliver & Herrington, 1995). E-books are more concerned with replicating the book metaphor within an electronic environment (Landoni, 1997).

Many countries are reinventing their public schools in terms of teaching and learning practices to integrate the use of the electronic teaching and learning technologies (Perkins et al., 1995). Particularly, in Malaysia, there is an urgent need to develop such technologies locally. For instance, as recently as August 2001, the Malaysian Education Ministry considered e-books as a priority area and has allocated 10 million Malaysian Ringgit (RM) to implement a pilot project on the use of electronic textbooks at 50 schools in the country (see Figure 1.1). The touch-screen e-book devices given to selected students incorporated textbooks, reference materials, exercises, supplementary books, dictionary and calculator (The Star, 2001; Azmi, 2001). With this in mind and although the methodology adopted in this study is applicable to any environment, Malaysia and e-books were selected as the focus of the research described in this thesis.

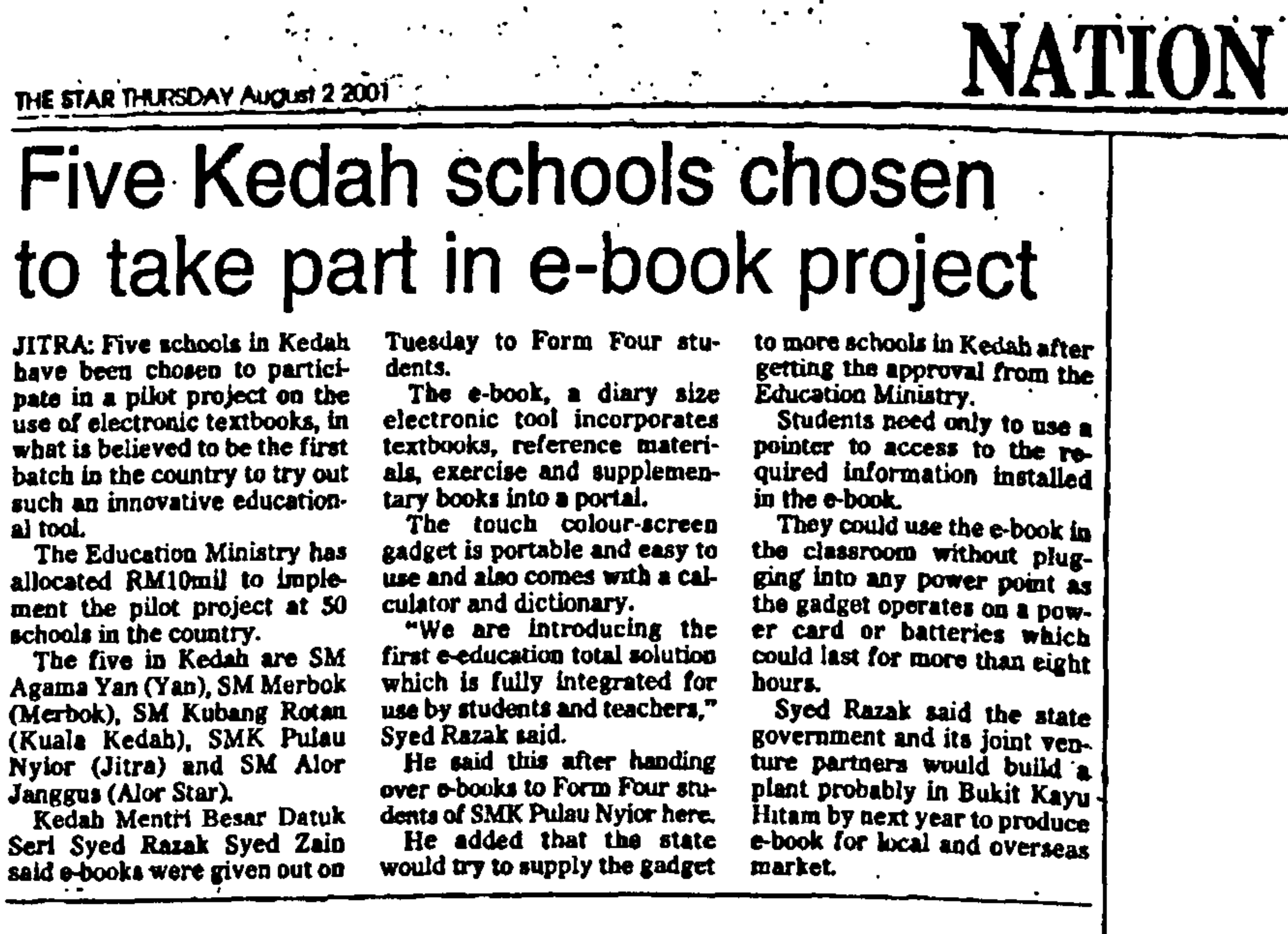


Figure 1.1: Malaysian Star newspaper reporting on an e-book project

<sup>1</sup> Edutainment = Educational + Entertainment. Webster's College Dictionary defines it as television programmes, books, software that are both educational and entertaining especially those intended for primary school children.

In addition to the above rationale, the focus of the research described in this thesis is on e-books for a number of reasons:

Firstly, as mentioned earlier, there is an urgent need for locally produced educational electronic products in Malaysia. The teaching and learning materials should combine the best of network-based, courseware-based and teacher-based materials. This is the key concept behind Malaysian Smart Schools: the schools of the 21<sup>st</sup> century (see chapter 2 for further details about the Smart School concept). Nonetheless, conventional materials such as printed textbooks, storybooks, newspapers, magazines, slides and films still co-exist with computer-based materials, and will not be entirely replaced in the foreseeable future (Malaysian Smart School: A Conceptual Blueprint, 1997). As such, studies on how to convert such conventional materials into their electronic counterparts without losing their current features are important. The textbooks were selected, as they are the most familiar and widely used traditional learning materials.

Secondly, e-books are gaining wider interest since the introduction of portable electronic reading devices that provide users with more realistic book reading experiences. They also, in particular, have the potential of lessening the burden of bringing heavy printed books to schools. Furthermore, the multimedia capabilities that can be incorporated in the e-books can also benefit the learners particularly young children. Therefore, exploring the possibilities of introducing these technologies to schools should be beneficial to all relevant stakeholders (e.g. teachers, children, parents and education departments).

Thirdly, present studies on e-books concentrate on adult surroundings. Projects dealing specifically with the needs of children are currently more on IMM, CAL and hypermedia (e.g. Ambron & Hooper, 1988; Rodrigue et al., 1999; Abbott et al., 1998; Elizaberth, 1990; Walker et al., 1999). There are very few projects dedicated to children and present e-books development. To

date (as at July 2002), only a few projects have been found to be somewhat related to the research described in this thesis:

1. A project by Barker and Giller (1991) which described the basic structure and development model of a hypermedia e-book for young learners;
2. A study by Fung et al. (1998), where the goals of their study were to:
  - estimate the contribution of portable e-book use to the composition of pupils' Records of Achievements;
  - provide some insight into the ways in which the books might enhance learning;
  - assess what impact the technology had upon the attitudes of pupils, teachers and parents.
3. Research by Maynard (2001) investigated the relationship between printed books and their electronic counterparts, and children's interaction with electronic storybooks;
4. Two e-book in the school projects<sup>2</sup> by a company called eBuku Sendirian Berhad in Malaysia. In 2001, they produced and tested a device containing learning materials on different subjects in order to investigate the feasibility of integrating e-books in the national curriculum;
5. A product called **Book Builder**<sup>3</sup>, which is currently on the market, allows children to build their own e-books and is highly relevant to this study. Since one of the primary goals of the research described in this thesis is to propose requirements for an e-book builder (a program which allows users to build e-books) (see section 1.2), this product was used as the basis for users' requirements modelling.

## 1.2 Objectives and Hypotheses

**E-Books for Children (EBoChi)** was the name given to this project. Its main objectives were derived from a principal research question (Q): how can the

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<sup>2</sup> More information on their projects and the descriptions of the device is available at <http://www.ia-ebuku.com/project.htm>

<sup>3</sup> The e-book builder can be downloaded at <http://www.spasoft.co.uk/bookbuilder.html>



teaching and learning materials in the Malaysian Smart School environment be improved?

In order to find an answer to this question a specific type of material, that is the textbook, was chosen and transformed into an electronic version. This electronic version should at least:

- include existing textbook features;
- be easy to use;
- contain features, which are perceived to be useful in catering for the diversity of children's learning styles.

Although the research described in this thesis focussed on e-books in an educational environment, the issues relating to the learning outcomes would not be addressed as this study was more concerned with the design features of such objects.

From the principal question, four more sub-questions were derived:

Sub-question 1 (S-Q1): How can electronic textbooks, which contain existing features of conventional counterparts and are easy to use be produced?

Sub-question 2 (S-Q2): How can the electronic versions of conventional textbooks be enhanced so that they cater for the diversity of children's learning styles?

Sub-question 3 (S-Q3): How can the usefulness and ease-of-use of e-books be assessed?

Sub-question 4 (S-Q4): How do users interact with e-books and e-book builder?

The main and sub-questions were further analysed to provide the basis for the related objectives of this study.

### **1.2.1 Main Objectives**

Three main objectives were formed to address the above questions:

1. To propose features for children's electronic textbooks, which contain existing printed textbook features, as well as features that are perceived to be useful in catering for the diversity of children's learning styles in the Malaysian Smart School environment.
2. To propose features for a children's e-book builder which are easy to use for both teachers and children, and useful for schools.
3. To test hypotheses related to the usefulness and ease-of-use of the functionalities provided in children's e-books and e-book builder.

In order to achieve the main objectives, further analysis was performed and additional sub-objectives were constructed. The results of this further analysis were the following 4 sub-objectives:

### **1.2.2 Sub-objectives**

- S-objective 1: Develop a conceptual model for an electronic textbook, which provides interactive educational activities that cater for the diversity of children's learning styles.

The learning styles concept relates to individual preferences during the learning process. A number of learning styles theories will be explored and finally the most suitable for children will be selected. In addition, the types of educational activities usually involved in classroom will be studied.

- S-objective 2: Specify e-book builder design requirements, which will enable users (i.e. teachers and children) to create e-books.

The requirements can be specified in three dimensions:

- i. environment/domain - i.e. the context in which the e-books and the e-book builder will function;

- ii. functional - descriptions of two main functionalities (Create-mode and Read-mode) to support users' needs;
- iii. non-functional - in terms of interface requirements.

When proposing design features for computer systems, the literature suggests using requirements engineering. The principal concept behind requirements engineering is eliciting what users want and what functions to include in a system. Hence, users' requirements of an intended system should be collected, specified and then presented in the form of models. The aim of the models is to make key aspects of the proposed system visible to users so that they can provide feedback for the designers to consider. A number of approaches to modelling requirements such as natural language, structured natural language, graphical notations, formal graphical notations and mathematical specifications can be utilised (Sommerville, 1996; Dix et al., 1998; Benyon et al., 1990).

- S-objective 3: Validate the proposed requirements through:
  - i. evaluating functionalities perceived as useful by teachers and e-book experts;
  - ii. evaluating perceived ease-of-use by the teachers.
- S-objective 4: Observe children's interaction with e-books on portable devices and the e-book builder.

### 1.2.3 Main Hypotheses

From the main objectives, this study was expecting that:

- H1: E-books containing interactive educational activities are useful for school children and teachers.

An important assumption of this study is that e-book usefulness can be improved by tailoring the e-books to the potential users. In order to produce e-books that are tailored to individual needs, the children and



teachers should be provided with an e-book builder that will allow them to build such objects.

- H2: An e-book builder with special functions to build interactive educational activities is also useful for teachers and children.

These two main hypotheses were further elaborated and broken down into more specific statements (i.e. sub-hypotheses) to test some additional expectations. These are listed in the following section.

### 1.2.4 Sub-hypotheses

H<sub>1</sub>: A number of specific educational activities (e.g. storytelling, singing, drawing, etc.) are perceived to be useful for catering for children's learning styles.

H<sub>2</sub>: An e-book is seen as more useful when a number of the specific activities, which can cater for children's learning styles are included.

H<sub>3</sub>: Due to its potential in assisting classroom teaching tasks, teachers perceive the **proposed e-book builder** as useful.

H<sub>4</sub>: Teachers' gender, age, teaching experience, computer experience and school location do not have any significant effects on the perceived usefulness of the **proposed e-book builder** functionalities.

H<sub>5</sub>: There is no significant difference between teachers' and experts' perceived usefulness of **Book Builder's** existing functionalities.

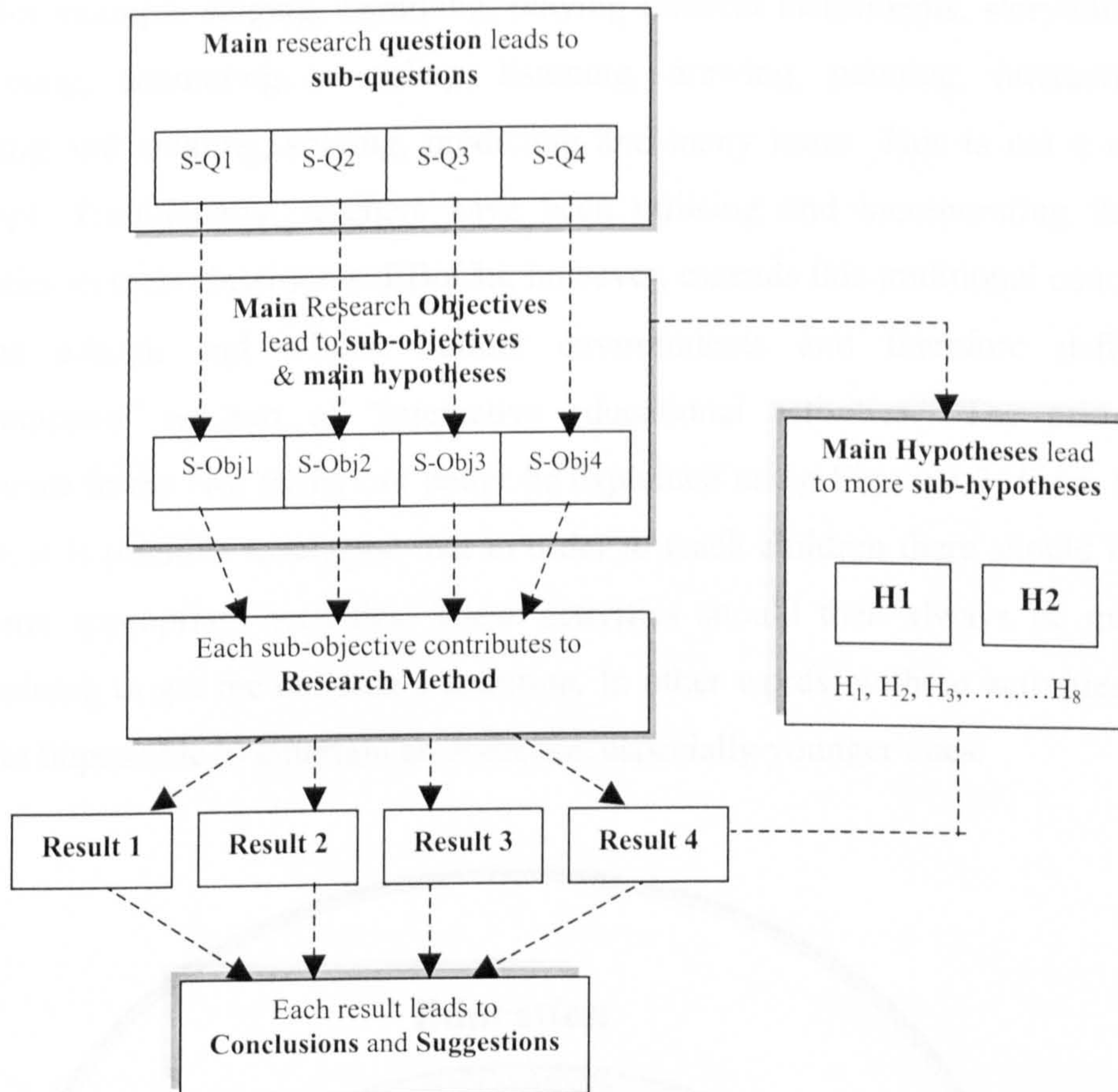
H<sub>6</sub>: There is no significant difference between teachers' and experts' perceived usefulness of the additional functionalities suggested for the **Book Builder**.

H<sub>7</sub>: Teachers' gender, age and computer experience do not have any significant effects on the perceived ease-of-use of **Book Builder**.

H<sub>8</sub>: Children's gender, age and computer experience do not have any significant effects on the ease-of-use of **Book Builder**.



Figure 1.2 shows the relationships between research questions, objectives, hypotheses, methodology and outcomes.



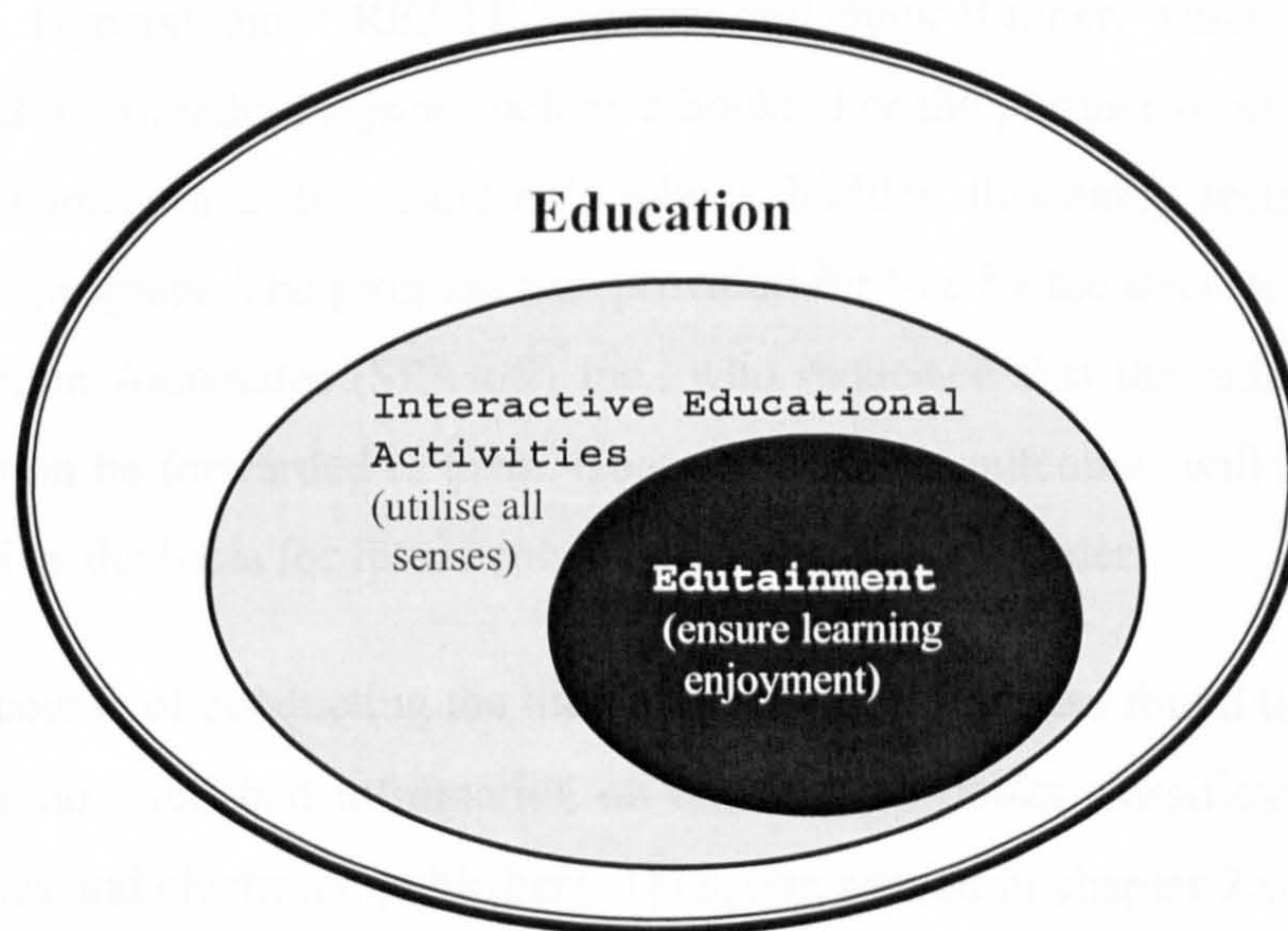
**Figure 1.2:** *Relation between research questions, objectives, hypotheses, methodology, results and conclusions*

### 1.3 Original Contributions

The use of a particular learning style theory as the foundation of e-book design was addressed in this project. The primary idea in the research described in this thesis was to teach one theme/subject area with various appropriate activities to cater for the diversity of children's learning styles. To be more specific, in any opened book page, relevant activities that support the content was incorporated. This idea has resulted in the formation of an electronic textbook model specifically for children, and is described in both its structural and content components (see chapter 4). In short, this idea emphasises the importance of appropriate variety of interactive educational activities while learning.



Learning does not only involve reading, writing and showing understanding but also for example singing, humming, playing musical instruments, storytelling, explaining, annotating, recording, listening, drawing, painting, interacting, building and creating, solving, predicting and many more. This is not a new concept. Traditionally, teachers have been utilising and incorporating these activities in their classrooms. EBoChi, however, extends this traditional concept to the e-book and e-book builder environments and therefore defines “edutainment” as part of “interactive educational activities”. The primary difference in the two terms can better be explained using Figure 1.3. From this figure, it is possible to suggest that in order to teach children there should first be some appropriate activities. These activities should then always be made entertaining to get the children’s attention. In other words, without activities, it is quite impossible to entertain an audience, especially younger ones.



**Figure 1.3:** *Relation between interactive educational activities and edutainment*

A flexible e-book builder model has been proposed in order to implement interactive educational activities to fit individual learning needs. The aim was to involve both teachers and children in the construction of tailor made e-books. For instance, teachers could make their own textbooks and children could build



their own storybooks (or any other kind of book, for example picture books, audio books, multimedia books, Web books, etc.). Principally, the e-book builder needed to provide users especially teachers with the capability to build interactive electronic activities (e.g. puzzles, sing-along programs, drawing, colouring images, etc.) automatically and easily without any knowledge of programming. This in particular is a new design aspect, which has not been exploited before in any e-book builder and is the prime advantage of the proposed e-book builder.

Another contribution of EBoChi is its insight and evaluation into children's e-book builder programs. To date, many e-book builders have been created for adults, for instance the Visual Book Builder (Landoni, 1997), the Hyper Book Builder (Catenazzi, 1993), TK3 Author (Night Kitchen, 2001), Microsoft ReaderWorks™, and Primis On-line e-books (McGraw Hill, 2001). There are also authoring software for children, such as Isis, Cocoa, Eco World, Lego Sheets, Hyperstudio, CREATE Together and Book Builder, which allows them to build multimedia projects such as e-books. For the purpose of eliciting users' requirements for a new children's e-book builder, this study tested the Book Builder program. The program was provided for free by the developer, Software Production Associates (SPAsoft) Inc., who requested that the outcomes of the evaluation be forwarded to them. Consequently, the outcomes will hopefully be utilised as the basis for future enhancements of Book Builder.

In the course of conducting the literature review, it was also found that presently there is no published information on children's e-books classification, current examples and electronic publishers. Thus, one section in chapter 2 was allocated to this purpose. In addition, there are no published reports on how children interact with the latest development in e-book technology; that is, the children's laptop and dedicated e-book reading device. Therefore, a part of the evaluation conducted in this research was focussed on this issue.

## 1.4 Thesis Structure

Chapter 2 presents the review of related literature. E-book definitions, distribution media, hardware-based and software-based readers, e-book builder examples, e-book examples, e-book compilers and learning styles theories are some of the sub-topics covered in this chapter. The research methodology is described in chapter 3 where an approach called Distance Collaborative Design (DCD) is introduced. In addition, the requirements engineering process, software evaluation methods, software modelling techniques and data gathering techniques are also outlined.

Chapter 4 presents the proposed e-book concept for this study. Special emphasis was placed on describing activities that support the interactive educational activities idea. Chapter 5 mostly reports the requirements elicitation outcomes as well as the requirements specification models. Included in this chapter are descriptions of the domain of the proposed e-book, suggested features for the e-book builder, and functional and non-functional models. In order to validate the outcomes of chapters 4 and 5, chapter 6 takes into account the models, tests them and outlines the results. The contents of this chapter include descriptions of the evaluation instruments, research sample, statistical procedures and the results of hypothesis testing. Additionally, the children's interactions with e-books on portable devices are also discussed. Finally, conclusions and recommendations are discussed and summarised in chapter 7.



# Chapter 2

## Literature Review

### 2.1 Introduction

This chapter discusses a number of topics related to e-book technology. It contains a series of literature reviews covering the following topics:

- discussion of the context and scenario for the Malaysian Smart School project;
- types of teaching and learning materials used in the Smart School environment;
- the concepts of both paper book and e-book and, in particular, various e-book definitions, distribution media, advantages and disadvantages of e-books, formats, standards and electronic publishing processes;
- descriptions and critical reviews of existing e-book initiatives;
- discussions on the main focus of the research described in this thesis (i.e. designing e-books which try to cater for the diversity of children's learning

styles). Several learning theories are described, with particular attention on the Multiple Intelligences theory and the reasons for selecting that theory.

As mentioned in chapter 1, the main question, which had prompted the research, was how to improve children's teaching and learning materials. Prior to the formation of this question, the researcher had set her mind to study on areas that could possibly contribute to a national project, mainly the setting up of Smart Schools. Thus, this chapter starts with a brief discussion on this matter.

## **2.2 Introduction to the Malaysian Smart School**

Malaysia has created the Multimedia Super Corridor (MSC) to help prepare for the technologies of the future. "The MSC project will accelerate Malaysia's entry into the information age, and through it, help actualise the Vision 2020 proposed by the Prime Minister, Datuk Seri Dr. Mahathir Mohammad in 1997. Vision 2020 is concerned with creating an educated and information-rich society through the application of a modern and sophisticated telecommunications network. The dissemination and expansion of information technology will produce a society capable of contributing towards the development of new technology to enhance the country's economic and industrial growth."<sup>1</sup> The MSC incorporates seven flagship applications: Electronic Government, National Multipurpose Card, Smart School, Telemedicine, Borderless Marketing centres, World Wide Manufacturing Webs and Research and Development (R&D) clusters. The research described in this thesis plans to contribute to the third flagship application, which is the Smart School concept.

In actualising Vision 2020, the Malaysian education system must undergo a radical transformation (Siti Hawa, 1997). The schooling culture must be transformed from one that is predominantly memory-based to one that is informative, creative and caring (Siti Hawa, 1997). This is the rationale for the adoption of the Smart School as one of the MSC flagship applications. The

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<sup>1</sup> A detailed descriptions on this national project can be found at the MSC official Web site at <http://www.mdc.com.my/>

Smart School concept is becoming a widely discussed topic in the educational setting and is defined as (Perkins, 1992; Nair, 2000):

*“A learning institution that has been systematically reinvented in terms of teaching-learning practices and school management in order to prepare children for the Information Age.”* (Malaysian Smart School: A Conceptual Blueprint, 1997).

Learning in Malaysian Smart Schools goes beyond the classrooms. Students will be able to access learning materials through computer-based resources or video conferencing. The teaching and learning activities should combine the best of network-based, teacher-based and courseware-based resources (Siti Hawa, 1997). Materials should be in various media, cognitively challenging and attractive so that students are motivated to learn and participate actively (Siti Hawa, 1997).

The Smart School project is targeting school children, as enriched education environments incorporating current technologies such as hypertext, hypermedia, multimedia, full motion graphics and Internet access could provide Malaysia with an expanded base of well-educated, well-informed and resourceful adults (Vesely, 1995). With this point in mind, and realising that schools are integrating technology in childhood education, it is believed that a study on the design of teaching and learning materials, and the use of technology in a Smart School environment will contribute positively to its implementation process and can play a crucial role in supporting the learning process (Wright & Shade, 1994; Davis & Shade, 1994).

### **2.2.1 Malaysian Smart School Conceptual Blueprint:**

#### **A Summary**

This section presents a brief summary of the extended definition of the Malaysian Smart School and its components.

### **2.2.1.1 Smart School Definition**

The Malaysian Smart School is a learning institution that has been systemically reinvented in terms of teaching and learning practices and school management in order to prepare children for the Information Age (Malaysian Smart School: A Conceptual Blueprint, 1997).

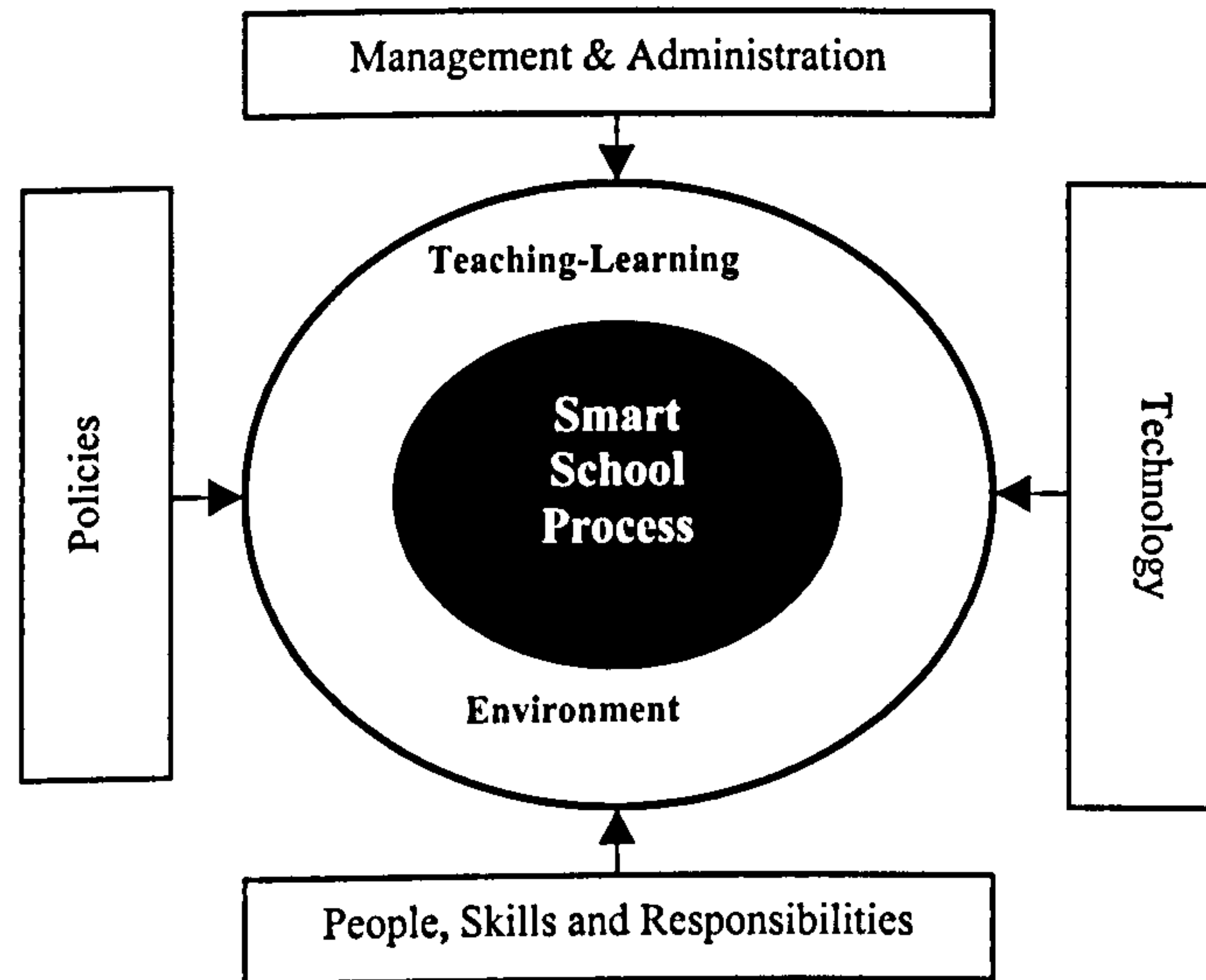
The Malaysian Smart School has the following characteristics:

- a philosophy that says all students can learn if taught, coupled with high expectations for all students;
- a broad curriculum that considers the different capabilities and needs of all students;
- a school climate that is conducive to learning;
- an on-going assessment that supports good instruction;
- strong and professional principals and teachers;
- a high level of parent and community involvement and support.

### **2.2.1.2 Smart School Components**

The key components of a Smart School are its teaching and learning environment, its management and administration, the people that are involved, the technology which will be used, the process it has to go through to deliver the intended outputs and the policies involved in implementing it (Malaysian Smart School: A Conceptual Blueprint, 1997). Figure 2.1 summarises the connection between these components.





**Figure 2.1:** *Smart School components*

**(a) Teaching and Learning Environment**

The teaching and learning environment comprises four areas:

- **Curriculum:** designed to help students achieve overall and balanced development.
- **Pedagogy:** allows for an appropriate mix of learning strategies to ensure mastery of basic competencies and the promotion of holistic development.
- **Assessment:** designed to give accurate feedback regarding students' readiness, progress, achievement and aptitude.
- **Teaching-Learning Materials:** cognitively challenging and motivating by combining the best of network-based, teacher-based, and courseware materials.

**(b) Management and Administration**

The nine primary functions listed below with respect to Smart School management are intended to efficiently and effectively manage the resources and processes required to support teaching and learning functions:

- school governance;
- student affairs;
- educational resources;
- external resources;
- finance;
- facilities;
- human resources;
- security;
- technology.

### **(c) People, Skills and Responsibilities**

Stakeholders involved in the implementation of Smart Schools should be equipped with specific skills and the requisite knowledge base to enable them to play their roles effectively. The key groups of stakeholders include students, teachers, principals, Ministry of Education officers, support staff, and parents.

### **(d) Technology**

Smart School practices in teaching and learning, management, and communication with external departments (e.g. district and state education offices) should dictate technical requirements and technology solutions.

### **(e) Processes**

Smart School processes are viewed as a part of a system. When the system is provided with inputs (e.g. pupils), the Smart School processes should work to produce the desired outputs (e.g. educated pupils). See chapter 5 for more details.

**(f) Policies**

To ensure the successful implementation of Smart Schools, changes in existing policies and regulations, as well as new policies and regulations will be formulated.

From the above-described components, a decision was made to focus on the teaching and learning environment, specifically the materials utilised in it and the technology attached to it. As a result of a further analysis of the Smart School blueprint, the following statements were extracted:

- technology would be utilised heavily in the Smart School environment;
- teaching and learning (T/L) materials should be designed to fully support the new teaching and learning technology;
- T/L materials should be cognitively challenging, attractive, motivate students to learn, and encourage active participation;
- T/L materials should support pupils' different learning styles;
- conventional materials, commonly used in today's educational settings (e.g. textbooks), should be used in an integrated manner with high-technology materials.

Taking all the above statements into consideration, the following sections therefore review the key issues concerned with this research.

## **2.3 Teaching and Learning Materials**

According to the Malaysian Smart School blueprint (1997), T/L materials can be divided into two categories: conventional and high-technology. Conventional materials can be further divided into three main categories as follows:

- (a) **Printed (Paper-Based)** which include books, encyclopaedias, magazines, newspapers, documents, flat pictures, drawings/paintings, maps, graphs/charts/diagrams, posters and cartoons/comics;
- (b) **3-D Objects** such as globes, puppets, and models;

- (c) **Audio/Visual** for example slides, tapes, filmstrips, radio programs, television programs, motion-picture films, microfilms/microfiches, audio cards and audio tapes.

High-technology can be divided into four main categories: electronic learning modules, design tools, communication tools and application software.

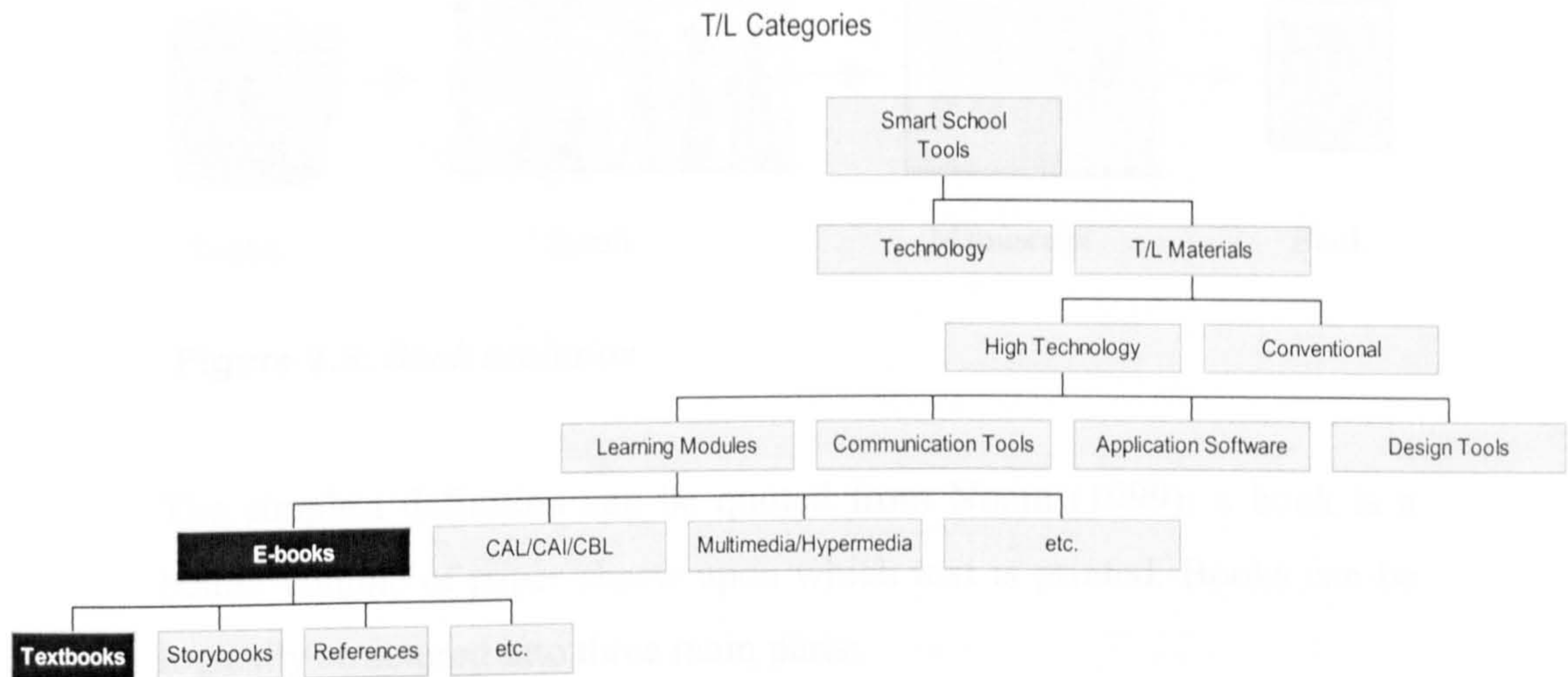
- (a) **Electronic Learning Modules** for instance interactive books, simulation games, drill and practice software, virtual reality system software, individual self-paced learning modules, problem-solving computer games and artificial intelligence modules;
- (b) **Design Tools** such as desktop publishing software, authoring language software, presentation software, draw and paint programs, animation software, musical instrument digital interface, music composition software and clipart;
- (c) **Communication Tools** for example video-on-demand, interactive television, on-line library, bulletin board, search engines, distance-learning, video-conferencing and e-mail;
- (d) **Application Software** such as database software, word processing software, spreadsheet software and computer-assisted design software.

Figure 2.2 shows a summary of the above high-technology media categories. For the purpose of this research, only one application of high-technology materials<sup>2</sup> was studied: the e-book with the focus on electronic textbooks. This study nonetheless began by analysing its conventional counterpart (i.e. paper books), as books have become and still are the most indispensable materials in educational environments (i.e. all schools are still treating books especially textbooks as the dominant teaching material).

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<sup>2</sup> Readers should realise that the e-book investigated in EBoChi could also be treated as learning modules, design tools and communication tools.





**Figure 2.2:** *Teaching and learning materials categories*

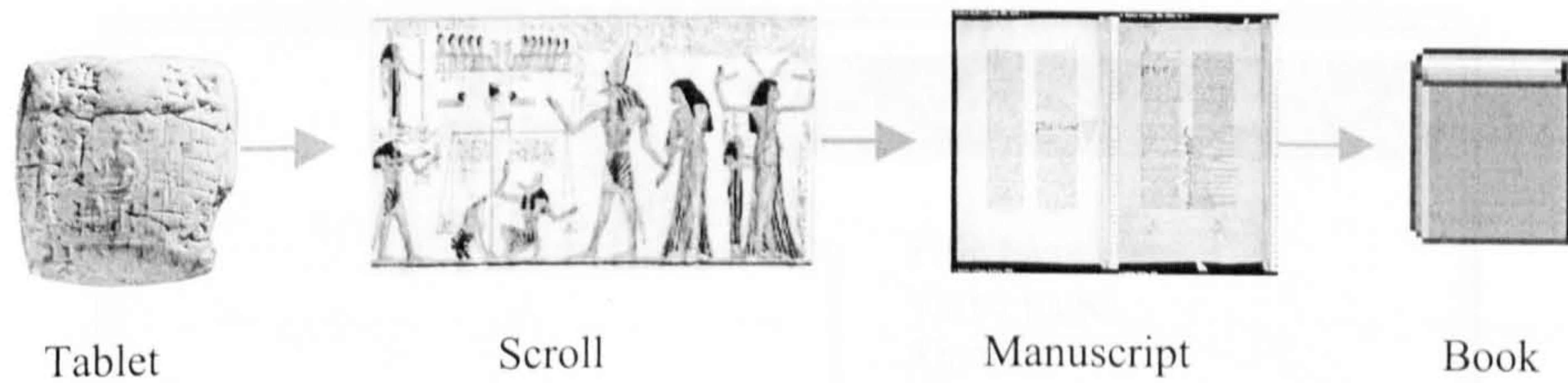
### 2.3.1 Books

The concept of recording information started from the Sumerian cuneiform tablet<sup>3</sup> (information is written on wet clay with a sharpened stick). It represents the oldest example of human textual writing. Then, the tablet gave way to papyrus and parchment scrolls for reasons of greater storage with less weight (Munyan, 1998). Later, when Julius Caesar folded his two-column correspondence, which he made by cutting blank scrolls into individual sheets, the evolution to manuscripts, page and book took place (see Figure 2.3).

In the mid-15<sup>th</sup> century, Gutenberg brought together the technologies of moveable type, paper, oil-based ink and the wine-press to more efficiently print books (Munyan, 1998). Printed books with a specific logical structure, features and design rules then replaced traditional manuscripts (Catenazzi, 1993; Landoni, 1997; Kahn & Lenk, 1998).

<sup>3</sup> Detailed information on the history of the Sumerian can be found at [http://www.usc.edu/dept/LAS/wsrp/educational\\_site/ancient\\_texts/Cuneiform.shtml](http://www.usc.edu/dept/LAS/wsrp/educational_site/ancient_texts/Cuneiform.shtml)





**Figure 2.3:** *Book evolution*

The simplest definition can be quoted from Noam (1999): a book is a bound volume of paper sheets upon which text is printed. Books can be logically structured into three main parts:

- front section;
- main section;
- back section.

Each section is further made up of sub-sections depending upon the type of book. For a textbook, the structure is normally as shown in Figure 2.4. The format of a book which is concerned with aspects such as its size (thickness and height), the typeface, the page and the margins, is comprehensively explained in Catenazzi (1993), Landoni (1997) and Kahn & Lenk (1998).

A book can also be formally defined using the markup language (such as HyperText Markup Language) or the following notations (Barker and Manji, 1991):

$$\langle \text{book} \rangle ::= \langle \text{front-part} \rangle \langle \text{main-part} \rangle \langle \text{back-part} \rangle$$

$$\langle \text{main-part} \rangle ::= [ \langle \text{page} \rangle ] \{ 1:N \}$$

Educational environments should stress the importance of reading materials: textbooks, novels, reference books, encyclopaedias, magazines, and newspapers as knowledge carriers. Printed books especially have been used as extremely useful aids for the support of many activities including teaching and learning for many years. However, another type of book, known as the e-book has recently emerged.



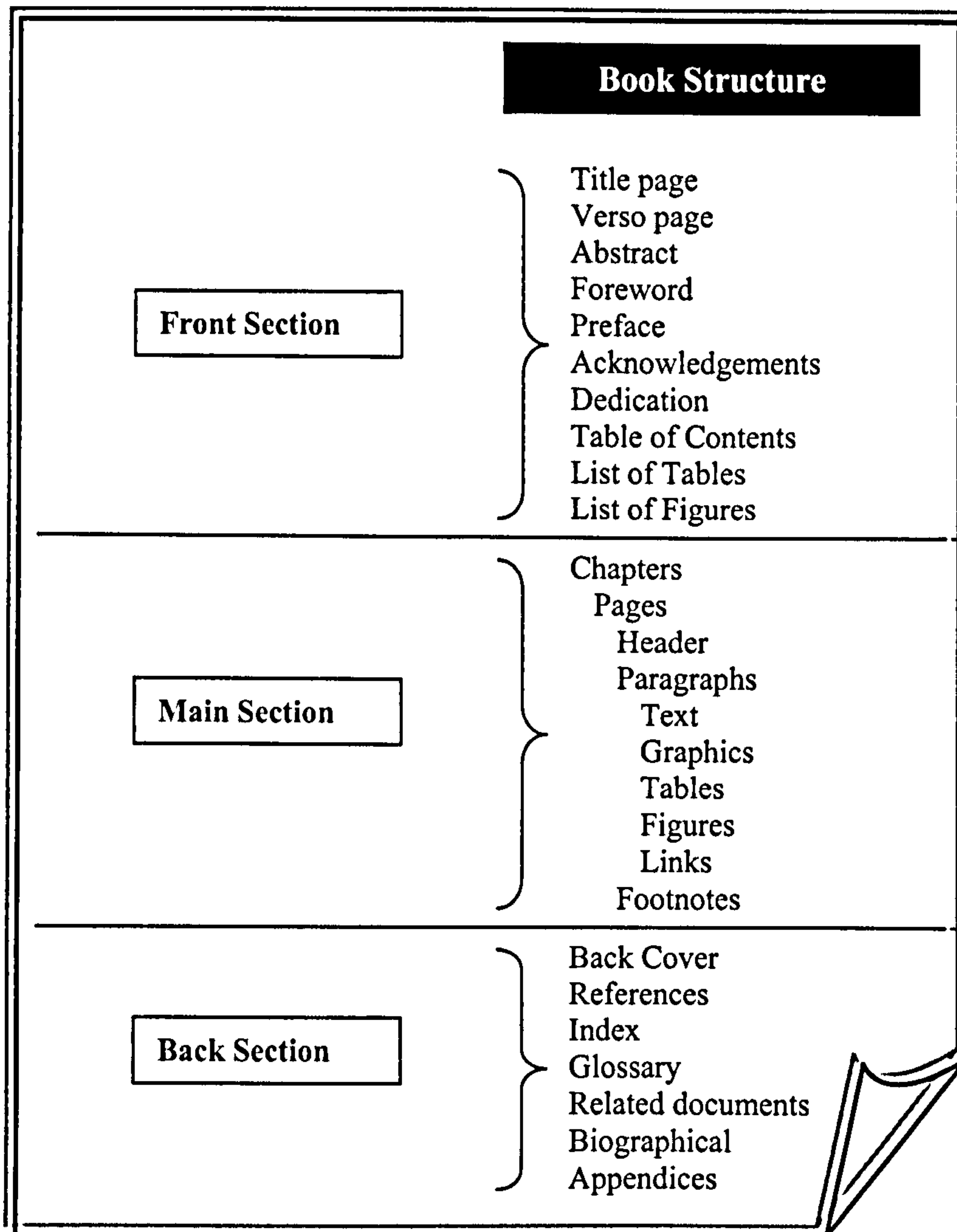


Figure 2.4: *Textbook structure*

## 2.4 Electronic Book (E-Book)

The e-books are becoming increasingly popular due to a number of factors. Most important of these factors include the advent of desktop publishing, the ease with which electronic information can be created, updated, copied, distributed, and searched, and the more widespread availability of both local area and global computer-based communication networks (Barker, 1999).

### 2.4.1 Definition of the Term E-Book

There is a growing interest in converting paper books to digital form as well as writing new titles in electronic format (Carvajal, 1999). This in

turn has resulted in a collection of hybrid definitions of the term e-book. Initially paper books which had been converted to a digital format (usually through digitising processes which allowed them to be displayed on computers) were defined as e-books. Then, the term also encompassed multimedia, hypertext or hypermedia systems that are based on a book metaphor. However, recently, the definition of an e-book has been extended to include book titles that are available on-line, can be read as email, can be retrieved by a portable electronic reading device, or as a file that can be downloaded onto a computer (Carvajal, 1999; Allen, 2000; Clister, 1999).

A recent interpretation of an e-book is the “print-on-demand” book whereby the contents of a book are stored in a system connected to a high-speed, high-quality printer, from which printed and bound copies are produced on demand with the possibility of buying chapter-by-chapter, customised books (Hawkins, 2000a).

E-books are also defined diversely by researchers to fit their own expectations. For example:

- Bonime and Pohlmann (1998) describe any kind of digitised information ranging from a CD-ROM title to an online interactive database or a collection of Web pages as an e-book;
- Barker (1998) defines an e-book as essentially a computer-based information storage/dissemination artefact that embeds a book metaphor. More precisely, an e-book is usually considered to be composed of a collection of reactive pages of electronic information that exhibit many of the characteristic features and properties of a conventional book (Barker, 1999);
- Landoni (1997) classifies an e-book according to three different criteria:
  - first, portable e-books, which can be taken everywhere and whose main purpose is to reproduce the portability of paper

books. These are normally used for reference publications, dictionaries and thesauri;

- books that are more concerned with preserving the logical structure, that is the organisation of a book in chapters, sections, and subsections. These provide full-text indexing, links, navigation and orientation through dynamic tables of contents and multi-window text displays;
  - books which support both the physical and logical aspects of a book.
- A different definition of an e-book is found in a project by Ozsoyoglu et al. (2000). They use the term e-book to cover learning environments which have an application containing a multimedia database of instructional resources that store pre-captured multimedia presentations about topics in a book. A traditional book structure (i.e. table of contents, chapters, sections and sub-sections) is used for data presentation.
  - Open eBook (OEB) Forum avoids using the e-book term since different people use the term differently. OEB defines a more precise terminology:
    - the digital content which users read (i.e. a paperless version of a book, article, magazine, etc.) is called publication;
    - the physical device used to read a publication is called a reading device (e.g. dedicated readers (see section 2.4.2.1), personal computers or personal digital assistants);
    - the combination of software and hardware that processes content and presents it to the users is called a reading system.

Some projects give distinct names to their e-books to represent the outcomes of their studies. These include:

- Catenazzi et al. (1993) who reported two forms of e-books used for scientific publications. One is called the Hyper-Book, which is created from existing electronic texts. Texts are accessed in a non-



linear structure following the concept of hypertext. The second innovation is known as the Visual-Book, which is created by converting a conventional paper-based book into an electronic form. de Diana & White (1994) on the other hand, referred to the conversion of reference, study or scientific materials into electronic versions as the Electronic Study Book (EBS) as they are used for studying purposes;

- As discussed above, Bonime and Pohlmann call a collection of Web pages an e-book. Card et al. (1996) instead, described a collection of Web pages as a Web book.

Table 2.1 summarises the many definitions of an e-book.

**Table 2.1:** *Different definitions of an e-book*

No.	Definition
1	Digitised information from paper version
2	Multimedia/hypermedia applications based on a book metaphor
3	Print-on-demand
4	A collection of Web pages
5	Portable reading devices
6	Researchers' own expectations

In general, and in the context of this research, the definition of an e-book is partly adopted from Landoni and Gibb (2000) who stated that the result of integrating a 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 e-book. A complete definition with regard to this project is presented below:

“ An e-book is defined as any digital content which exhibits a classical book structure that is made available on computers or portable devices, and which may be read using custom designed software or a Web browser.”



## 2.4.2 E-Book Technology

*“ Obviously, the medium upon which a book is published can significantly influence its "look and feel", its capacity, its availability, its reactivity, the types of information that it can embed, and the ease with which its contents can be shared with others.”* (Barker, 1999)

There are a large number of media<sup>4</sup> available for the delivery of information as described by Collier (1998) in Table 2.2.

**Table 2.2: Information delivery media**

Type of information	Delivery Media
Printed materials	Books, journals, magazines, newspapers
Broadcast	Television, radio, film
Portable	Tape, CD-ROM, CD-I, CD audio, diskette
Person to person	Telephone, mail, meetings, workshops
Telenetworked	Internet-based services (e.g. emails, conferencing, WWW)

At present, the delivery of e-books through CD-ROM and the Internet is the most popular mode. Nevertheless, in 1998 another type of e-book medium was introduced to the public: dedicated readers or hand-held devices.

### 2.4.2.1 Hardware-Based Readers

The emergence of the e-book has resulted in many companies manufacturing electronic reading devices used for displaying, reading and storing electronic information. NuvoMedia Inc., SoftBook Press Inc., EveryBook Inc. and Sony are examples of manufacturers of such devices (Sanders & Sanders, 2000).

<sup>4</sup> The term “medium/media” is used rather loosely in the literature. Some people defined it as objects on which data can be stored or distributed, while others used it to mean audio, graphic, etc. Throughout this thesis, the following terminology is used to avoid misconceptions:

- medium – objects which data can be stored or delivered (e.g. paper, disk, tape, CD-ROM, etc.)
- information type – text, graphic, audio, video, etc.



However, the Gemstar International Group, one of the leading companies involved in electronic technology, acquired NuvoMedia Inc. and SoftBook Press Inc. in early 2000. The nature of the devices market has been evolving. Initially the companies only targeted professionals who required access to lots of reference material (Judge, 1998). Now, they are targeting a more general mass market such as students, academics and individuals.

These machines are produced specifically 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™ (refer Figure 2.5);
- Microsoft IPM-NET Myfriend™;
- Cytale Cybook™.



**Figure 2.5:** *REB 1100 and REB 1200 by Gemstar*

O'Donnell (1998) stated that all these devices have one common function in that they are dedicated to reading e-books only, and are not as sophisticated as hand-held computers or personal digital assistants (PDAs). This statement no longer holds, however as since the year 2000, hybrid devices which contain



address books, diary, calculator and PDA-associated functions have also been used to read e-books (Wilson, 2001). Additionally, these devices can also be used for emailing, Internet surfing, word processing, and MP3 playing. An example is the Franklin eBookMan (refer to Figure 2.6). The latest addition to PDA technology is the all-in-one colour monitor hand-held (such as O<sub>2</sub> xda by O<sub>2</sub>) which allows users to access the Internet, make phone calls, send emails, capture image through embedded-digital camera, use Microsoft Word and Excel, read e-books, organise a diary, listen to music and play games. PDAs are rapidly becoming a common technology at school<sup>5</sup> because they allow students and teachers to do essential tasks such as note taking, word processing, graph drawing, emailing and browsing.

In addition to PDAs, Game Boy machines (see Figure 2.6) are also now capable of functioning as e-book readers. Crowe (2002) 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 to the machine format and supports many languages, colour schemes and font sizes.

The latest device which is still under development, is the ReBook from Real Time Touch (2002). It will allow print, video, audio, interactive touch and wireless communications. Another one is the EInk project by E Ink Corporation (2002), 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 very early stages, but EInk has expressed the desire to create the technology to allow the development of electronic

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<sup>5</sup> For more detailed information and discussion on this issue, see articles in <http://www.becta.org.uk>, <http://publishing.about.com>, <http://www.eschoolnews.org> and <http://eduscapes.com>



devices that work like paper books (i.e. reusable pages bound together to form a book-like device).



Franklin eBookMan



Game Boy

**Figure 2.6:** *Franklin eBookMan and Game Boy*

In contrast, Oregon Scientific (2002), VTECH (2002), and IQ Builders (2002) are producing computer-based learning laptop machines and hand-held devices for children aged between 3 to 12 years old (refer to Figure 2.7) (Norshuhada & Landoni, 2003). 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 by buying storage devices designed specifically for the machines. In summer 2002, VTECH introduced another innovative machine for children in the form of touch-screen hand-held devices (see Figure 2.7). In addition to electronic activities, the hand-held devices also provide tools such as advanced word processing software with facility to upload documents to Microsoft Word, personal organiser, artwork studio, music composer, scientific calculator, typing tutor, periodic table, phone books, games and software for wireless Internet connectivity.



**Figure 2.7.** *Examples of children's laptop machines and hand-held devices*



#### **2.4.2.1.1 Advantages and Disadvantages of E-Book Devices**

Nuvomedia Inc., SoftBook Press Inc. and EveryBook Inc. were the pioneers in terms of introducing reading devices (Manes, 1999). They have a number of advantages and disadvantages. Some of the advantages over traditional paper books include:

- they can store tens to hundreds of titles, making them suitable for convenient, portable access to reading material from virtually any location (Thomson Multimedia, 2000);
- they incorporate features such as interactive dictionaries, bookmarking, instant searching, note taking and cross referencing;
- the back-lit display and font size can be adjusted to improve readability (Selvidge & Phillips, 2000).

Full descriptions of the advantages of these reading devices can be found in Williams (2000a).

The e-books have the potential to relieve their users from the burden of carrying heavy books, which has been a perennial problem especially for schoolchildren (Judge, 1998). Students are required to be actively engaged with many texts and new information by practising active reading and learning, and must often transport books from home to school (Schilit, 1999). This hardship could soon be lessened with the technology of electronic reading (e-reading), which uses a screen to display the information.

Although they have a number of advantages over paper books, reading from these devices is reported to cause more eye strain and glare (Williams, 2000b). The display quality is poor (because of the low resolution) compared to paper and the devices are still too expensive for the average person to buy.

#### **2.4.2.1.2 E-Book Device Contents**

Content for e-book readers can come from a variety of on-line sources such as novels, journals, newspapers, magazines, and manuals. Unfortunately the number of printed books, especially textbooks, in electronic format is relatively low. On-line books currently consist mostly of works whose copyrights have expired (Moschella, 1999). Project Gutenberg (2002) 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 iUniverse (2002) and Franklin Electronic Publisher (2002) have successfully produced and sold new electronic titles.

Customers have shown an interest in books about computers and business as well as romance and science-fiction novels (Allen, 2000; Hawkins, 2000a; Carvajal, 2000). Well known writers such as Stephen King are among those interested in marketing their books in electronic format. Additionally, content can also be downloaded from digital libraries such as The Internet Public Library (2002), University of Virginia's E-Book Library (2002) and Net Library (2002).

A study by Stork (2000) found that different types of content will be easier or more difficult to implement based on the type of device. For example, reference books containing large amount of text are better viewed on larger laptop screens. Black and white screen readers are most suitable for recreational reading. Coloured screen readers are much better for technical material with illustrations.

### 2.4.2.2 Software-Based Readers

In addition to e-book reading devices, general-purpose software-based book readers have also been developed which are used on personal computers or laptops. They function in a similar way to dedicated readers but no special hardware is required. Microsoft Reader, Adobe Acrobat Reader and Adobe Acrobat eBook Reader are examples of such software. One advantage of software-based readers is that in addition to offering the functions of dedicated readers, they also offer extra facilities because of the presence of a keyboard and larger screen sizes (Lynch, 2001).

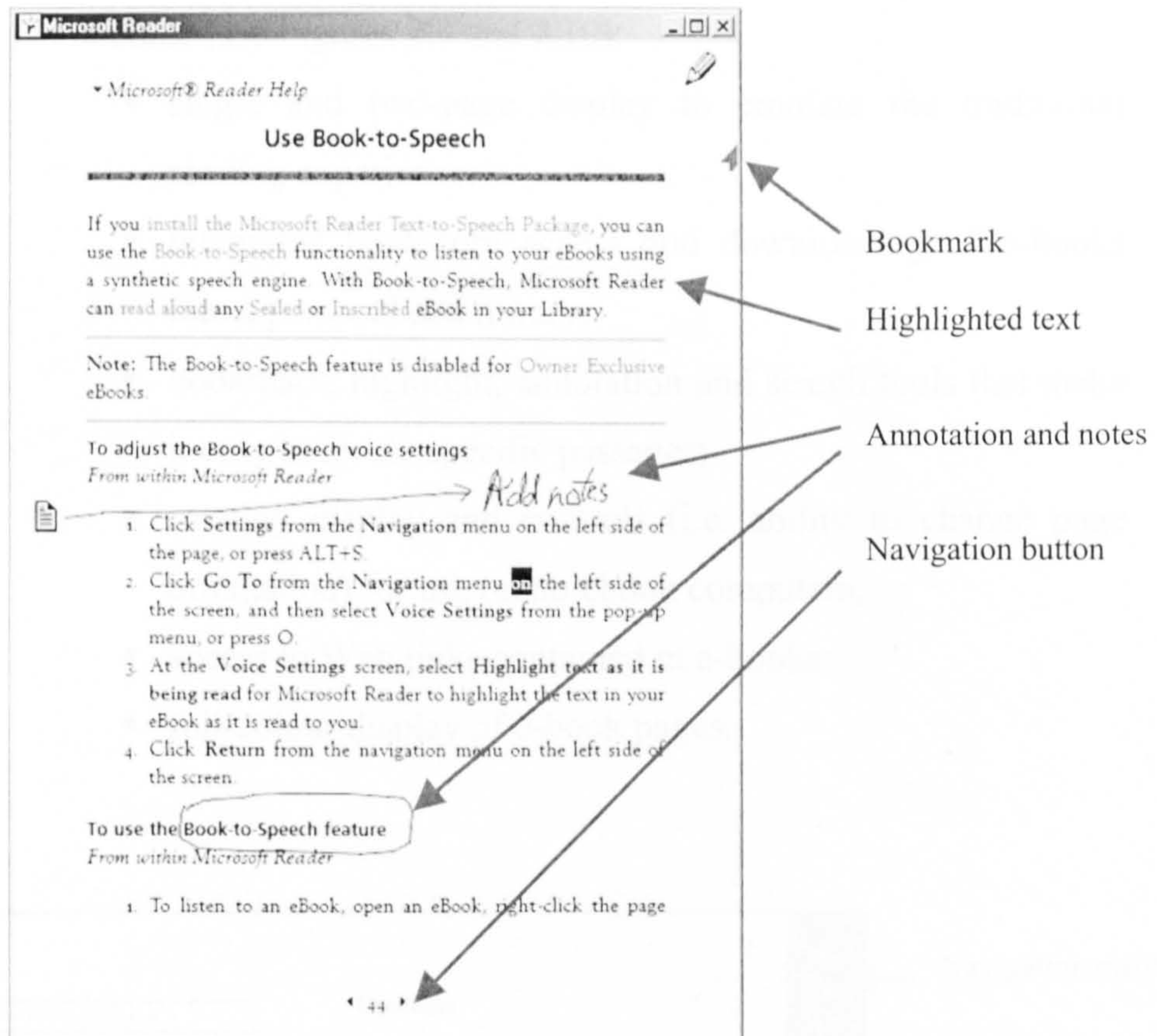
#### Microsoft Reader

In July 2000, Microsoft released its e-book reading software, Microsoft Reader. It is available as a free download from the Microsoft Web site. Two versions of Microsoft Reader are available:

- for desktop and laptop computers which can read encrypted e-books, such as those available at BarnesandNoble.com and Amazon.com, as well as unencrypted e-books found usually at electronic publishers' Web sites;
- the second version is available for Pocket PC devices manufactured by companies such as Hewlett-Packard, Casio and Compaq. It reads only unencrypted e-books.

The reader interface is designed specifically for reading online. It includes ClearType technology developed by Microsoft to enhance LCD (Liquid Crystal Display) screen clarity, and allows annotation, bookmarking, and drawing, and alteration of font size. A text-to-speech feature can be activated when the associated software is downloaded from the Microsoft Web site. However, it supports only a one-page view (see Figure 2.8) as opposed to Adobe Acrobat eBook Reader.





**Figure 2.8:** Page display in Microsoft Reader

### Adobe Acrobat Reader

Adobe's Acrobat Reader is free downloadable software that allows users to read Portable Document Format (PDF) files. Acrobat Reader is widely used and comes pre-installed on most computers, making PDF a popular e-book format.

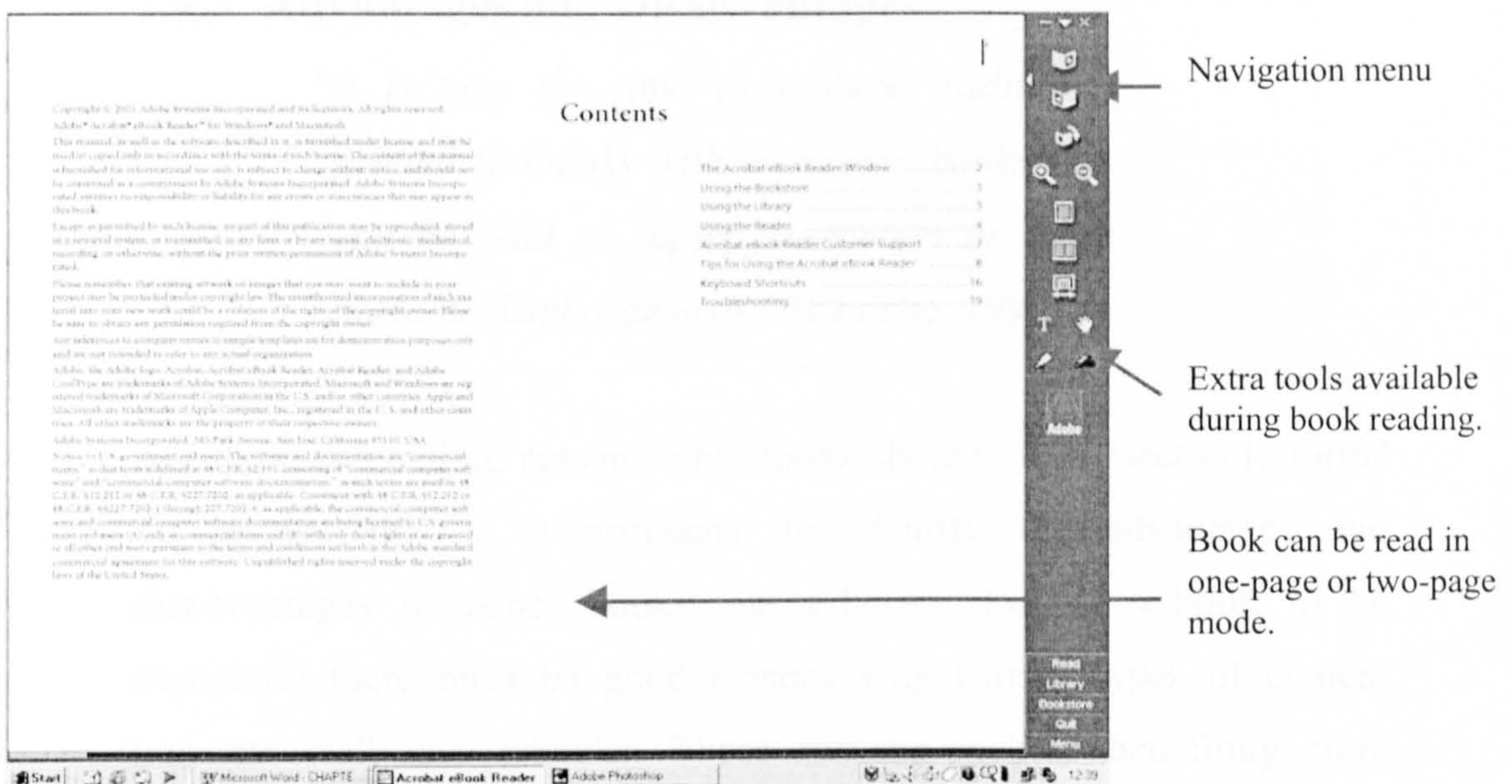
### Adobe Acrobat eBook Reader

Glassbook Reader was recently renamed Adobe Acrobat eBook Reader and is a free downloadable program that enables users to read PDF-based e-books on laptops, notebooks, or desktop PCs. It allows easy buying and downloading of e-books at the Adobe eBook Mall and other online booksellers such as eBookTech.com, McGraw-Hill Primis Online, Taylor & Francis eBookstore, Harcourt College Publishers, CyberRead.com and



BarnesandNoble.com. Some of the more important features include (see Figures 2.9 and 2.10):

- single and two-page display to emulate the traditional reading experience;
- integrated bookstore access and downloading of e-books into a personalised library;
- bookmark, highlight, annotation and search tools that make it easy to locate specific passages;
- rotating display and controls (i.e. ability to change page orientation) for use on notebook computers;
- access to Web links contained in e-books;
- full-colour display of e-book pages.



**Figure 2.9:** Table of Contents in Acrobat eBook Reader



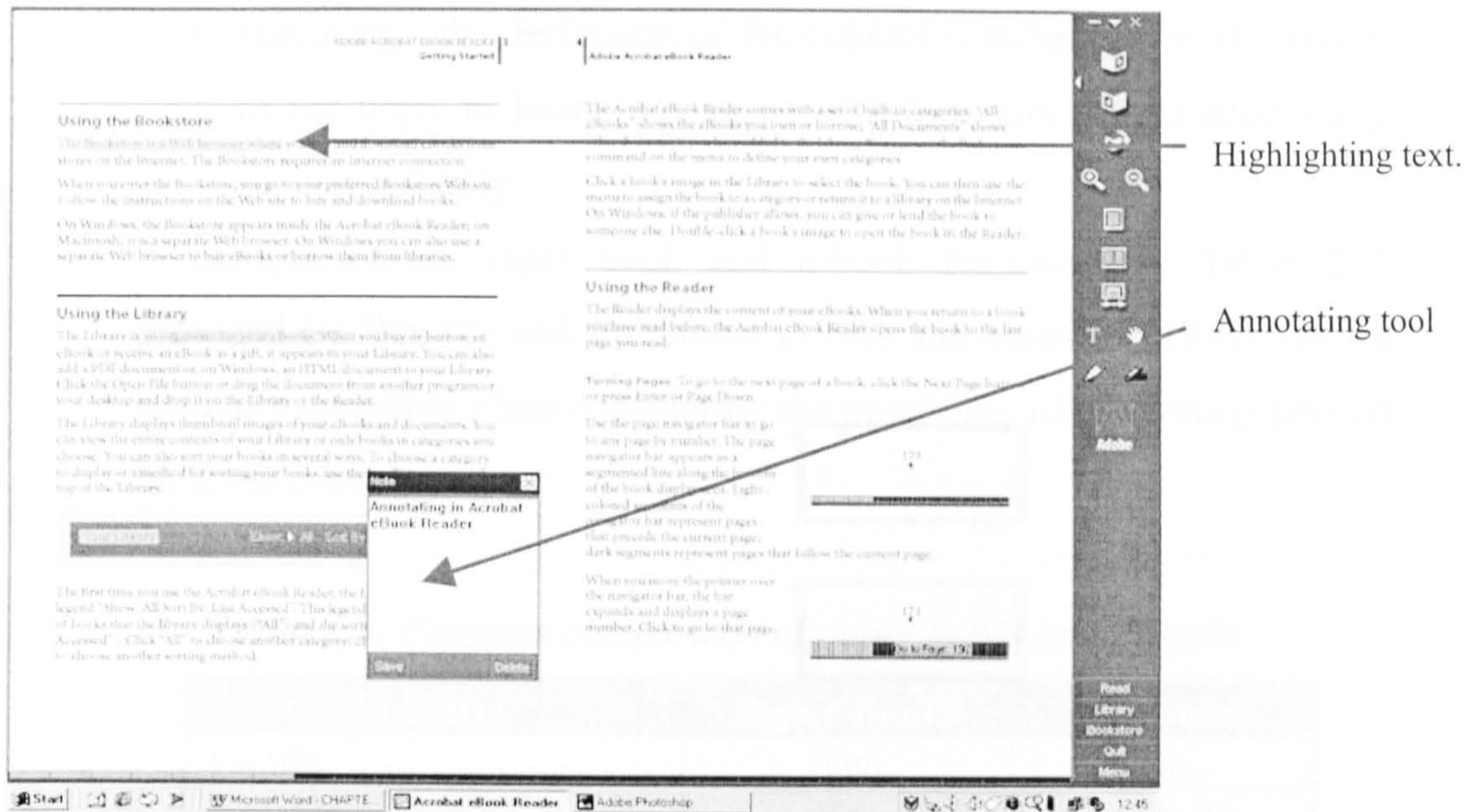


Figure 2.10: Highlighting and annotating in Acrobat eBook Reader

### 2.4.3 Advantages and Disadvantages

*“It is now the time to replace traditional printed textbooks with electronic books that can be read on laptop computers or other portable display devices.” (Christie, 1998)*

Are there compelling reasons why books should be in electronic form? To answer this it is necessary to identify the advantages and disadvantages of paper books and e-books. For an e-book to be successful there must be good reasons why certain types of content translate well into e-books. These reasons include benefiting from (Bonime & Pohlmann, 1998):

- hyperlinking - contents can be linked to other pages inside and outside the book;
- non-linearity - i.e. the order of access can be determined by users.
- addition of multimedia - i.e. content presentation is enhanced by mixing information type (i.e. sound, video and so on);
- data density - storage capacity is decreased while at the same time increasing portability;



- searching - the usefulness of the content is enhanced by the ability of the users to locate any piece of information, or to access any section instantly.

A comparison of paper book and e-book features (see Table 2.3) provided by Bonime and Pohlmann (1998) and Rawlins (1991) can be used as a guideline when considering the possibility of converting printed books to e-books.

**Table 2.3:** *Features comparison of paper books and e-books*

<b>Features</b>	<b>Paper Books</b>	<b>E-books</b>
Tactile	Yes	No
Portable	Yes	Yes & No
Access without devices	Yes	No
Easy random access <sup>6</sup>	No	Yes
Multiple access at one time	Yes	Yes
Customisable (font size, annotations etc.)	No	Yes
Hyperlinks	No	Yes
Text	Yes	Yes
Pictures	Yes	Yes
Audio	No	Yes
Animation/video	No	Yes
Instant search facility	No	Yes
Easily and conveniently read	Yes	No
Easily damaged (i.e. tear)	Yes	No
Content updated easily	No	Yes
Go out of print	Yes	No
Highly interactive	No	Yes
Good legibility	Yes	No
Easily reproduced with the same quality	No	Yes

In the case for children's books, results of some studies suggest that involvement with computers through the use of e-books, multimedia, hypermedia, CAL and CAI and other new technologies, can promote positive attitudes towards learning and higher achievement among

<sup>6</sup> Random access in e-books requires less effort, thus probably is easier than paper books.

children (e.g. Clark, 1987; Ebersole, 1997; Campbell-Gibson & Graf, 1992; Kajs et al., 1998; Carlson & White, 1998; Causey, 1996; AlKahtani, 1998; Cakir, 1999; Govil, 1997; Ferguson, 2001; Espinosa & Chen, 2001; Xin & Rieth, 2001; McCreary et al., 2001). Studies also show that computer-based learning tools lead to significant gains in children's performance in reading, mathematics, computer knowledge and grammar (Shields & Behram, 2000). Furthermore, computers and technology tend to have more positive effects on young children than negative effects (Seniuk, 2001).

Nonetheless, it should be noted that not everyone agrees with the real impact of technologies on children's learning. A number of comprehensive reviews have concluded that there is no good evidence that any learning technology (i.e. printed, radio, television, and computer) produces more learning or motivation than any other technology (Heinich et al., 1996; Clark & Craig, 1992; Brooks, 1997). Likewise, some literature also strongly suggests that the media used to deliver instruction is not a significant variable in affecting students' attitudes (McGred, 1994). In addition, excessive, unmonitored use of computers and other screen technologies can place children at risk for harmful effects on their physical (e.g. eyes, back and wrists), social and psychological development (Shields & Behram, 2000).

To conclude this section, a quote from Bonime and Pohlmann (1998) is an excellent guideline for deciding whether a book should be converted or not.

*“Writers should ask themselves how converting existing content into an interactive title, or writing an original e-book instead of a print book, will have added value to the user. At the same time, the writer must consider such issues as the loss of portability, the need for a playback device, and the loss of the physical possession of a book. If it is*

*determined that there is a distinct advantage to presenting the content interactively, then chances are good that the result will be a very useful or entertaining title.”*

Upon deciding to produce e-books, authors should then select the file format for their books from various alternatives as discussed in the next section.

#### **2.4.4 Formats**

E-books are available in a wide range of formats, the simplest of which is plain ASCII-standard text. However, this format is extremely unappealing to read, can not preserve formatting and can not handle graphics. To solve these problems, the following formats can be used (Allen, 2000; Armstrong & Lonsdale, 1998; Hawkins, 2000a):

- Adobe Acrobat’s Portable Document Format (PDF);
- Microsoft Reader’s Literature (LIT);
- Rich Text Format (RTF);
- Night Kitchen’s Tool Kit 3 (TK3);
- Markup Language (e.g. HyperText Markup Language - HTML, Standard Generalised Markup Language - SGML, eXtensible Markup Language - XML);
- Software for PDAs such as AportisDoc for Palm Pilots and Pocketbooks, Palm Reader and MobiReader for Palm Hand-held, Handspring Visor, and Window CE devices.

The most popular formats according to Hitchcock et al. (1997) are either HTML or PDF. Although their study is now rather dated, in general the findings still hold as throughout this research, the dominant formats encountered in existing e-books are still the ones mentioned earlier. However, this may soon change as LIT format is becoming widely used.



#### **2.4.4.1 Standards**

Although a single standard for e-book formats does not yet exist (as at the end of July 2002), in 1999, NuvoMedia and SoftBook Press co-developed and proposed the Open eBook Publication Structure standard (OEBPS). The OEBPS standard is based on HTML and XML specifications for the content, structure and presentation of e-books and is supported by more than 200 companies including IBM, Microsoft and Adobe (Thomson Multimedia, 2000; Hawkins, 2000b). However, although Adobe is one of the members of the OEB Forum, the company is actively pushing its PDF format to be the de facto e-book standard. Microsoft, on the other hand is in favour of HTML and Word documents, and has developed LIT which supports OEBPS.

Both OEBPS and PDF formats according to their supporters have better features<sup>7</sup> and strengths than the other. Frauenfelder (2000) in his article described and compared these features, and finally concluded that publishers will not mind which format becomes the de facto standard so long as it is OEBPS or PDF.

#### **2.4.4.2 Children's E-Book Formats**

E-book formats for children's books are essentially the same as those mentioned above. Publishers who are currently selling children's e-books use HTML, LIT and PDF formats, and executable (.EXE) files (Norshuhada & Landoni, 2003).

Among the popular publishers, Antelope Publishing (2002) produces, publishes and sells children's storybooks, picture books, teenage novels and fiction/non-fiction books in HTML

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<sup>7</sup> Too many features to mention, interested readers should read Frauenfelder (2000) and see <http://www.dclab.com/ebookstandards.asp>

format. They are targeting children from pre-school to young adults and books are read using Web browsers. Although their books are read using Web browsers, the books are stored on CD-ROM making them possible to be viewed on-line or off-line.

BarnesandNoble.com produces some fairy tales and storybooks in .EXE files to be used by children aged between 2 to 10 years old. Books can be bought either on CD-ROM or sent via email. Other publishers such as Bookmice.com, DiskUsPublishing.com, BookLocker.com, ZorbaPress.com and DeAgostini.co.uk sell children's classic books, sci-fi books, audio books and learning books in PDF and HTML formats. EbookMall.com, Webs4Kids.com and Amazon.com sell books in LIT format.

Creating e-books in the formats described previously involves a publishing process which is outlined in the following section.

### **2.4.5 Publishing Process**

Books that are produced and stored electronically rather than in print are the result of electronic publishing (e-publishing). From a financial point of view, e-publishing eliminates, printing, binding, storage and transportation costs (Borchers, 1999). Nevertheless, it is probably just as costly (or more costly) to employ highly-skilled editorial and technical staff (such as graphic artists, audio and video specialists, animators and so on) to prepare data for electronic publication as it is for paper-based publication.

The e-publishing process closely resembles traditional print publishing and goes through similar stages (Modeland, 2000; Prabha, 2000):

1. manuscripts are evaluated (for new books) or acquired (if paper versions exist);
2. if a book is marketable, contracts are signed;



3. content editors edit the manuscript for better quality;
4. manuscripts are proof-read;
5. the final edited manuscripts are processed (i.e. e-books are created) and saved in various formats. This involves a further four sub-steps: planning, designing, creating and testing.
6. book is stored and delivered on suitable media (see section 2.4.2).

In the e-publishing process, stage 5 entails further phases (i.e. planning, designing, creating and testing) which are adopted from the software development life cycle (see software engineering books for more information on software development) to provide the e-books with an appropriate user interface, functionality and content presentation.

The phases involved in stage 5 also depend greatly on the type of content to be produced and their purposes. The contents can be in any of the following form:

- any one information type (for example fully textual, only graphics content, or only audio content);
- multimedia or hypermedia (i.e. mixing more than two information type).

Each category according to Borchers (1999) can be used in education (e.g. textbooks), as reference (e.g. dictionaries), leisure (e.g. novels, magazines, comics), browsing (e.g. newspapers) and advertisement (e.g. brochures). If producing an e-book for learning purpose, its development process should also consider instructional design issues (i.e. a systematic approach to designing instructional materials to achieve specified learning objectives) and accommodate a wide range of different learning styles (see section 2.5) (Bostock, 1998).

One good example in creating textual e-book content is to follow the phases suggested by Landoni (1997). She started by selecting a

formalism (either logic or grammar) then constructed a conceptual model, which defines the structure of the e-book. Having defined the conceptual model, the interface was designed with specific attention paid to ergonomic and text-presentation issues. Creating textual e-books is becoming easier with the introduction of e-book compilers (see section 2.4.5.3). Books are created by merging existing text files, and the compilers automatically generate the structure and the interface for the books.

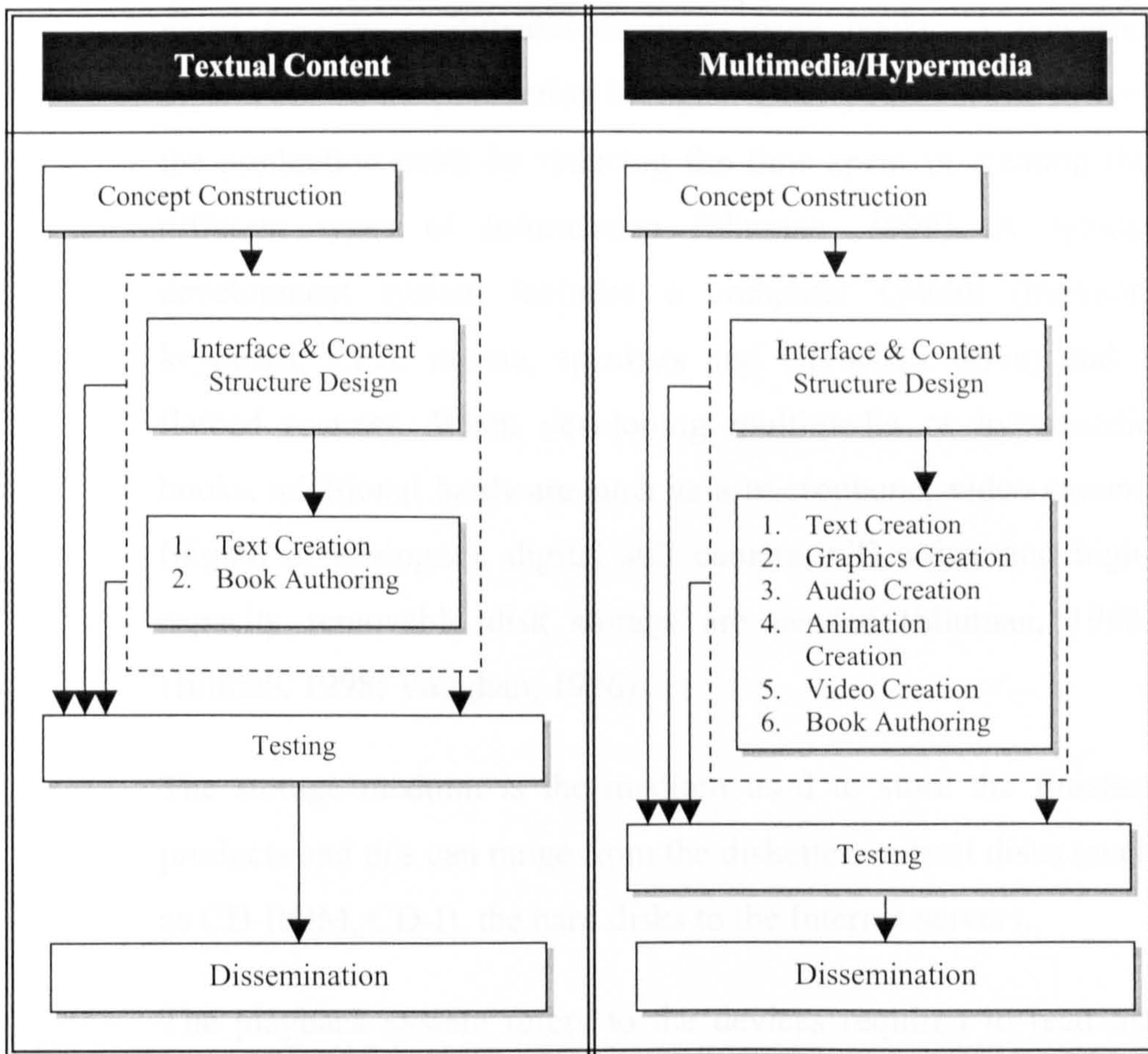
Designing multimedia or hypermedia books normally requires more steps as it often involves using more information type. In textual e-books (or any other single information type), designers need only to work by following guidelines such as using appropriate fonts, making text readable and considering type styles and colours. In multimedia or hypermedia books, on the other hand, design considerations are focused on the appropriate use of graphics, audio, animation, video, text as well as on their combination. Figure 2.11 shows the difference in publishing phases between textual and multimedia/hypermedia content. Each multimedia component is created with the assistance of computer hardware and software, which are discussed in the next section.

#### **2.4.5.1 Hardware**

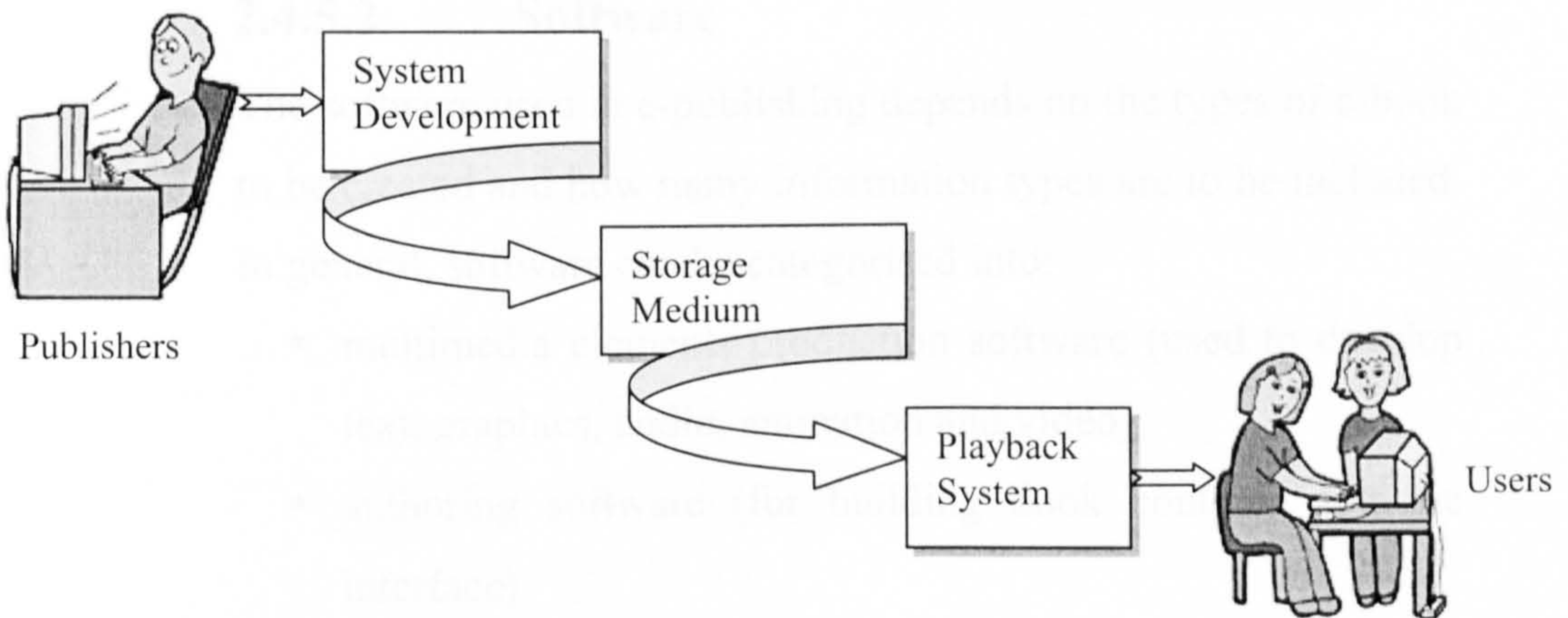
E-publishing requires computer technology for three purposes (see Figure 2.12):

- development of publishing materials;
- storage medium;
- playback (i.e. reading or viewing the contents).





**Figure 2.11:** *Publishing phases between textual and multimedia/hypermedia content*



**Figure 2.12:** *Technology required for e-publishing*

The development system, should ideally be the fastest and most powerful, and needs to have large storage capacity especially

when creating multimedia or hypermedia books. A powerful system allows the production of higher-quality results, and lowers the production costs by reducing the time spent in creating the different types of information (Shuman, 1998). A typical development system includes a computer system (monitor, keyboard, CPU, mouse, speakers and CD-ROM drive) and a flatbed scanner. When developing multimedia or hypermedia books, additional hardware such as a microphone, video camera (digital or analogue), digital still camera, CD-writer and high-capacity removable disk storage are needed (Shuman, 1998; Hillman, 1998; Vaughan, 1996).

The storage medium is the medium used to store the finished products and this can range from the diskettes, optical disks (such as CD-ROM, CD-I), the hard disks to the Internet servers.

The playback system refers to the devices required to read the books and these can range from personal computers to readers based on the newest technology available (see section 2.4.2.1).

### **2.4.5.2 Software**

The software used in e-publishing depends on the types of e-book to be created and how many information types are to be included.

In general, software can be categorised into:

- multimedia elements production software (used to develop text, graphics, audio, animation and video);
- authoring software (for building book contents and the interface).

#### **2.4.5.2.1 Multimedia Elements Software**

Multimedia elements can entail text, graphics, audio, animation and video. For each of these elements, specific software is used to



create the required assets (Shuman, 1998; Hofstetter, 1995; Bonime & Pohlmann, 1998; Mai & Neo, 1997; Hillman, 1998).

### **Text**

Word processing programs, such as Microsoft Word and WordPerfect are useful for creating text for books that are text intensive. Once text is created using these programs, it can easily be saved in different formats for example RTF and HTML.

When conventional versions exist, text in books can be scanned using an optical character recognition (OCR) program. This program will translate the scanned text into a form that can be read by most word processing software.

### **Graphics**

Software for creating and editing graphics can be classified into three types as suggested in Shuman (1998):

- graphics programs that come with operating systems (such as Microsoft Paint) or which are included in authoring programs. These programs however have limited features;
- drawing programs such as Adobe Illustrator<sup>TM</sup> and Freehand<sup>TM</sup>, which create freehand lines as well as geometric shapes (often called vector graphics);
- paint programs that provide tools to create or edit photographic images (often called bitmap images). These programs are useful for making changes to the brightness or textures of images. Adobe Photoshop<sup>TM</sup> and PaintShop Pro<sup>TM</sup> are among the most popular programs.

These software tools allow graphics to be saved in several formats including Bitmap (BMP), Tagged Image File Format (TIFF), and Windows Paint (PCX) as well as standard file formats for the World Wide Web (WWW) such as the Joint Photographic Experts Group (JPEG) and Graphics Interchange Format (GIF) standards.

### **Audio**

A whole range of sounds can be played through a computer, including music, narration and special-sound effects. Sounds are critical in multimedia or hypermedia and especially in children's books as they are often used to attract attention, elicit emotion or dramatise a point (Shuman, 1998).

Popular software used to create or edit audio are Sound Edit 16<sup>TM</sup>, Sound Forge<sup>TM</sup> and Wave Studio<sup>TM</sup>. Audio files can be saved in various formats such as Microsoft WAV, Macintosh AIFF, and MID (Midi audio) (Bagwell, 1998). Sounds that are intended to be delivered through the WWW are usually compressed in order to reduce their file sizes. Typical formats used for Web delivery include Real Audio (RA) and Motion Picture Experts Group (MPEG) (Voice of America News, 2000).

### **Animation and Video**

Animation and video play a significant role in providing action, realism, visualisation and demonstration (Mai & Neo, 1997). Children's titles, in particular rely heavily on animation to attract children's attention and increase their interests in exploring more content (Shuman, 1998).



Animation can be produced in the following types:

- 2D (Two-dimensional) animation which usually refers to either cell or path animation. Cell animation is based on the changes that occur from frame to frame to give the illusion of movement and can be created using programs such as Macromedia Director<sup>TM</sup> and Flash<sup>TM</sup> (Shuman, 1998). Path animation moves an object along a prespecified path on the screen and is easily designed using built-in functions in authoring programs;
- 3D (Three-dimensional) animation, unlike 2D, presents animation with textures and depth and involves three creation steps: modelling, motion defining and rendering (Hofstetter, 1995; Shuman, 1998). 3D Studio Max<sup>TM</sup>, Extreme 3D<sup>TM</sup> and LightWave 3D<sup>TM</sup> are examples of programs used to create 3D animations;
- Animation involving special effects such as morphing. Morphing is the process of transforming one image into another via a series of frames and can be produced using programs such as Elastic Reality<sup>TM</sup> (for Windows/Mac), Morpher<sup>TM</sup> (for Windows/Mac), MorphMan<sup>TM</sup> (Windows) and WinMorph<sup>TM</sup> (freeware for Windows).

There are many ways to go about creating video for e-books. The possibilities range from low-cost techniques to sophisticated studio-class productions (Ozer, 1998; ETeach, 2000). Digital video clips can originate from two sources: digitised analogue video and raw digital video (obtained from digital video devices). Raw digital video files are very large, commonly 50 Mega bytes for each

minute of video. As with audio, video material needs to be compressed in one way or another. Various standards exist for this purpose including Microsoft's Windows Media Tools and Real Media technology. Video material is often stored in Audio Video Interleave (AVI) format.

Video creation processes are outside the scope of this project. Therefore, no video elements will be created for use in this project, hence topics on this matter will not be discussed else where in this thesis. However, more information on video creation can be found in Heuris (1998). This source explains the theories behind each of the main generations of video technology:

- 1st Generation - Linear Digital Editing;
- 2nd Generation - The Early Days of Multimedia;
- 3rd Generation - The Service Bureau Stopgap;
- 4th Generation - MPEG Encoding on the Desktop;
- 5th Generation - DVD: The Big Picture.

#### **2.4.5.2.2 Authoring Software**

Authoring software is used to build the interface as well as the content of e-books. It also is the environment used to integrate all media elements developed prior to the authoring stage. There are many programs which can be utilised for this purpose. They can be divided into two groups:

- stand-alone authoring programs (where the outputs can also be viewed on Web browsers with special plug-ins);
- Web authoring programs (where the outputs can also be saved on CD-ROM and viewed using Web browsers).



### Stand-alone authoring programs

Among the popular stand-alone authoring tools are Macromedia Director<sup>TM</sup>, Macromedia Authorware Attain<sup>TM</sup> and Asymetrix Toolbook Instructor<sup>TM</sup>. Director<sup>TM</sup> is a software package which is used mostly for the construction of animated applications and is often utilised to develop children's storybooks. It can be extended with the Lingo scripting environment and C++. In order to view Director<sup>TM</sup> content over the Internet the user must download the Shockwave plug-in<sup>8</sup> (Turner, 2000).

Authorware Attain<sup>TM</sup> is a dedicated icon-based tool for developing multimedia projects such as learning materials. Its applications can also be delivered on the Web but users must also download a plug-in. The animation capabilities are not as good as in Director<sup>TM</sup>, but executable files from Director<sup>TM</sup> and Flash<sup>TM</sup> (a Web animation package by Macromedia) can be embedded within Authorware<sup>TM</sup>.

Toolbook<sup>TM</sup> is another package which can be used to develop learning applications. It is designed to be used by non-programmers and has possibly the shortest learning curve of any of the packages for novice users wanting to construct a fairly straightforward learning package (Turner, 2000). Other popular programs are:

- Multimedia Friend<sup>TM</sup> is a multimedia software program for students to produce home pages, games, electronic image albums, CD-ROM titles, homework, and more;

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<sup>8</sup> A plug-in application is a program that can be installed and used as part of Web browsers.

- HyperCard™ which is used to develop hypertext and hypermedia systems.

### **Web authoring programs**

Web page authoring software hides all the difficult formatting actions from the users (Walker, 1998). There is no bother with HTML tags; that is, designers do not need to know how to write HTML code. Importing images or making hyperlinks involve only a few mouse clicks.

As for stand-alone authoring tools, there are many programs available for Web authoring, but the most popular are Netscape Composer™, Microsoft FrontPage™ and Macromedia Dreamweaver™ (Walker, 1998). A survey by GCN (1998) - a USA Government Computer News found Microsoft FrontPage was by far the predominant program in the survey. FrontPage™ made up forty percent of Web page authoring software, compared to eighteen percent for Composer™.

Dreamweaver™ is in the form of WYSIWYG (What You See Is What You Get) mode. Text, tables, frames, and everything else are created without having to see the HTML tags (these are generated automatically). However, the HTML code can be inspected and modified. While it might be difficult for beginners, this facility is relatively easy to use, intuitive, and powerful (Fiedler, 1998).

According to Fiedler (2000), to a certain degree all these products share certain basic features: on-screen editing and markup; in-line graphics display; easy links to URLs and image files; and support for the HTML standard. In



addition, some word processors like Microsoft Word allow documents be saved in HTML format (Clark, 2000).

To produce XML based applications, users can utilise XML authoring tools such as XML Spy™ by Altova, Xmetal™ by SoftQuad, MSXML™ by Microsoft and XPublish™ (for Apple Macintosh only) by Media Design in Progress. XML is the universal format for data on the Web. It allows developer to describe and deliver rich, structured data in a standard, consistent way.

### **Children's authoring programs**

A number of tools are available for children's use such as Isis, Cocoa, Eco World, Lego Sheets, Hyperstudio and CREATE Together. However, none of these allow the development of e-books following the printed book metaphor.

Content created using the software described above can easily be altered to follow the logical structure of books. This is achieved through the use of e-book compilers that are discussed in the next section.

### **2.4.5.3 E-Book Compiler Software**

Contents which have been developed and saved as HTML, text pages or sometimes PDF formats can be turned into a single executable file. This is achieved through the use of a software program called an e-book compiler.

A compiler can be defined as a piece of software that is designed to take a number of HTML or text pages and combine them into a single file. There are numerous compilers (see Figures 2.13, 2.14,

2.15, 2.16 and 2.17) on the market: EBook Edit Pro<sup>TM</sup>, Activ EBook<sup>TM</sup>, HyperMaker HTML<sup>TM</sup>, HTML Compiler Pro<sup>TM</sup>, NeoBook<sup>TM</sup>, Ebook Creator<sup>TM</sup>, ebook Generator<sup>TM</sup>, and WinEBook<sup>TM</sup>. For students or individuals who can not afford to buy commercial compilers, there are also free and trial compilers that can be downloaded from the Internet (e.g. Ebook Builder 4<sup>TM</sup> and KeeBook Creator<sup>TM</sup>).

Microsoft too has developed its own compiler, ReaderWorks<sup>TM</sup>, which supports Microsoft Word documents, text and HTML files, and the finished products are read using Microsoft Reader. Other tools, which can be used to build Microsoft Reader e-books, include Microsoft Reader add-in for Microsoft Word 2000<sup>TM</sup>, Microsoft Reader Content SDK<sup>TM</sup>, and Mobipocket Publisher<sup>TM</sup> (go to Microsoft's Web site for more information). To create PDF files, users can use Gymnast<sup>TM</sup>, freeware by Robert Schifreen<sup>9</sup>, which supports hyperlinks, annotations, and automatic generation of bookmarks from headings (Norshuhada et al., 2002a; 2002b).

Each compiler has its own set of features. Some have more features than the others, some have similar features and some have features unique to their compilers only. More detail on the features of HyperMarker<sup>TM</sup> and ebook Generator<sup>TM</sup> can be found on their Web sites. Almeida (2001) provides a review of most of the compilers listed earlier.

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<sup>9</sup> For more information on this product, visit his Web site at [http://www.pdfzone.com/products/software/tool\\_Gymnast.html](http://www.pdfzone.com/products/software/tool_Gymnast.html)



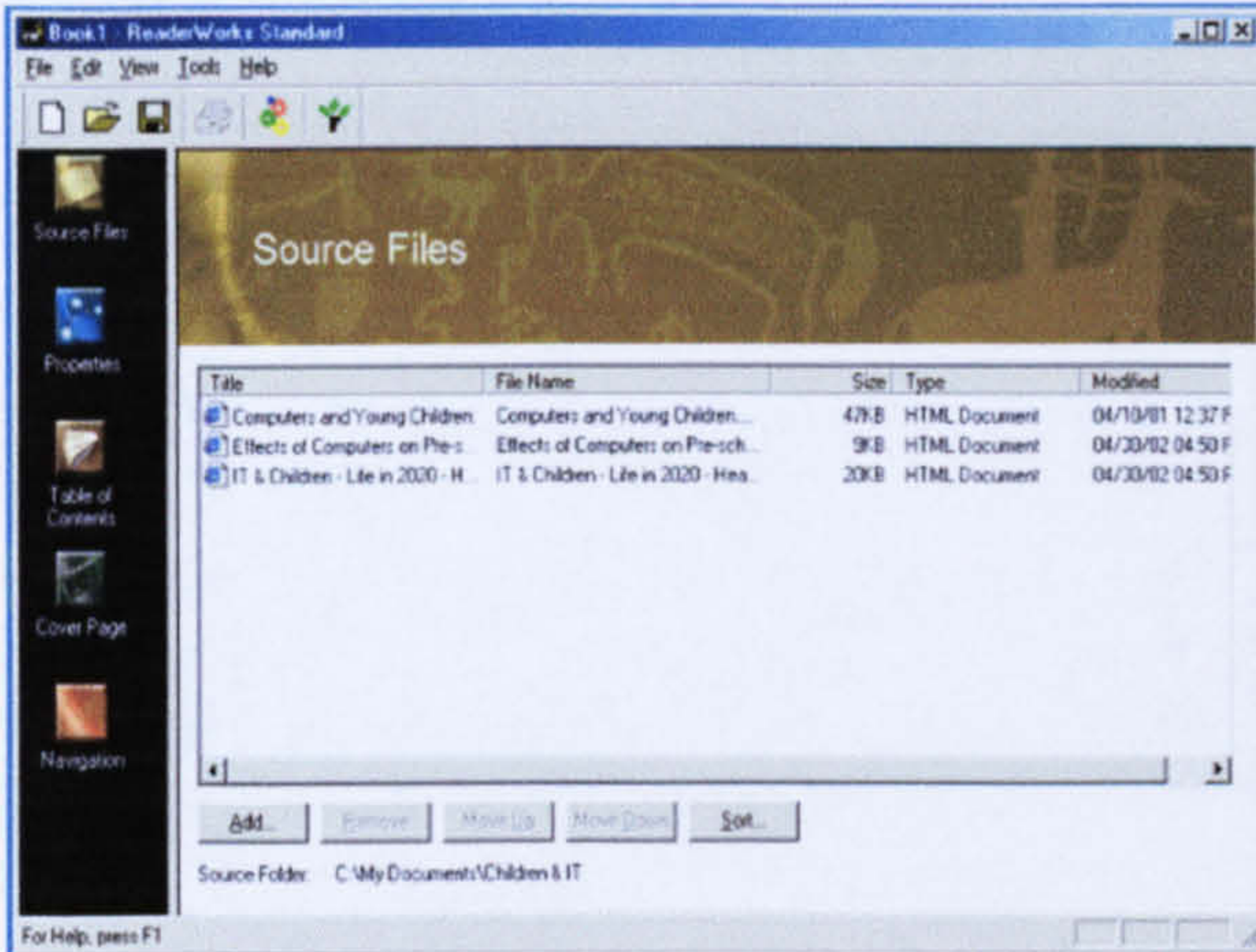


Figure 2.13: Microsoft ReaderWorks interface

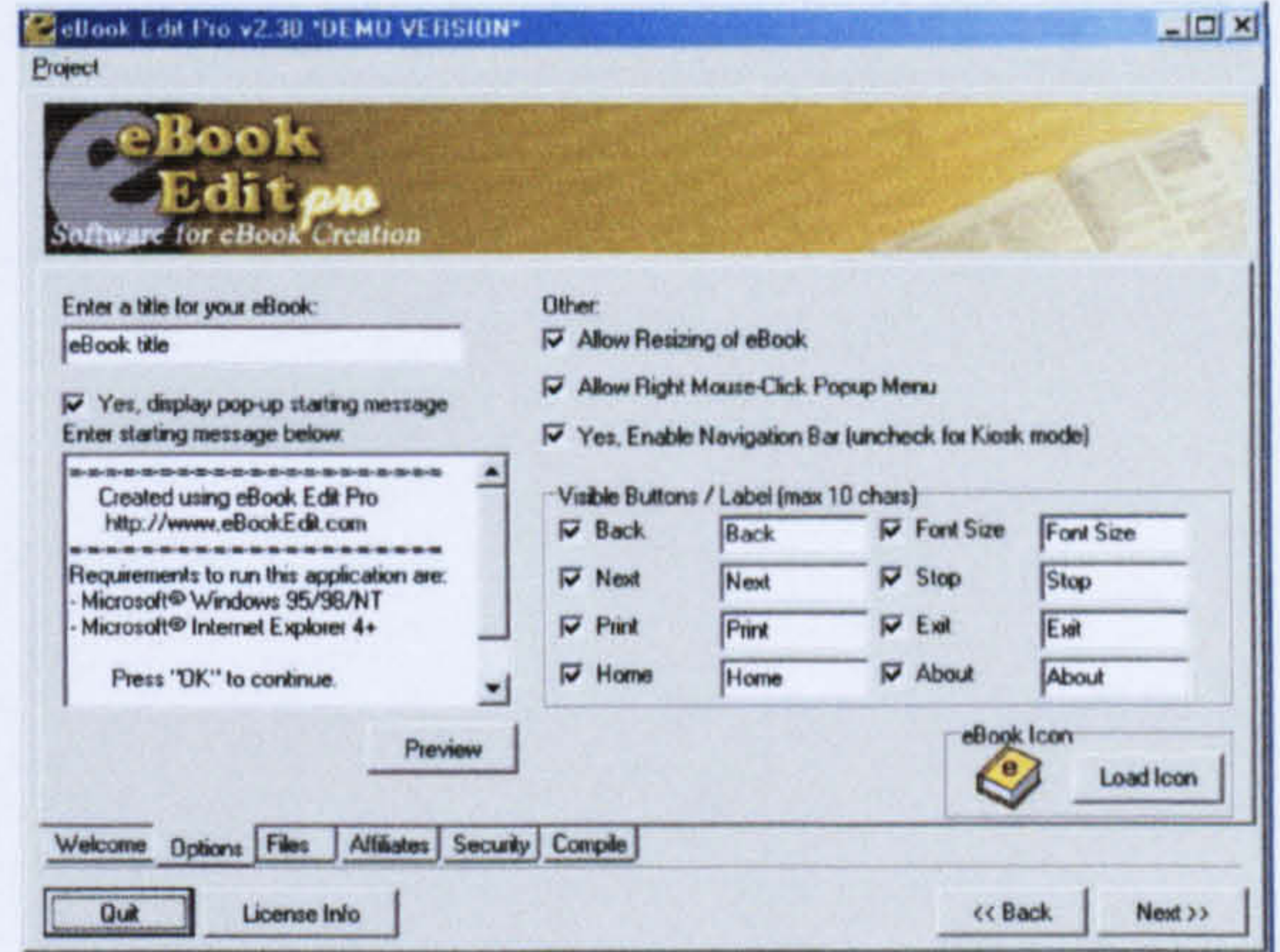


Figure 2.14: eBook Edit Pro interface

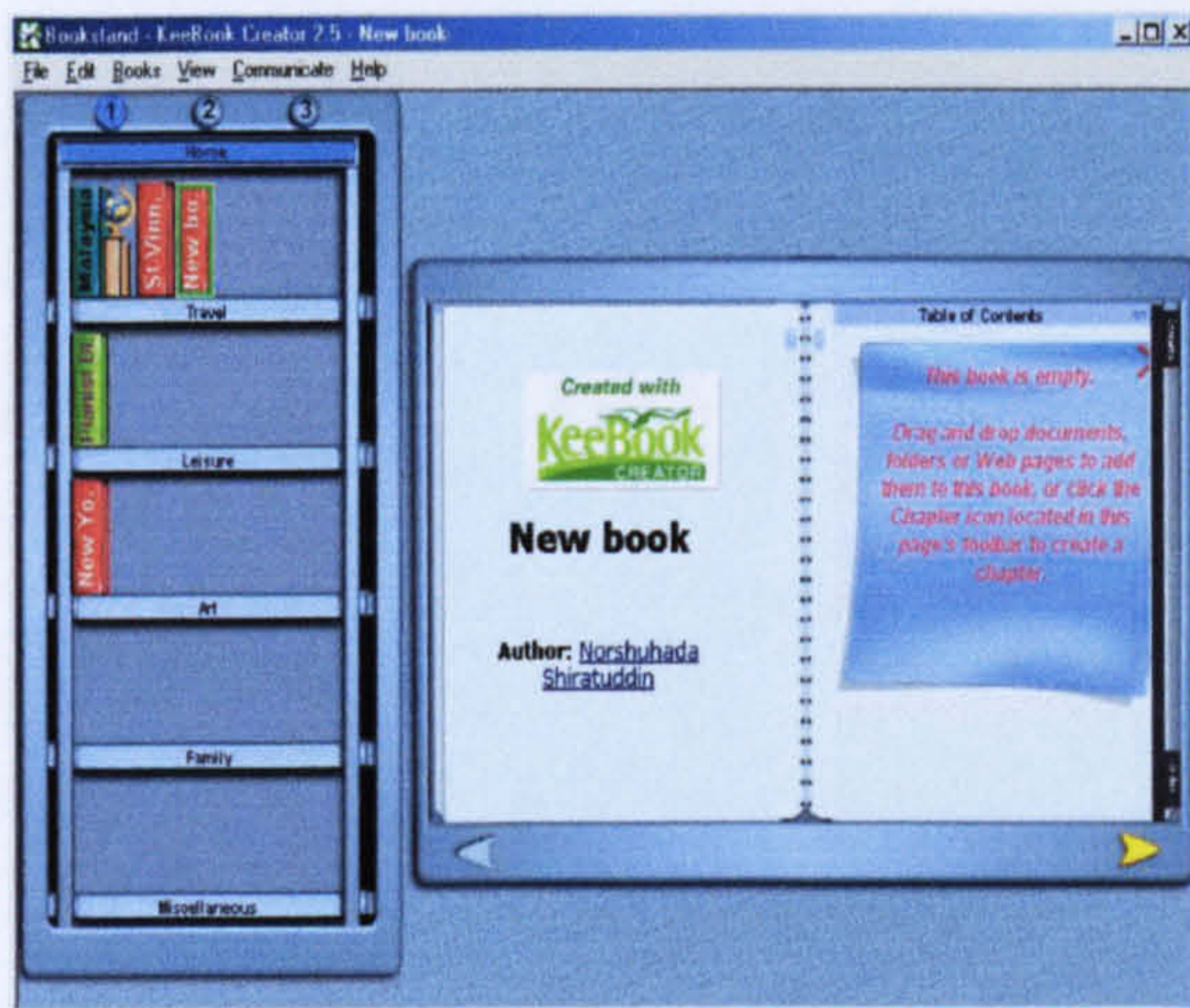


Figure 2.15: KeeBook Creator interface

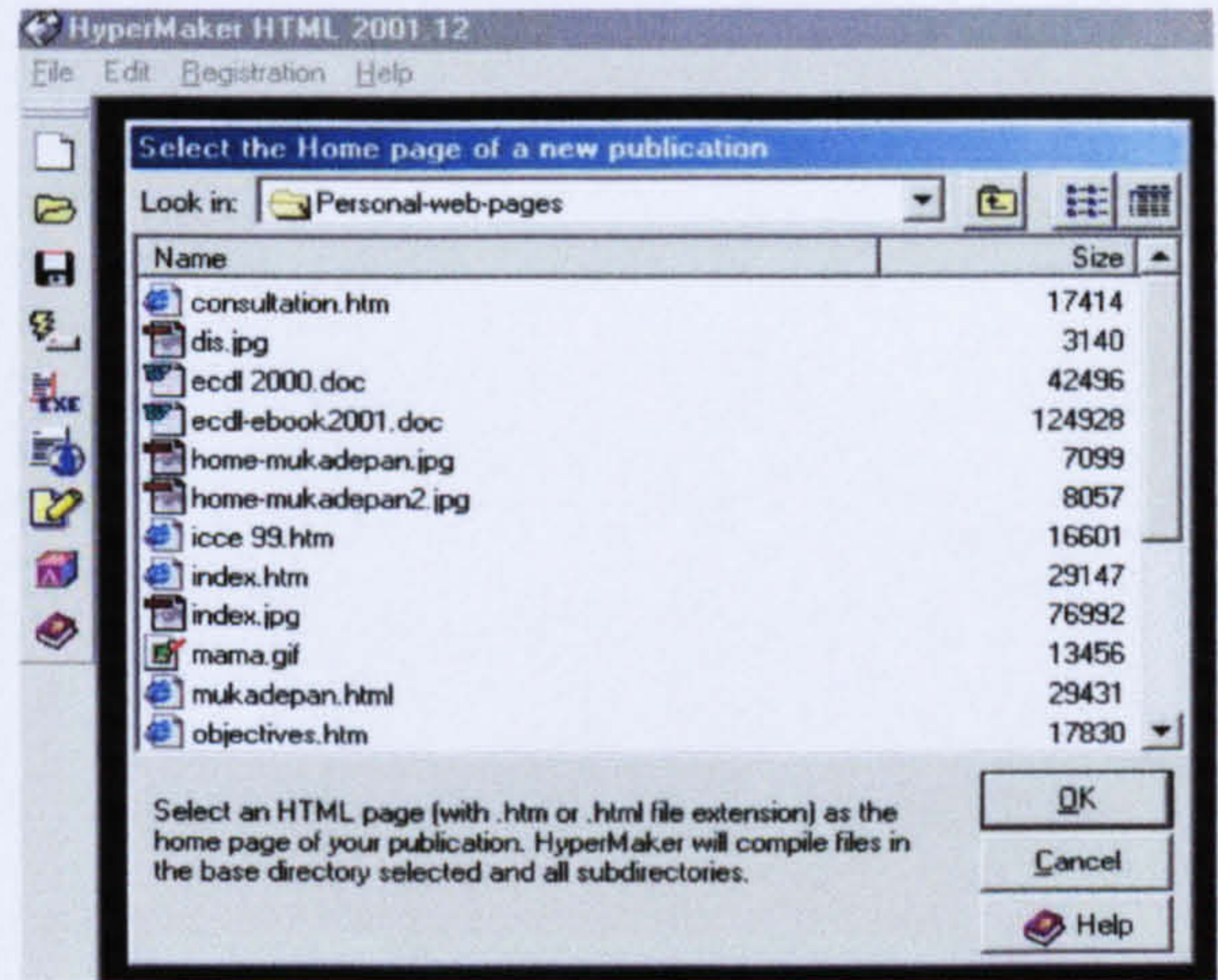


Figure 2.16: HyperMarker interface

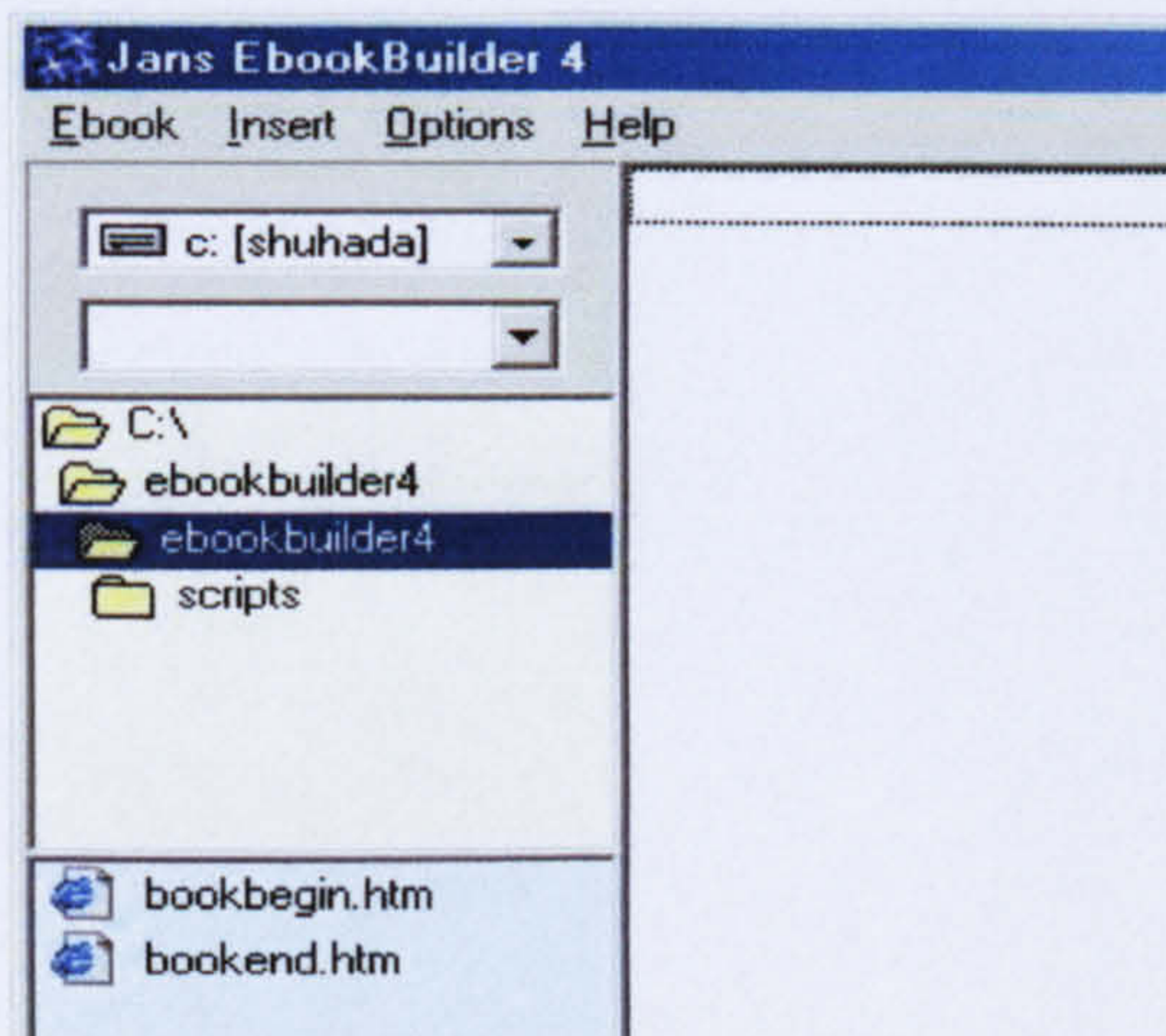


Figure 2.17: EBook Builder 4 interface



#### 2.4.5.4 Submitting Manuscripts

There are a number of resources, which give advice and guidelines for authors who are interested in publishing e-books. A typical example is Writing-World.com where information on publishing processes can be found. There is also a directory (eBook Writer's Market Directory) that lists more than 300 e-book publishers and e-book stores that accept submissions. Among the popular ones are: OzoneBooks.com, Atlantic Bridge Publishing, Artemis Press, Bogsidebooks.com, Books Onscreen, BookZone, Crystal Star Publishing, Ebook Express and eBook Mall.

Some publishers require submissions to follow certain guidelines to ensure easy conversion to their e-book format. For instance, Webs4Kids.com, a publisher of children's e-books to be read using Microsoft Reader asks the following:

- files must be in plain ASCII (.txt) format;
- manuscripts must consist only of these characters A – Z, 0 – 9, “ = : ? £ \$ % & ( ) - + @ ! , .
- manuscripts must be divided into chapters, and saved as a separate file for each chapter;
- each chapter must be numbered in sequence, and the chapter number must be included on the first line;
- manuscripts must be unformatted;
- image size is not larger than 510x680 pixels, and be in .JPG or .GIF format only.

Authors have three e-publishing choices: commercial, subsidy<sup>10</sup> and self-publishing (Henke, 2001). Commercially published e-books are sold primarily through the publisher's Web site and online bookstores. Authors pay no publication fee, and receive

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<sup>10</sup> Subsidy publishing is also known as vanity publishing.



royalties. Subsidy e-publishers produce and distribute books for a fee, and authors receive royalties. Unlike commercial published books, manuscripts for subsidy books are usually accepted regardless of their quality, and publishers do not provide editorial services or proof-reading, and the responsibility for promoting a book rests primarily with the authors (Henke, 2001; Allen, 2000). In self-publishing, authors are responsible for the entire process of publishing their books, from development to marketing. More detailed information about these publishing choices is discussed in Henke (2001) and in van Buren and Cogswell (2001).

Having described how to produce and publish e-books, the next section reviews existing examples of e-books in order to gain some insights into good and bad practice.

## **2.4.6 E-Book Initiatives**

Some good examples of e-books are reported in Landoni (1997). She discussed examples of two basic types and introduced the terms “page-turner books” and “scrolling books”. A recent addition to her classification revealed during this study is another type of e-book which exhibits both page-turner and scrolling book features – the “page-turner plus scrolling books”.

### **2.4.6.1 Page-Turner Books**

Page-turner books can either be those which imitate the original paper book (i.e. displays of original images of the book pages) as found in many PDF format books - for example the book by Dupre (1996) - or books that imitate the book metaphor as in the Hyper-Book project (Catenazzi, 1993), Visual Book (Landoni, 1997) and Kaiser’s Web Book (1996).



The Hyper-Book, and Kaiser's Web Book are more hypertext oriented which in a way gives additional advantage over the paper versions. The Hyper-Book and Visual Book both provide a mixture of paper and computer-related services to their users. There are navigation tools for users to flip and turn pages: the table of contents and index can become active pages, and users are able to annotate and insert bookmarks. In addition, users are also provided with printing, zooming and searching facilities.

“The Joy of Visual Perception: A Web Book” by Kaiser (1996) takes advantage of colour graphics, animated figures and graphs. In other words, in this book, text supplements the extensive use of graphics. As a consequence, to use this book on the Web it is important to have graphics capabilities in the browser.

The purpose of this book is to stimulate interest in the sense of vision and encourage users to find out more about visual perception. The book makes use of the paper book metaphor but without the option of a two-page mode display. It includes a table of contents, hyperlinked indexes and references. Pages are written to fit users' display screens so they do not have to scroll up and down or left and right (see Figure 2.18 for a screen shot of the book).

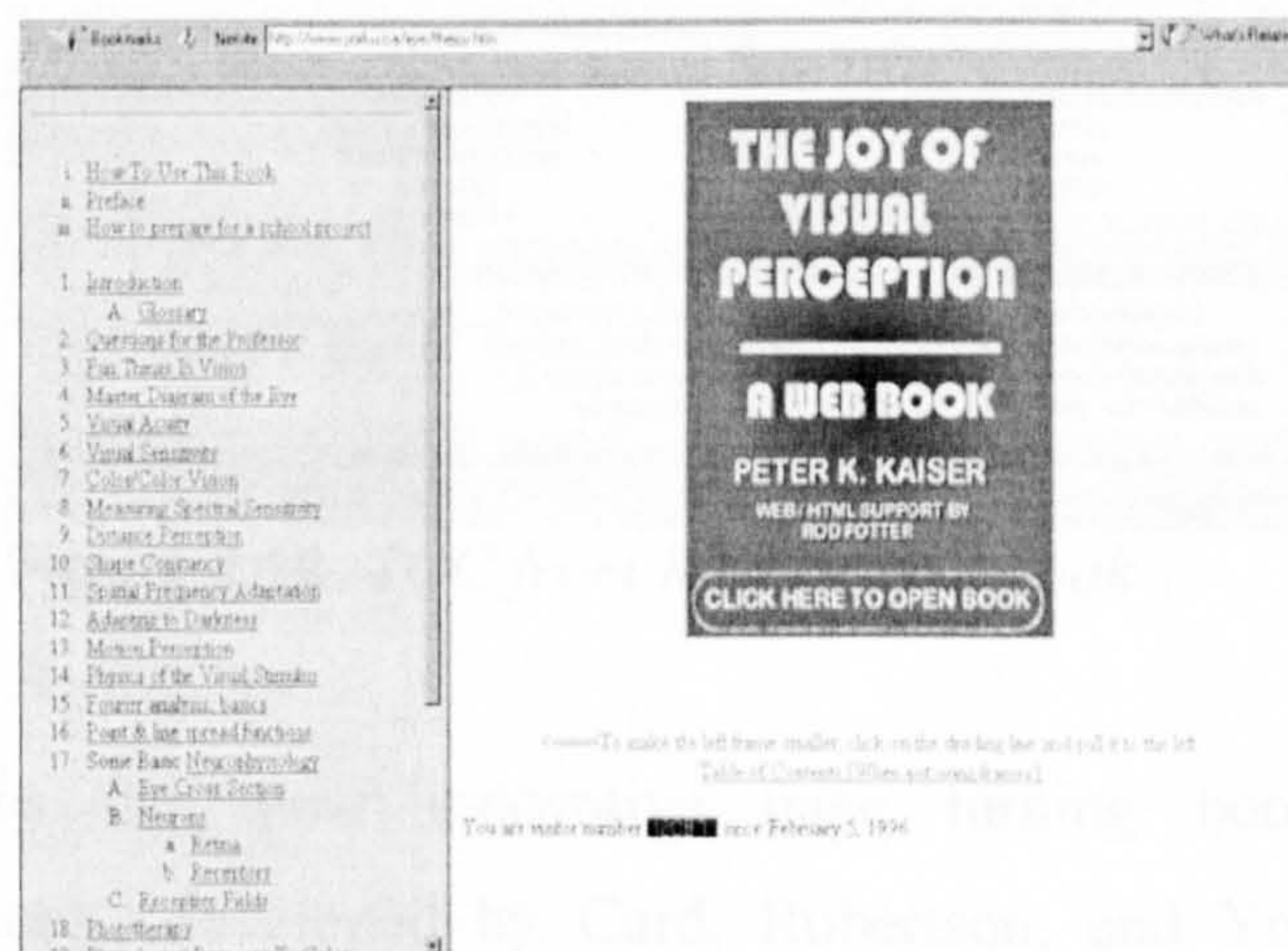


Figure 2.18: An e-book by Kaiser



The e-books described above are examples of books used for learning which are in the textual category (i.e. the content is mostly text). Examples of other books which simulate the page turning concept but which are used for different purposes (such as leisure and reference) are a novel by Pesci (2000) and the Stanford Encyclopedia of Philosophy (2000), respectively.

An example of a multimedia book in this category is that created by Rubinstein (1998). His book blends text, graphics, slides, audio, computer application and Internet access. Users can jump to desired topics by using built-in navigation features. Internet sites can be reached through highlighted hypertext. Definitions of terms and notation, additional information about selected subjects, numerical examples, recorded sound and video clips, and interactive computer applications are incorporated through buttons and icons (refer Figure 2.19).

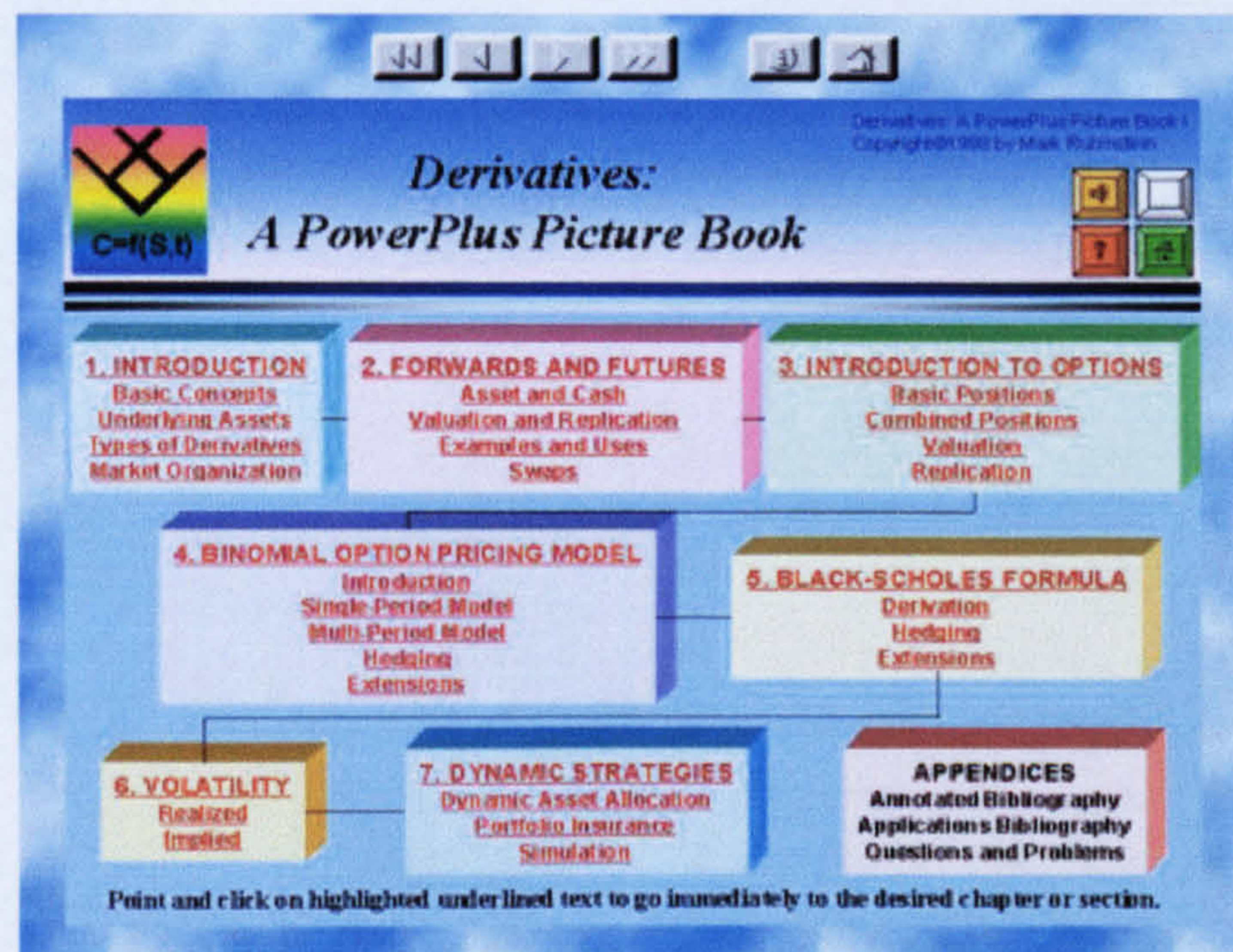
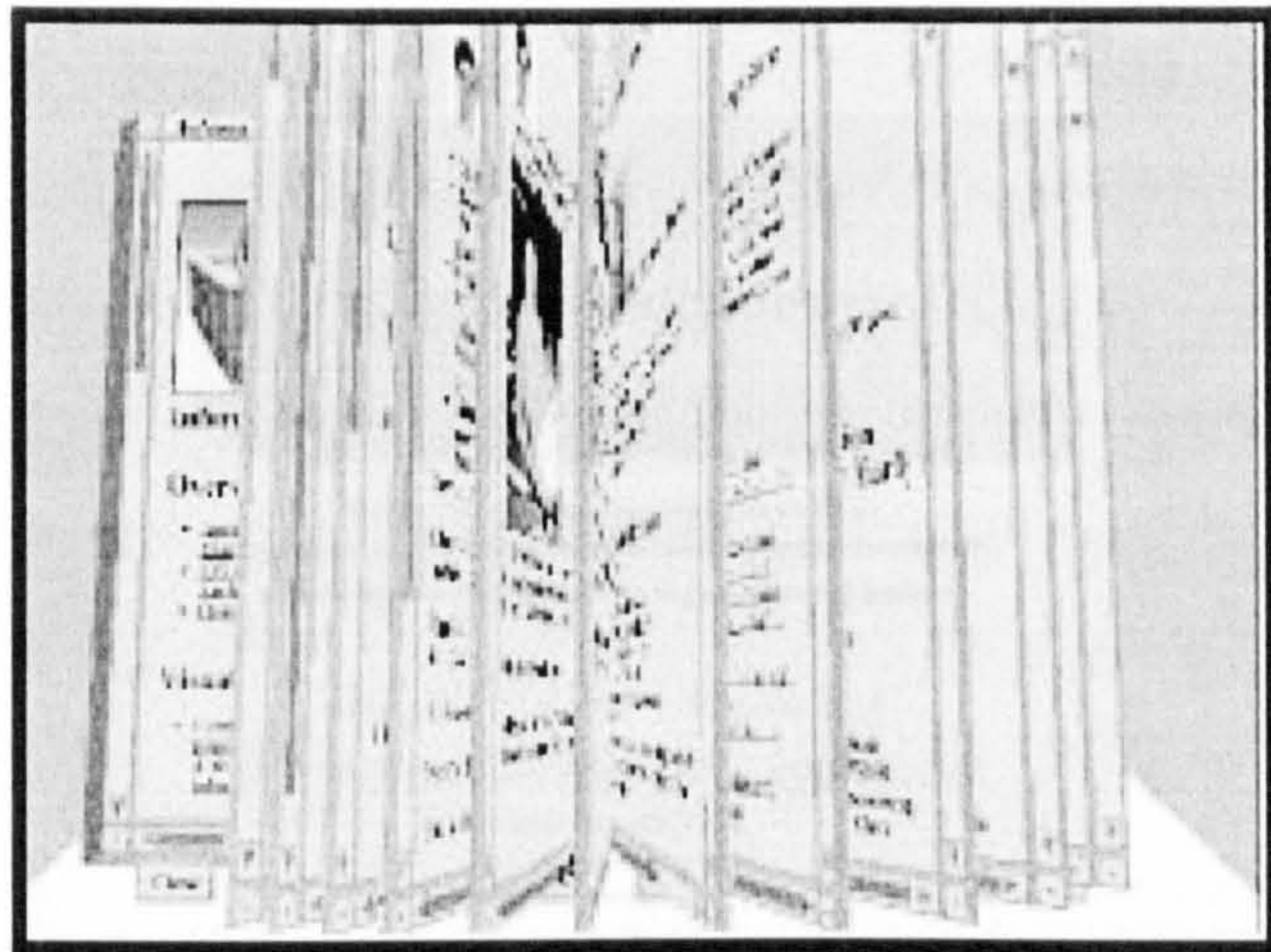


Figure 2.19: TOC from Rubinstein's book

Probably the most innovative page turning book is the "WebBook" developed by Card, Robertson, and York (1996) from Xerox Palo Alto Research Center in California. It is a 3D



interactive book of HTML pages. Each page of the WebBook is a page from the Web. Users can ruffle through the pages (see Figure 2.20) by clicking and holding the mouse button down. In addition, the font can be scaled whereby images remain the same size but the text changes size. Moreover, users can leave a bookmark on any page. When the book is closed, a bookmark is automatically left for the last page that was viewed.



**Fig. 2.20:** *Example of ruffling pages in a WebBook*

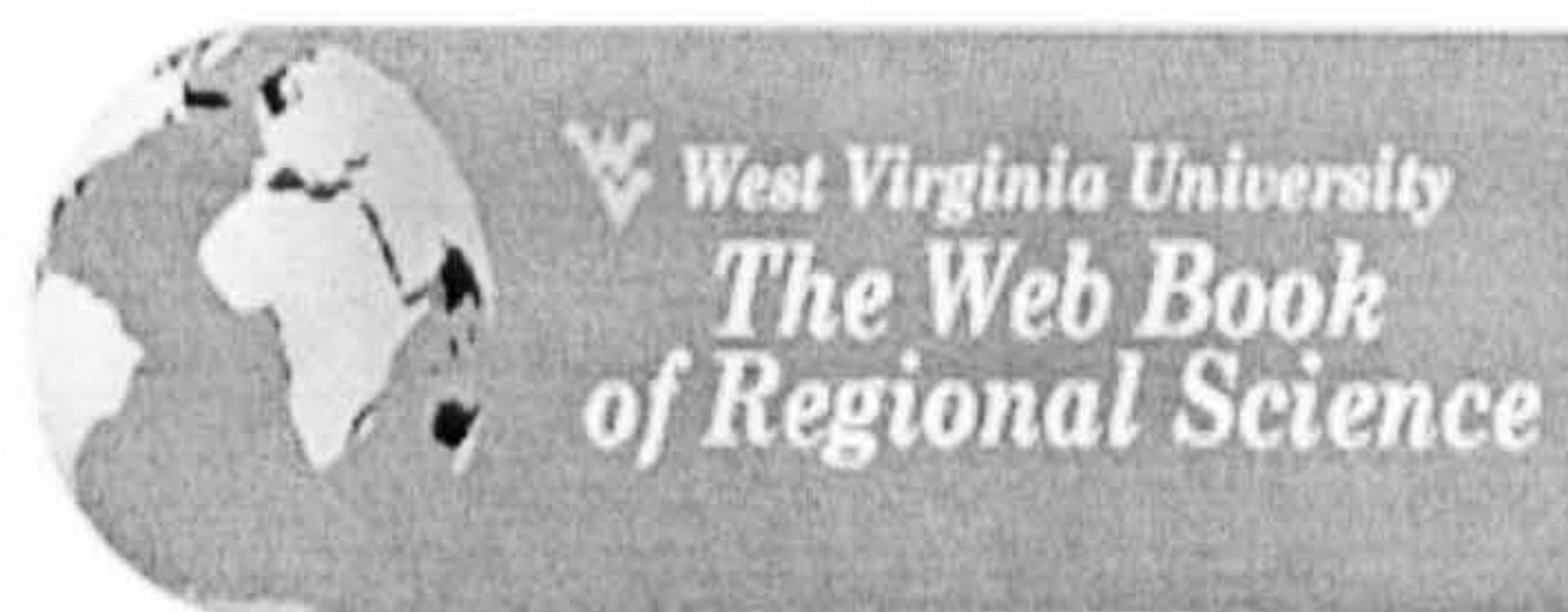
#### **2.4.6.2 Scrolling Books**

Scrolling books are ones where text is presented according to a scroll metaphor (Landoni, 1997). The text scrolls limitlessly (until the end of the book) and page numbers no longer exist. Consequently, users can easily get lost in the flow of the content. Nonetheless, these types of book maintain the logical structure of paper books whereby content is still divided into chapters, sections and subsections.

There are two kinds of scrolling book. The first type displays its content all at once and requires users to scroll from the start to the end of the book as evident in “The Egyptian Book of the Dead” (Hansson, 1998). The second type displays content according to



chapters or sections; that is, one chapter or one section at once. In order to read the material, users scroll only within a particular chapter/section, thus requiring scrolling chapter by chapter or section by section instead of the whole book. The “Analysis of Land Use Change: Theoretical and Modeling Approaches” by Briassoulis (2000) (see Figure 2.21) and the “Molecular Biology Web Book” produced by Web Book Publication (2002) are good examples of this kind of book.



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*Analysis of Land Use Change:  
Theoretical and Modeling Approaches*

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1 Introduction

1.1 Overview of Issues Related to Land Use Change

1.2 The Purpose of the Analysis of Land Use Change

1.3 Defining Land, Land Use and Land Use Change

1.3.1 Land

1.3.2 Land Use and Land Cover

1.3.3 Land Use Change and Land Cover Change

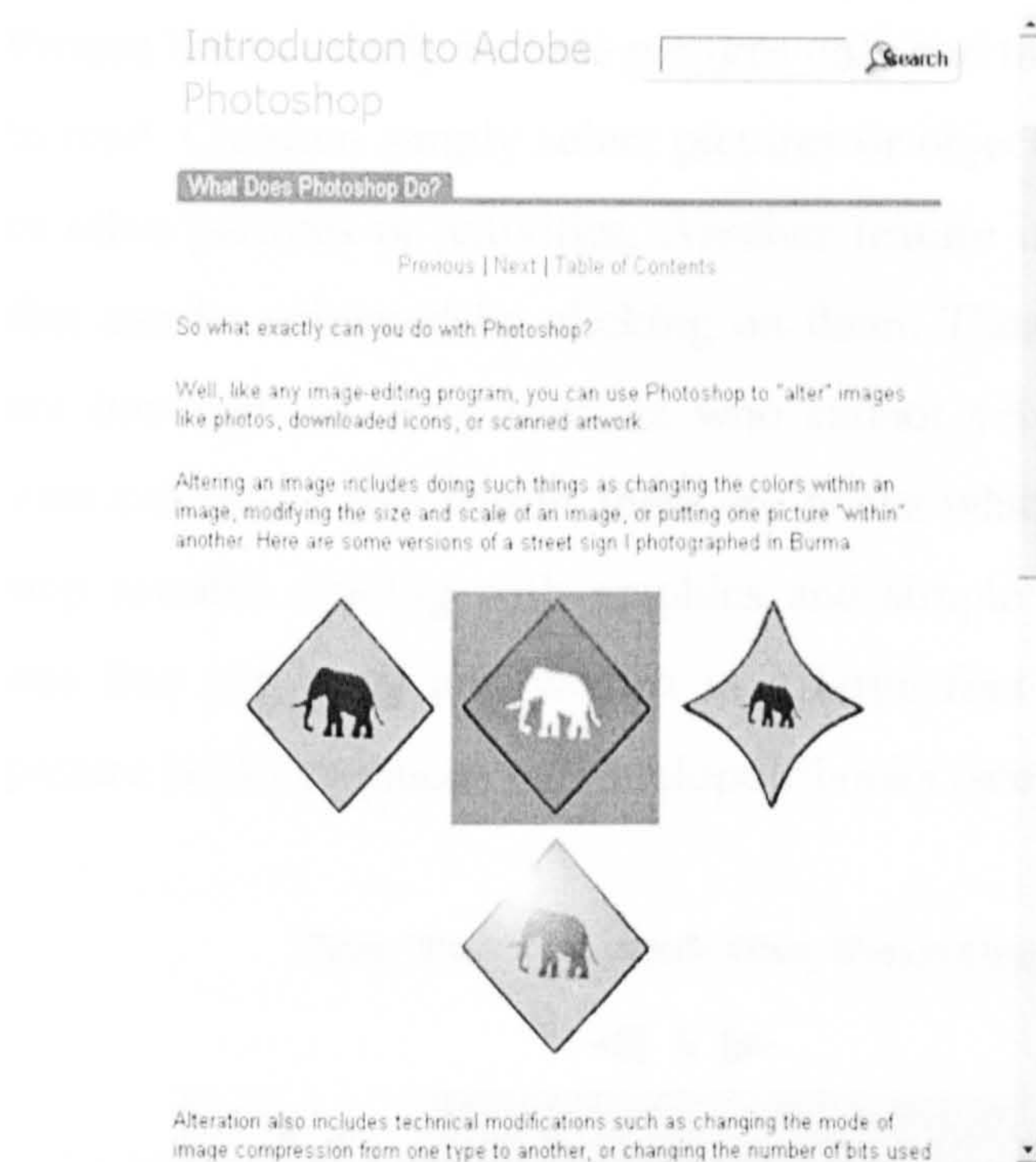
**Figure 2.21:** TOC from “Analysis of Land Use Change: Theoretical and Modeling Approaches”

### 2.4.6.3 Page-Turner Plus Scrolling Books

These types of e-book exhibit both page-turner and scrolling-book features. Pages in such books usually require each page to be turned (for new pages) and scrolled (for more information on that particular page). “An Introduction and Guide to the World of Electronic Books” at [ebookconnections.com](http://ebookconnections.com), “Introduction to Adobe Photoshop” by eXtropia (2002) (see Figure 2.22), “Introduction to Web Design” (eXtropia, 2002), and “Handbook



of Information Security Management” (Krause & Tipton, 1997) are examples of such books.



**Figure 2.22:** A page in “Introduction to Adobe Photoshop”

#### 2.4.6.4 Children’s Books

The three classifications discussed earlier (i.e. page-turner, scroll, and page-turner plus scroll) illustrate some possible book navigation methods. Not all methods apply to children as pointed out by Nielsen (2002) recently. According to his findings, children rarely scrolled pages and they mainly interacted with information that was visible to them. He also added that animation and sound effects were positive design elements for children. Accordingly, the existing e-book initiatives especially children’s books can also be grouped into at least the following three categories, usually for the purpose of learning or story telling (see Barker, 1992; 1999; Bartolome, 1995 for more classifications and their definitions):

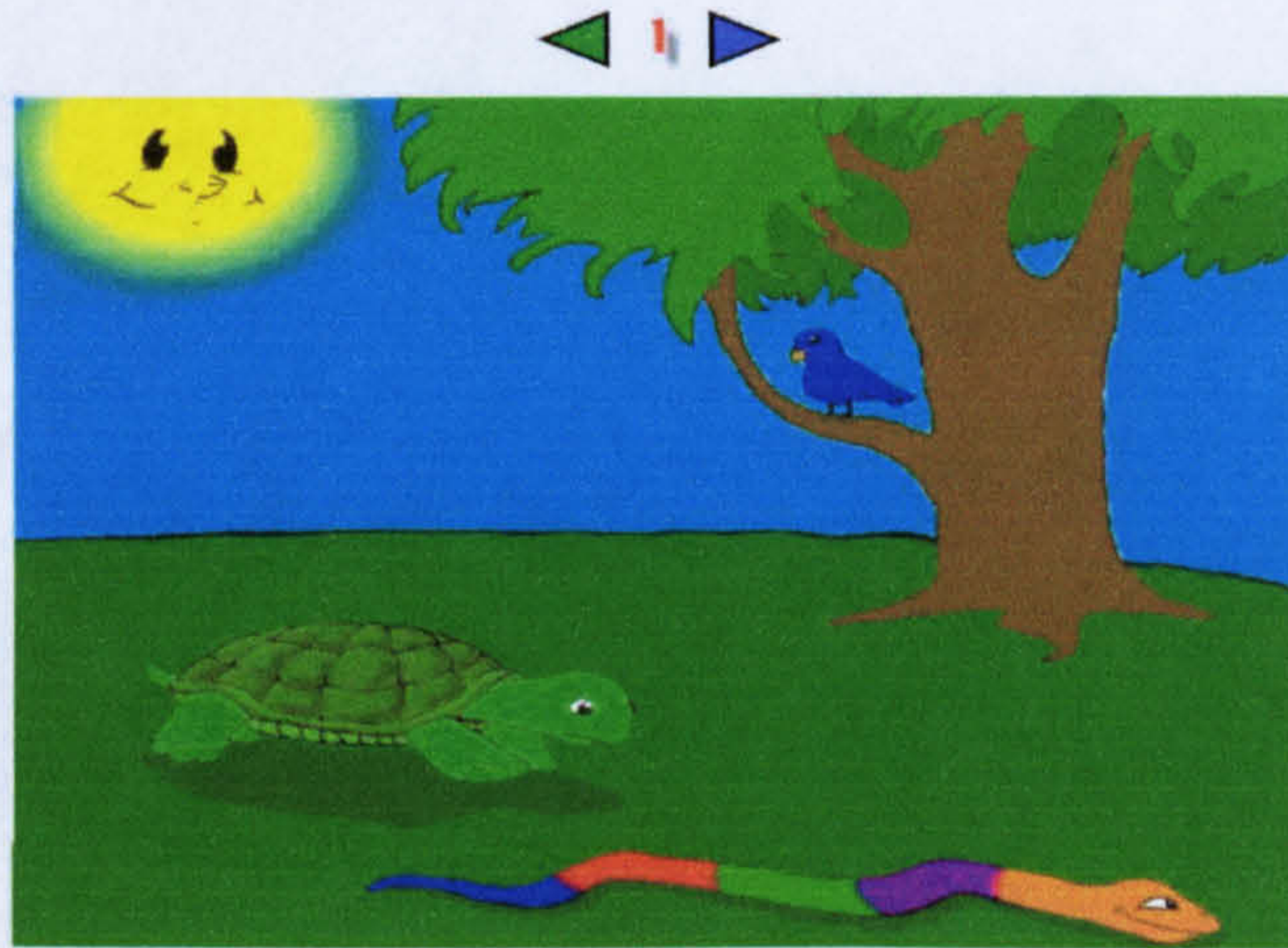
- picture books;



- audio books;
- multimedia or hypermedia books.

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. Another feature includes graphics that can be animated by clicking on them. These kinds of book are intended for early learners who cannot yet read. For those who can read a few words, there are books which provide a first step towards reading with graphics and simple sentences, often one line per page, and written in a large font size such as in picture books produced by Antelope-Ebooks (see Figure 2.23).

### **The Turtle and the Paintbox**

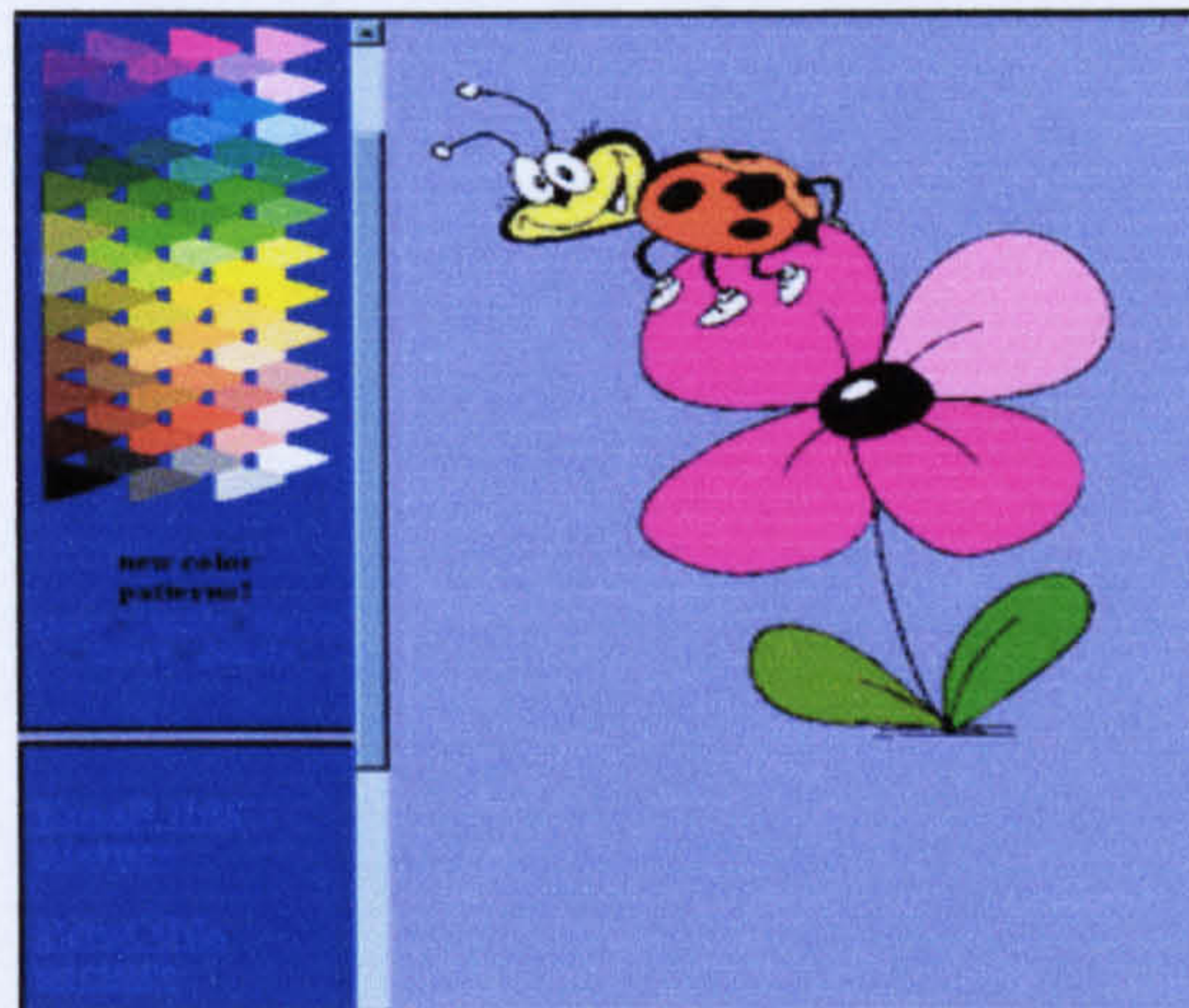


**Figure 2.23:** *Example of a picture book*

Other examples of picture books include a project developed by LiveAndLearn.com and Coloring.com. LiveAndLearn.com 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 (e.g. low and high, small and large, etc.).



Coloring.com provides various types of picture that children can colour (see Figure 2.24). The coloured pictures can then be printed, saved into the user's own art gallery, which is provided in the e-book or posted through email to friends and families.



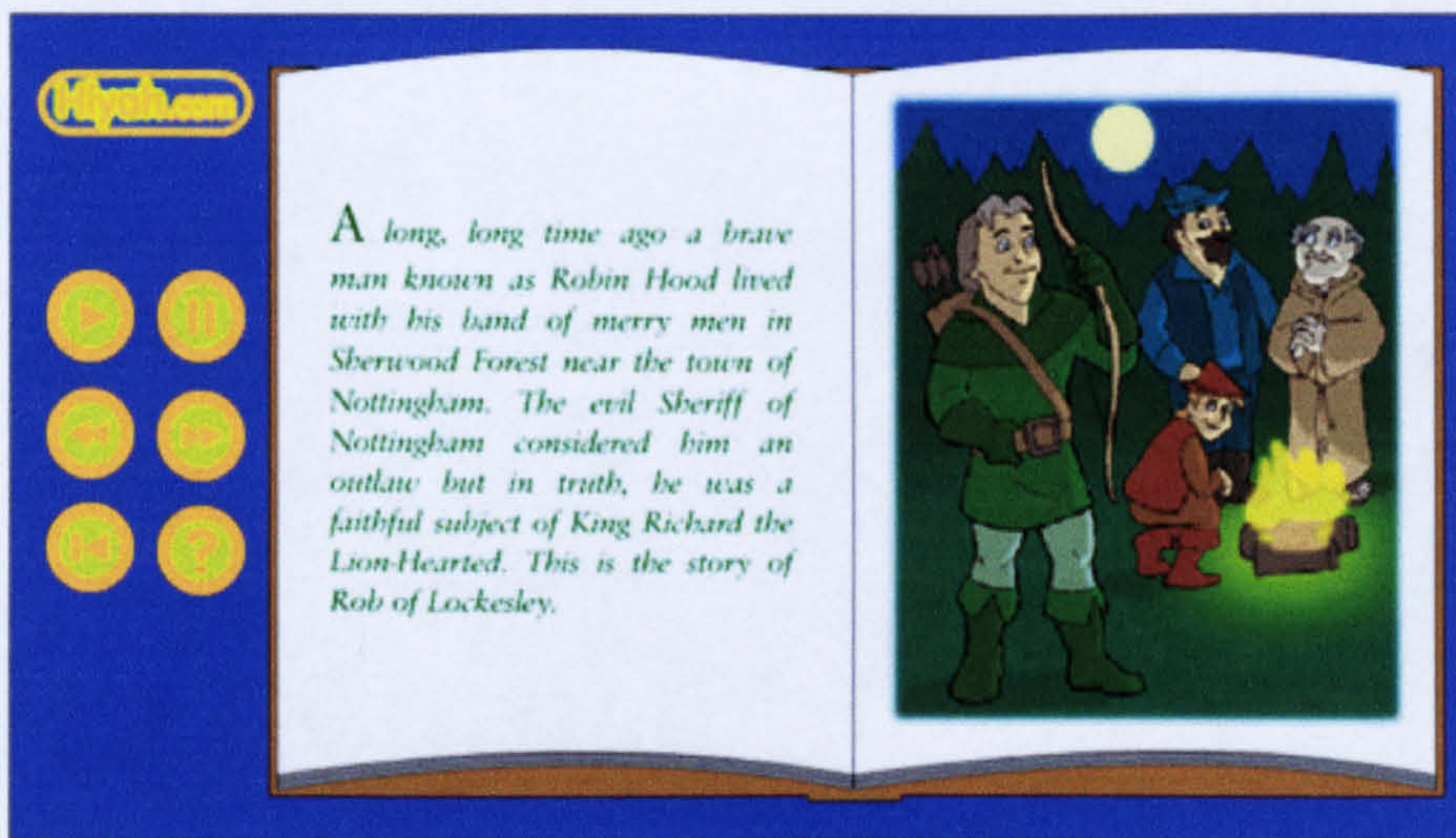
**Figure 2.24:** *An example of a colouring book*

Audio books are normally stored on cassettes or CD-ROM or delivered to listeners through email. The contents of the books are played back to the children and this is a particularly effective use of technology for children with disabilities such as visual impairment 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 voice (boy, girl, etc.). FictionWorks.com produces children's audio books with titles for example by Townsend (2000). The Audio Book Club (2002) provides users with free books which are emailed to members.

Multimedia books incorporate text, graphics, audio, animation/video in their content to provide a powerful experience for children (NCIP Library, 1998). If applied carefully, they can improve learning, and entertainment value (Hoogeveen, 1995). Antelope-Ebooks produces and publishes many kinds of e-book



including multimedia books. However, most of its books are used for the purpose of entertainment (i.e. storybooks, humour, cook books, fantasy and so on) with limited interactivity (mainly next and previous buttons) and include only graphics, background music and only a little low-quality animation. Hiyah.com, on the other hand produces multimedia books with more features which imitate the book metaphor (see Figure 2.25). Books are played back by the computer (i.e. the contents are read aloud) and children are provided with a pause button. Options are given whether 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 2.25:** *An e-book by Hiyah.com*

All the above-described examples are either stand-alone or Web based e-books. To read books that require a software-based reader, users can visit Webs4Kids.com site and download books to be read using Microsoft Reader. Webs4Kids publishes and sells e-books specifically for children aged between 6 to 14. They also include free e-books for popular titles such as “Aladdin and the Wonderful Lamp”, “Beauty and the Beast”, “Snow White” and “The Little Mermaid”.



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 the number of children's e-books has grown immensely.

The examples described so far are not primarily used for learning purposes. Children's learning books can be categorised into two types and are influenced by the theories on how children learn:

- edutainment;
- drill and practice.

Books in the first category are based on constructivist theory which acknowledges that children know a lot before they get to school and therefore the emphasis should be on providing tools that allow children to continue to learn new things as naturally as they are exploring their daily activities (Druin & Solomon, 1996; Alexander, 1999). In short, this theory adopts 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 active learning experiences (Blanchette & Kanuka, 1999). Additionally, the play element enables children to also stretch their young imaginations (Lopez, 1998).

Edutainment allows 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). Books in this category are most commonly found on CD-ROM with diverse titles by many companies including Edmark, Disney Interactive, Educational Activities Inc. and Mattel Interactive.



Drill and practice programs are usually the result of applying behaviorist theory which supports the concept of teachers as disseminators of information (Druin & Solomon, 1996). In this type of e-book, children are taught through a series of carefully moderated exercises (usually multiple-choice questions) at different levels of difficulty that address the same skill objective. Correct answers for questions are rewarded with points; however for incorrect answers, children are encouraged to try again. Although this type of e-book has been shown to raise children's test scores, their method of delivery easily becomes boring after a while (Druin & Solomon, 1996). Suppes (1969) is among the earliest researchers whose work is based on this approach.

Most of the learning materials developed for use in Malaysian schools belong to the drill and practice category (Gan, 1995). Clear examples are CD-ROMs developed and published by CIE Integrated Ltd. (1997) in accordance with the Malaysian Government School Syllabus. The CD-ROM encompasses Malay language, English and Mathematics subjects for school children ages 7 to 12. Each module comprises a set of lesson notes and exercises with suitable graphics and sound effects. The contents of the lessons have been directly converted from school textbooks.

Other initiatives in Malaysia include a project called "Bacaan Awal (BAWAL): Early reading package for children" (Halimah, 1997), multimedia titles currently under development by Educational Technology Section (BTP), Malaysian Ministry of Education<sup>11</sup> and Computer-Assisted Learning for primary school Geography/Kajian Tempatan (Norshuhada et al., 1997).

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<sup>11</sup> Full project descriptions can be found at <http://www2.moe.gov.my/~btp/multimedia.html>



Table 2.4 summarises children's e-book classifications and features.

**Table 2.4:** *Children's e-book classifications and features*

Type	Features
Picture books	<ul style="list-style-type: none"> <li>▪ Pictures only usually storybooks or colouring books;</li> <li>▪ Click objects to activate interactivity;</li> <li>▪ For very young children who can not yet read;</li> </ul>
Audio books	<ul style="list-style-type: none"> <li>▪ Contents are read aloud to children;</li> <li>▪ Rate of reading can be changed;</li> <li>▪ Sentences are highlighted while reading;</li> <li>▪ Options for different voices.</li> </ul>
Multimedia books	<ul style="list-style-type: none"> <li>▪ Incorporate multimedia elements;</li> <li>▪ Highly interactive;</li> <li>▪ Usually used for learning purposes and storytelling.</li> </ul>
Hypermedia books	<ul style="list-style-type: none"> <li>▪ Very similar to multimedia books except that they embed non-linear web-like information structure;</li> <li>▪ Incorporate multimedia elements;</li> <li>▪ Highly interactive;</li> <li>▪ Usually used for learning purposes.</li> </ul>

There are two problems currently faced by developers of e-books to support children's learning. Drill and practice applications (as discussed in previous section) are not what children want and the majority of edutainment products on the market today do not offer activities with enough variety so that children will engage for a longer period of time and use the books more than once (Druin, 1997; Druin & Solomon, 1996; Stearns, 1999). In their study, Foster and Wright (1996) found that a constructivist methodology (i.e. using hands-on and play activities to teach) is perceived by educators as the most appropriate for elementary children. The result of their study supports the notion that current learning approaches (favoured by educators and researchers) are active student involvement in the construction of knowledge, interaction with peers and adaptation of materials to individual needs. However, another study by Mioduser



et al. (1999) reveals that these favoured approaches are still far from being implemented in most educational technology innovations.

As noted in the above paragraph, e-books for learning should include activities and be adapted to individuals' needs. Therefore, relevant literature in this area was explored and presented in the following section.

## 2.5 Learning Styles

*“Learning materials should more likely correspond effectively with children's individual learning styles.” (Gan, 1995)*

Learning styles are simply the different approaches that people use to learn or a preferred and consistent set of approaches to learning (Blackmore, 1996; Litzinger & Osif, 1993). Additionally, a learning style can also be defined as the habitual mode of acquiring knowledge through study and experience (Beishuizen & Stoutjesdijk, 1999).

Studies on learning styles have made some general conclusions on the importance of understanding students' learning styles (O'Connor, 2000):

- students will learn better when using preferences in which they are successful;
- students will be better learners when they can expand their preferences;
- teachers can construct activities that include multiple or specific learning preferences.

Teachers who recognise the various learning styles among their students and can tailor instruction for them, can help students improve their attitudes towards learning, thereby increasing academic achievement and creativity along the way (Rockman, 1999). It has also been shown that adjusting teaching materials to meet the needs of a variety of learning styles benefits all students (Agogino & Hsi, 1995). When introduced into a learning environment that supports



individual learning styles, learners also have a higher level of understanding the materials (Gilbert & Han, 1999). In addition, it is suggested that in order to promote improved design of learning materials, knowledge about individual differences needs to be integrated and connected directly with the design process, so that the materials are not only flexible, but also supportive of diversity and capable of accommodating a wide range of learning styles (McLoughlin, 1999).

### 2.5.1 Children's Learning Styles

*“Students have different learning styles, characteristics, strengths and preferences in the ways they take in and process information. Some students tend to focus on facts, data, and algorithms; others are more comfortable with theories and mathematical models. Some respond strongly to visual forms of information, like pictures, diagrams, and schematics; others get more from verbal forms, written and spoken explanations. Some prefer to learn actively and interactively; others function more introspectively and individually. Functioning effectively in any professional capacity, however, requires working well in all learning style modes.”* (Felder, 1996)

Smart School teachers will be enabled, through the use of technology, to consider students' individual learning preferences in designing and recommending instructional methods and materials. There is a need to deal with a diversity of skills, abilities, and enthusiasm levels in every group of students. A growing body of research suggests that many students have learning styles that are not catered for in traditional classroom environments, thus to accommodate the diversity, teachers should ensure that they include a variety of different types of lesson and learning experience (Malaysian Smart School: A Conceptual Blueprint, 1997; Felder, 1996).



There are many learning style theories (or some people called models). Typical examples of these are: Myers-Briggs Type Indicator (McCaulley, 1990), Kolb's Learning Style Model (Kolb, 1984), Herrmann Brain Dominance Instrument (Herrmann, 1990), Felder-Silverman Learning Style Model (Felder & Silverman, 1988), and Gardner's Multiple Intelligences Theory (Gardner, 1993). Gardner's theory is considered by experts as among the most suitable for a children's application (see section 2.5.1.1.5).

Which theory educators choose is almost immaterial (Felder, 1996), since the instructional approaches that teach around the cycle for each of the models are essentially identical. Whether educators are designing a course or curriculum, writing a textbook, developing instructional software, forming co-operative learning teams, or helping students develop interpersonal, leadership, and communication skills, they will benefit from using any of these theories as the basis of their efforts. However, in this study, Multiple Intelligences (MI) theory was selected mainly for the following reasons:

1. it is mentioned in the Smart School Blueprint;
2. it has been proven to suit children (Edwards, 1999);
3. it has attracted a lot attention from teachers world-wide (refer to section 2.5.1.2 for proof of studies).

In the next section, five learning style theories (including MI theory) are described. The other four learning style theories are selected because their descriptions are closely similar to MI. It should be noted that no attempts were made by the researcher to explore these four theories in depth. These theories are described here mainly to show readers that there are other available learning styles theories, which exhibit some similarities between themselves and with Gardner's MI theory. The major parts of this section are directed at MI theory.



## **2.5.1.1 Learning Style Theories**

### **2.5.1.1.1 The Myers-Briggs Type Indicator (MBTI)**

This theory classifies students according to their preferences on scales derived from psychologist Carl Jung's theory of psychological types. Students may be:

- extraverts (try things out, focus on the outer world of people) or introverts (think things through, focus on the inner world of ideas);
- sensors (practical, detail-oriented, focus on facts and procedures) or intuitors (imaginative, concept-oriented, focus on meanings and possibilities);
- thinkers (skeptical, tend to make decisions based on logic and rules) or feelers (appreciative, tend to make decisions based on personal and humanistic considerations);
- judgers (set and follow agendas, seek closure even with incomplete data) or perceivers (adapt to changing circumstances, resist closure to obtain more data).

The MBTI type preferences can be combined to form 16 different learning style types. For example, one student may be an ESTJ (extravert, sensor, thinker, perceiver) and another may be an INFJ (introvert, intuitor, feeler, judger).

### **2.5.1.1.2 Kolb's Learning Style Theory**

This theory classifies students as having a preference for concrete experience or abstract conceptualisation (how they take information in), and active experimentation or reflective observation (how they internalise information). The four types of learners in this classification scheme are:

- Type 1 (concrete, reflective). A characteristic question of this learning type is "Why?" Type 1 learners respond well to



explanations of how course material relates to their experience, their interests, and their future careers. To be effective with Type 1 students, an instructor should function as a motivator.

- Type 2 (abstract, reflective). A characteristic question of this learning type is "What?" Type 2 learners respond to information presented in an organised, logical fashion and benefit if they have time for reflection. To be effective with this type of student, an instructor should function as an expert.
- Type 3 (abstract, active). A characteristic question of this learning type is "How?" Type 3 learners respond to having opportunities to work actively on well-defined tasks and to learn by trial-and-error in an environment that allows them to fail safely. To be effective with this type of student, an instructor should function as a coach, providing guided practice and feedback.
- Type 4 (concrete, active). A characteristic question of this learning type is "What if?" Type 4 learners like applying course material in new situations to solve real problems. To be effective with this type of student, an instructor should stay out of the way and maximise opportunities for students to discover things for themselves.

#### **2.5.1.1.3 Herrmann Brain Dominance Instrument (HBDI)**

This theory classifies students in terms of their relative preferences for thinking in four different modes based on the task-specialised functioning of the physical brain. The four modes or quadrants in this classification scheme are:

- Quadrant A (left brain, cerebral) - logical, analytical, quantitative, factual, critical;
- Quadrant B (left brain, limbic) - sequential, organised, planned, detailed, structured;



- Quadrant C (right brain, limbic) - emotional, interpersonal, sensory, kinesthetic, symbolic;
- Quadrant D (right brain, cerebral) - visual, holistic, innovative.

#### **2.5.1.1.4 Felder-Silverman Learning Style Model**

This model classifies students as:

- sensing learners (concrete, practical, oriented towards facts and procedures) or intuitive learners (conceptual, innovative, oriented toward theories and meanings);
- visual learners (prefer visual representations of presented material - pictures, diagrams, flow charts) or verbal learners (prefer written and spoken explanations);
- inductive learners (prefer presentations that proceed from the specific to the general) or deductive learners (prefer presentations that go from the general to the specific);
- active learners (learn by trying things out, working with others) or reflective learners (learn by thinking things through, working alone);
- sequential learners (linear, orderly, learn in small incremental steps) or global learners (holistic, systems thinkers, learn in large leaps).

#### **2.5.1.1.5 Howard Gardner's Multiple Intelligences (MI) Theory**

*“Varying teaching techniques to target different types of intelligences allows teachers to play to the different strengths of children represented in a classroom, thereby producing more positive learning experiences for everyone. Exploring a particular theme through five or six different intelligence areas can be a particularly effective way of teaching to the entire classroom.”*  
(Burrell, 1999)



Children learn in at least seven different ways; verbal/linguistic (word smart), logical-mathematical (number smart), visual/spatial (picture smart), bodily-kinesthetic (body smart), musical (music smart), interpersonal (people smart) and intrapersonal (self smart). Each child could learn in any one of these ways or through a combination of several ways (Gardner, 1993; Gardner, 1991; Armstrong, 1994; Armstrong, 1995; Al-Rawahi, 1996; Edwards, 1996; William, 1998; Berg, 1999; Winters, 1996; Campbell, 1997).





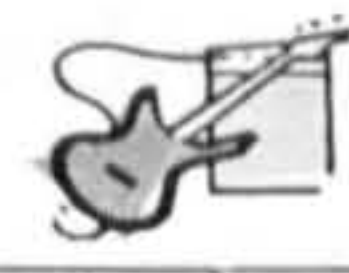


These learning styles originate from a theory suggested by Howard Gardner (1993). According to Gardner there exists at least seven types of intelligence in each individual and we are able to know the world through language, logical-mathematical analysis, visual representation, musical thinking, the use of the body to solve problems, an understanding of other individuals, and an understanding of ourselves. Where individuals differ is in the strength of these intelligences. Since we possess different kinds of intelligence, we therefore learn, remember, perform and understand in different ways. This theory has proven to provide educators with concrete strategies for addressing the needs of every learner (Thornburg, 1998; Veenema & Gardner, 1996).

Gardner defines intelligence as the capacity to solve problems. His definition deviates significantly from established practices in the field of intelligence. Most definitions focus on the capacities that are important for success in school. In sharp contrast, in his formulation, a candidate's ability emerges as intelligence<sup>12</sup> (Gardner & Hatch, 1990). Gardner believes all children possess all the intelligences. The difference lies in the degree or amount of each of the intelligence they possess. Each child can learn how to strengthen each of his/her intelligences. The job of a teacher (and learning materials) is to help children develop each intelligence to its fullest



extent. Table 2.5 describes the difference between the learning styles and Table 2.6 shows the activities associated with each style.

**Table 2.5:** *Descriptions of learning styles*

A child is verbal/linguistic if he/she loves words and enjoys reading, writing and story telling.	
A logical-mathematical child is more interested in concepts, numbers and scientific exploration.	
A visual/spatial child learns best through pictures and images, enjoys art and mentally visualises things easily.	
A bodily-kinesthetic child needs to move and touch to learn.	
A musical child uses rhythm and melody to learn.	
An Interpersonal child learns best with other people around.	
An Intrapersonal child gets more out of being left alone to learn.	

**Table 2.6:** *Examples of activities*

<b>Children who are strongly:</b>	<b>Enjoy:</b>	<b>Need:</b>
Linguistic	reading, writing, telling stories, playing word games	books, tapes, writing tools, paper, diaries, dialogue, discussion, debate, stories.
Logical-Mathematical	experimenting, questioning, figuring out logical puzzles, calculating	things to explore and think about, science materials, field trips.
Spatial	designing, drawing, painting, visualising, doodling	art, building blocks, video, movies, slides, imagination games, mazes, puzzles, illustrated books.
Bodily-Kinaesthetic	dancing, running, jumping, building, touching, gesturing	role play, drama, movement, things to build, sports and physical games, tactile experiences.
Musical	singing, whistling, humming, tapping feet and hands, listening	sing-along sessions, trips to concerts, music playing, musical instruments.
Interpersonal	leading, organising, relating, manipulating	friends, group games, social gatherings, community events, clubs.
Intrapersonal	setting goals, mediating, dreaming, planning	self-paced projects

<sup>12</sup> Note that EBoChi adopts Gardner's definition of intelligence.



### 2.5.1.2 Reasons for Choosing MI

The theory of MI has grabbed the attention of many educators and hundreds of schools are currently using its philosophy to redesign the way they educate children (Armstrong, 1998). Today's teachers are considering this theory for many reasons including (Wilson, 1998; Pickering, 1999; Armstrong, 1998):

- it provides at least seven different potential pathways to learning. If a teacher is having difficulty reaching a child in the more traditional linguistic or logical ways of instruction, the theory suggests several other ways in which the material might be presented to facilitate effective learning;
- it aids teachers in creating more-personalised instructional materials;
- it validates teachers' insightful and intuitive assessments of children's natural talents;
- it provides teachers (as well as children and their parents) with a more extensive conceptualisation of giftedness;
- it helps increase children's level of motivation through natural talents;
- it increases self-confidence in the ability to learn using each of the intelligences, thus valuing and nurturing individual differences;
- it makes assessment of learning become “how are you smart?” rather than “how smart are you?”;
- it includes personal and social development as part of the curriculum.

MI theory also supports other studies, for instance two studies dealing with the use of drawings discovered that children expressed meaning or stories through drawings and showed their emotions through the use of colour (Dyson, 1989; Miller et al.,



1998). This indicates that drawing and colouring can be positive alternative learning modes.

Project SUMIT: Schools Using Multiple Intelligence Theory (one of the sub-projects in Project Zero) conducted by the Harvard Graduate School of Education, and McGraw-Hill School Division are examples of projects that adopt Gardner's concept as the basis for structuring lessons.

Harvard Project Zero, a research group at the Harvard Graduate School of Education, has investigated the development of learning processes in children, adults, and organisations for over 32 years. They place the learner at the centre of the educational process, respecting the different ways in which an individual learns at various stages of life, as well as differences among individuals in the ways they perceive the world and express their ideas.

McGraw-Hill School Division lends itself to making connections with all seven types of intelligence. In their products, children write reports, hear sounds, perform physical exercise routines, discuss given topics and colour/paint objects.

In concluding this section, it is important to emphasise that the design of e-books should take into account the different learning styles and attitudes of each user - particularly when the users are young children (Fetherston, 1998; Thornburg, 1998; Kennedy, 1997). Thus, research on individual differences may help the development of learning environments that are useful to a wide range of users who have different learning styles and preferences (Chen & Ford., 1996). Designing an e-book to deal with users' individual differences is not an easy task. E-



books should be designed to give users a high degree of flexibility (Beltran, 1992).

### **2.5.2 Giving E-Books Flexibility**

There are many ways to give flexibility to users (Norshuhada & Landoni, 2000b). One example is by providing tools, which can be used by users while consulting the e-book. Landoni (1997) and Catenazzi (1993) in their e-books provided readers with facilities such as personalisation (e.g. highlighting, bookmarking, note taking), searching through an index or table of contents (TOC), history (i.e. remembering the path followed during reading process), navigation (navigating from the TOC down to units of text, navigating references across text and going forward or backward) and printing.

Another method is by providing adaptive hypermedia or adaptive system capabilities. Adaptive teaching systems are often widely known to be defined as systems which integrate two distinct technologies: an intelligent tutoring system and a hypermedia system. It builds a model of each individual user, in order to adapt documents and links in order to meet the needs of particular users (Pilar da Silva et al., 97; Pilar da Silva et al., 98; Brusilovsky et al., 98; Brusilovsky et al., 96).

In addition, de Diana (1994) also implies some other facilities, for instance information marking, annotation, and support for group-based learning. Other examples of flexibility are designing interfaces which:

- cater for different users (for example; individual use, group use) or to consider the likelihood that teachers will use the e-books as a demonstration in class (Collis, 1991);
- allow the use of different levels of content, that is, easier content for beginners and harder content for more experienced users (Díaz et al., 1998).



## 2.6 Conclusions

This chapter has reviewed the main issues surrounding e-book technology. It was obvious from the review, the primary issue to consider first is to establish the need to produce or translate printed books into their electronic counterparts. In the case of children's books, the following reasons are very appealing:

- e-books allow contents to be presented in various information type (e.g. text, graphics, audio, animation, video and combination of these);
- e-books can include hyperlinks and interactive activities;
- e-books are not easily ripped and damaged.

The printed book was investigated where it was found that there are positive and negative features. The negative features could be overcome by introducing e-books where, in addition to incorporating new electronic associated features, the existing printed version features should also be retained. For the purpose of looking at good e-book design practice, and concluding what features to adopt, many existing e-book initiatives, and the features and technology attached to them were studied. For instance, it was found that using the Adobe Acrobat eBook Reader to read an e-book was very satisfying and easy to use. It supports reading tasks better than Adobe Acrobat Reader, with extra functionalities such as viewing of book collections in its library, highlighting, bookmarking, annotating, font changing and selecting between two modes of book display (i.e. one or two pages) (Norshuhada et al., 2002a; 2002b). Another example is the book by Rubinstein (1998). Although his book is a good on-line example, he presents his table of contents (TOC) as active slides which exclude the printed book TOC style. As a result, his TOC presentation is rather confusing.

From the e-book classifications, according to either the navigation methods (i.e. page turner, scrolling and page turner plus scrolling) or the type of information (i.e. fully textual, audio books, multimedia books, etc.), it was realised that for children's e-books, scrolling for information should be avoided as children rarely scrolled, and multimedia elements should be included as children want



content that is entertaining, funny, colourful and uses multimedia effects (Nielsen, 2002). Furthermore, Inkpen (1997) pointed out that what works for adults will not necessarily work for children, for instance common adult metaphors such as the desktops do not make sense to children.

As there is still no single standard format and indeed no universal definition of an e-book, the process of producing it can still be interpreted in many different ways depending on the type of e-book and its purpose. For example, for textual e-books, the process can be from simply digitising a printed book to applying markup languages. Recently, building textual e-books has become easier with the development of e-book compiler software. For multimedia or hypermedia books, a different approach often requiring additional steps such as creating graphics, audio, animation and video are involved. In addition, if producing e-books for learning purpose, the development process should also consider instructional design (a systematic approach to designing instructional materials to achieve specified learning objectives) (Bostock, 1998) and accommodate a wide range of different learning styles to ensure learning gains.

The e-book publishing industry is currently concentrated mainly on textual e-books with very limited multimedia content (van Buren & Cogswell, 2001). E-books for learning purposes, especially for young children, are more concerned with assisting users' learning by taking advantage of multimedia and interactive experiences. The publishing process should therefore be based on a combination of traditional publishing, software engineering, IMM productions and instructional design/courseware engineering models. Therefore, with regard to this research, e-book publishing involves a combination of steps as suggested by Modeland (2000), Prabha (2000), Bostock (1998), Kotonya and Sommerville (1998) and Shuman (1998). The important steps are:

1. manuscripts are evaluated (for new books) or acquired (if paper versions exist);
2. if a book is marketable, contracts are signed;
3. content editors edit the manuscript for better quality;
4. manuscripts are proof-read;



5. the final edited manuscripts are processed (i.e. e-books are created) and saved in various formats. This involves a further four sub-steps: planning, designing, creating and testing.
6. the book is stored and delivered on suitable media.

If a book is not to be commercially published, then usually only stage 5 (i.e. e-book development) is involved. In stage 5, during the planning phase, a concept which should achieve learning objectives is developed, users' requirements are specified, and if the intention is to include multimedia content, then the scripts and storyboards (i.e. the appearance of each page) are planned (see chapter 4). In the design stage the e-book interface, functionality and interactivity (e.g. how the users navigate through the book) which have been specified and validated in the planning stage are designed. Next, the book content, that is the electronic version of text or any other information type, is created based on the decisions made in the previous two steps. The book is then tested for its usability level. Although it is listed as the final step in the development process, testing is an ongoing process and can even start during the concept planning stage.

Providing flexibility within an e-book is another issue to be considered. In EBoChi, it is proposed that providing an e-book with different activity modes will allow users to achieve flexibility. In this context, flexibility is provided by letting users deal with their own personal needs with the assistance of the e-book features. So for instance, to teach children the concept of "less and more", one could:

- use an electronic storybook and ask children to read;
- ask children to draw objects in the e-book to show "less and more";
- open a sing-along activity about the "less and more" concept that asks children to participate;
- ask children to write their own understanding of the concept using a children's word processing software or e-book builder which is linked to the e-book;
- ask a group of children to solve electronic puzzles associated with the concept which is included in the e-book.



In order to demonstrate the different ways of achieving flexibility, EBoChi developed a conceptual model to describe what is involved. This is described in Chapter 4.

Taking into account these conclusions, the methodology for the entire study was developed. The next chapter (i.e. the methodology chapter) highlights the actions taken to achieve the objectives of this study.



# Chapter 3

## Methodology

### 3.1 Introduction

This chapter describes the actions taken in order to achieve all the objectives detailed in chapter 1. A decision was made to undertake a research that would possibly benefit the implementation of Malaysian Smart Schools by proposing a design concept for children's electronic teaching and learning tools. The research started with reviews of relevant literature in the area of Smart Schools, and teaching and learning tools. This resulted in:

- the selection of the e-book (more specifically, electronic textbooks) as the tool to be considered and which is described in depth in chapter 2
- the formation of the main and sub-objectives of the research (see chapter 1).



These objectives were addressed by adopting two main research approaches as suggested by Sekaran (1992), Loucopoulos & Karakostas (1995), Benyon et al. (1990) and partly implemented by Landoni (1997). The approaches that were used are known as:

- the investigative, elicitative and deductive approach; and,
- the analytical, constructive and hypothetico<sup>1</sup> approach.

The relationship between these two approaches is illustrated schematically in Figures 3.1 and 3.2. The techniques identified in these figures are discussed in more detail in subsequent sections of this chapter. The Distance-Collaborative Design approach is also discussed and relevant modelling techniques and evaluation techniques are outlined.

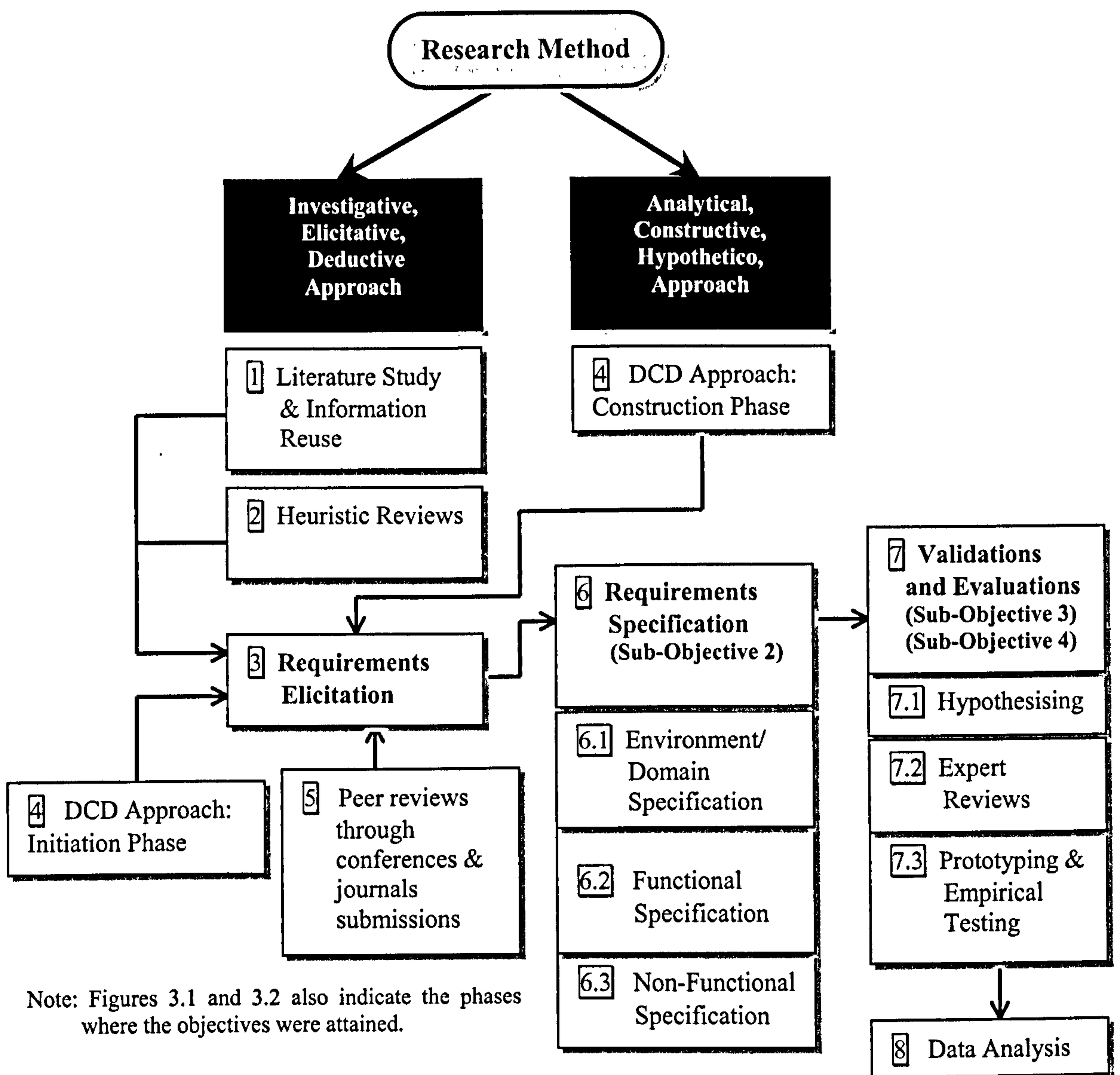


Figure 3.1: Summary of research method



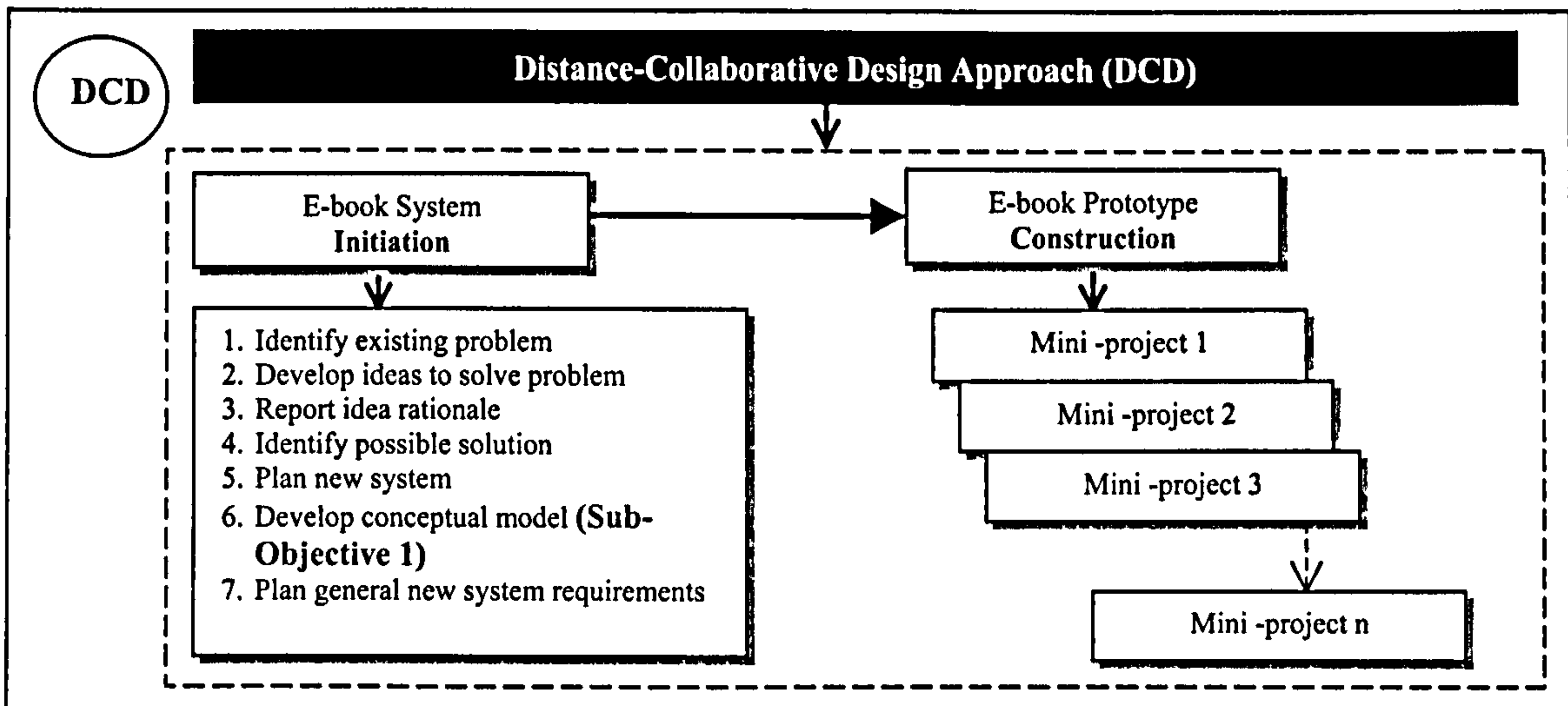


Figure 3.2: Summary of DCD approach

### 3.2 The Investigative, Elicitative and Deductive Approach

In the investigative, elicitive and deductive phase, relevant literature and bibliographical resources related to the Smart School environment, learning style theories, and teaching and learning materials issues were first reviewed. When it was decided to focus on e-books, existing projects with similar scope were considered and examined carefully in order to extract and seek information about the issues under consideration and form the main assumption of the study (i.e. that the book metaphor is also appropriate for children). Further, critical reviews of existing e-book initiatives were conducted so as to decide which projects should be selected that could have some influence on the e-book model development. The next stage was requirements elicitation, which was performed in order to gain relevant knowledge about the context in which the proposed electronic textbook model is intended (Loucopoulus & Karakostas, 1995). The activities involved in this stage included identifying and acquiring additional sources of knowledge, which had not been considered in the first stage, and deciding on the relevance of the information obtained. A variety of methods were used for elicitation ranging from interviews (e.g. with domain experts such

<sup>1</sup> This word (i.e. hypothetico) was taken from Sekaran (1992). But the word was introduced by Popper which basically means "proving of a theory using hypothesis testing". For more information see <http://www.geog.ouc.bc.ca/physgeog/contents/3b.html>



as teachers and head teachers), creation of a prototype and reuse of information acquired previously (e.g. literature on e-book technology, e-book design standards). This phase was also used to identify problems of the current multimedia initiatives, plan the possible solutions and develop a conceptual model for the proposed e-book. The activities involved are depicted in Figure 3.2 and are further discussed in section 3.4.

Input for elicitation was also obtained from the researcher's subjective review of the existing Book Builder program whereby its functionalities were evaluated for adequacy and inadequacy in terms of supporting users when creating e-books.

Finally, in this investigative, elicitive and deductive phase (see its summary in Figure 3.1), conclusions were deduced by interpreting the meaning of the input gained from the elicitation processes. These conclusions were then considered as input into the requirements specification stage in the analytical, constructive and hypothetico approach.

### **3.3 The Analytical, Constructive and Hypothetico Approach**

The activities involved in the second approach (analytical, constructive and hypothetico) were mainly based on the "Distance-Collaborative Design" (DCD) approach (specifically the construction phase). This is discussed in section 3.4. The other important activities were "Requirements Engineering" processes (specifically the specification and validation phases). These are discussed below.

The early stages of software design usually involves undertaking a Requirements Engineering (RE) analysis. RE can be defined as the systematic process of developing requirements through an interactive co-operative process of analysing the problem, documenting the resulting observations in a variety of representation formats, and checking the accuracy of the understanding gained

(Pohl, 1993). In short, it is a set of systematic activities used to derive and validate the requirements of the software system that is to be developed (Sommerville, 1996; Loucopoulus & Karakostas, 1995). In EBoChi, RE can be interpreted as eliciting from users what they want, developing (with assistance from the users) a representation of what the system under design should look like, and verifying with users that this is what will satisfy their needs. RE therefore was utilised to accomplish sub-objective 2, which was specifying formal models of the requirements.

RE involves three processes: elicitation (which has been described in the previous section), specification and validation (Loucopoulas & Karakostas, 1995). Each stage involves specific activities and methods as follows (see Table 3.1):

- requirements elicitation is the process of acquiring all necessary knowledge to be used in the production of a specification;
- requirements specification is the process of creating a formal model of the requirements;
- requirements validation attempts to verify that the produced formal model satisfies users' needs.

It should be noted at this point that there are other RE process definitions. For instance, Sommerville (1996) suggests five stages:

- feasibility study – an estimate is made of the feasibility of the proposed system;
- requirements analysis – where observation of existing systems, discussions with stakeholders and literature study are conducted;
- requirements definition – where information gathered during analysis is documented using natural language supported by diagrams;
- requirements specification – a more detailed and precise description of the requirements is created and formalised as a model;
- requirements validation – which is concerned with showing that the requirements actually define what the users want.



**Table 3.1:** *Activities and methods involved in Requirements Engineering*

Elicitation	Specification	Validation
<ol style="list-style-type: none"> <li>1. Involved in discovering the requirements such as: <ul style="list-style-type: none"> <li>▪ Application domain;</li> <li>▪ Specific problems;</li> <li>▪ Specific needs.</li> </ul> </li> <li>2. Methods used: <ul style="list-style-type: none"> <li>▪ <b>Interviews</b></li> <li>▪ <b>Scenarios</b> (story telling by users) <ul style="list-style-type: none"> <li>▪ Use a set of interaction scenarios;</li> <li>▪ End users simulate interaction using the scenarios;</li> <li>▪ Require working face to face with users.</li> </ul> </li> <li>▪ <b>Observations</b> (e.g. ethnography) <ul style="list-style-type: none"> <li>▪ Dependent on ethnographer personality;</li> <li>▪ Must be accepted by participants.</li> </ul> </li> <li>▪ <b>Requirements reuse</b> – use existing requirements from similar systems</li> <li>▪ <b>Prototyping</b> (paper prototyping, automated prototyping) <ul style="list-style-type: none"> <li>▪ Allows end users to experiment with the software;</li> <li>▪ Allows demonstration of requirements;</li> <li>▪ Help establish the usefulness of the software;</li> <li>▪ Effective way of showing user interface.</li> </ul> </li> </ul> </li> </ol> <p>This phase is also known as:</p> <ul style="list-style-type: none"> <li>▪ Requirements Identification</li> <li>▪ Requirements Determination</li> <li>▪ Requirements Acquisition</li> <li>▪ Task Analysis</li> </ul>	<ol style="list-style-type: none"> <li>1. For expressing the requirements usually notations are used.</li> <li>2. Need to specify: <ul style="list-style-type: none"> <li>▪ Domain requirements: context in which system will function;</li> <li>▪ Functional requirements (i.e. functionalities of the system);</li> <li>▪ Non-functional requirements such as interface, security, reliability, etc.</li> </ul> </li> <li>3. Methods used: <ul style="list-style-type: none"> <li>▪ <b>Natural language;</b></li> <li>▪ <b>Structured natural language;</b></li> <li>▪ <b>Formalised Grammar;</b></li> <li>▪ <b>Tabular;</b></li> <li>▪ <b>Graphical notations;</b></li> <li>▪ <b>Formalised graphical notations;</b></li> <li>▪ <b>Mathematical specifications.</b></li> </ul> </li> </ol> <p>This phase is also known as:</p> <ul style="list-style-type: none"> <li>▪ Requirements Analysis</li> <li>▪ Problem Analysis</li> <li>▪ Problem Definition</li> <li>▪ Requirements Definition</li> </ul>	<ol style="list-style-type: none"> <li>1. Check the requirements to certify that they represent the acceptable description of the system.</li> <li>2. Methods used: <ul style="list-style-type: none"> <li>▪ <b>Prototyping;</b></li> <li>▪ <b>Laboratory testing;</b></li> <li>▪ <b>Expert reviews;</b></li> <li>▪ <b>Empirical testing;</b></li> <li>▪ <b>Surveys.</b></li> </ul> </li> </ol>



Sommerville makes a clear separation between the terms requirements definition, requirements specification and software specification. He defines requirements definition as the high-level abstract description of requirements, and requirements specification as the structured detailed description of what the system should do. To him, software specification is an even more detailed description than requirements specification. The output of requirements definition is the draft statement of requirements, while the output of specification is the final and structured requirements document.

His definition, on the one hand, makes a clear separation of how to perform RE (especially to inexperienced analysts or researchers), but on the other hand, some stages seem to be redundant. For example, the main purposes of both a requirements analysis and a feasibility study are to elicit relevant information, and these two stages could be integrated in a stage called elicitation as suggested by Loucopoulos & Karakostas (1995). In his later book (Kotonya & Sommerville, 1998), Sommerville adopts the word elicitation to mean the analysis phase.

Kirakowski (1997) suggests three main RE stages:

- user context analysis – which consists of understanding the initial requirements and performing an analysis of the main user groups, their tasks and working environment;
- feasibility and prototyping – which is concerned with concept development and representing possible concepts by means of prototypes, which then allow users to assimilate each concept easily and to comment on their feasibility; and,
- user requirements synthesis – which incorporates the design phases of concept descriptions, general system characteristics, system functions, user-system interfaces, user support needs, usability goals and the approach to be adopted for installing the system.



According to Kirakowski, his definition is an attempt to give an account of how RE, from Human-Computer-Interaction (HCI) perspectives, differs from a software engineering perspective.

As the analytical, constructive and hypothetico phase in EBoChi was concerned with requirements specification and validation, a discussion on these two topics is further detailed in the following paragraphs.

### **Requirements specification**

Requirements specification should be viewed from three perspectives (Loucopoulos & Karakostas, 1995; Kotonya & Sommerville, 1998):

1. Environment/domain requirements – the context in which the system will function.

It provides a context and justification for the intended system and typically identifies organisational structure, different stakeholders, roles, responsibilities and intentions between stakeholders, activities and processes involved and products of the domain.

2. Functional requirements – the descriptions of the fundamental functions of the software components:

This describes what the system is supposed to do and is classified into:

- structural components – the descriptions of the structural components of the system; and,
- behavioural components – which is concerned with the specification of the tools and users' actions in the system.

3. Non-functional requirements – the restrictions or constraints placed on the system.

These are requirements, which are not specifically concerned with the functionality of the system, and they specify the external constraints that the system must meet. Requirements in this category are interface requirements, acceptance requirements, performance requirements,

security requirements, reliability requirements, safety requirements, documentation requirements, and so on (Sommerville, 1996; Kotonya & Sommerville, 1998).

Using the output from the elicitation activities, the requirements (in terms of the three perspectives) were specified (see the list of sub-objectives given in chapter 1) and presented in the form of graphical notations, tables and simple mathematical syntax (see chapter 5). In selecting the most appropriate modelling representation, a study of formal methods for system representation was undertaken prior to the specification process (see section 3.5).

### **Requirements validation**

The aim of the requirements validation process is to validate the requirements which have been obtained from the elicitation and specification stages. Basically, it is concerned with answering the question “have we got the requirements right?” (Kotonya & Sommerville, 1998). In EBoChi, this process involved the school teachers, children and e-book experts in order to achieve sub-objective number three, which was to analyse the perceived usefulness and ease-of-use of all system features (see chapter 6 for more information). Expert reviews, prototyping and empirical testing approaches were adopted. Nevertheless, before these approaches were selected, reviews of existing evaluation methods were undertaken (see section 3.6).

As discussed in sections 3.2 and 3.3, an approach called Distance-Collaborative Design (DCD) was part of the research method. The next section explains the concepts behind the approach and the activities involved.

## **3.4 The Distance-Collaborative Design (DCD) Approach**

Traditional system development is normally carried out by designers who have complete control over the design; this approach however, often produces systems which lack usability (Uden & Dix, 1999). To overcome this, approaches



such as User-Centred Design (UCD) and Participatory Design (PD) or collaborative design are often utilised. User-centred design typically positions users as testing subjects for designers to ensure users' needs are met (Scaife & Rogers, 1999). PD or collaborative design, on the other hand, is popular because it involves users in all the design phases as testers, informants<sup>2</sup> and design partners (Theng et al., 2000; Druin et al., 1999; Scaife & Rogers, 1999).

In this project, the importance of involving users in all phases of the project was recognised. However, since the research subjects were intended to be only from Malaysian schools (which are located far from Scotland where the project was run), an approach called Distance-Collaborative Design (DCD) was used (Norshuhada & Landoni, 2001c). Using this approach distance users were involved in the elicitation process. It should be noted that since this project did not intend to focus on cultural difference issues (such as how western children and teachers perceived the e-book model), no participants were taken from other parts of the world.

In this collaborative approach, users (i.e. 1 head teacher, 1 teacher, 2 children and 2 program developers/parents) who live in Malaysia were selected as the major stakeholders. To take advantage of telecommunications technology and at the same time save costs, communication was performed through the use of email, the Internet (Web site, chatting program) and the telephone, instead of face-to-face meetings. The head teacher and teacher were employed as informants and design partners to identify problems, verify the teaching strategies, as well as give feedback on interface design issues. Since the children in this project were young and EBoChi was aware of the extent to which they could be involved (due to limitations on their knowledge and experience), they were employed as testers and informants rather than design partners. Their parents helped them in the communication processes. The parents of the selected children were knowledgeable in computer system design as they themselves are

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<sup>2</sup> Informants can provide information, but are not necessarily the testers or design partners. Design partners, however, are involved as informants and decision-makers.

working in a system development environment. Thus, they represented not only parents but also design experts and became informants and design partners.

As shown in Figure 3.2 DCD has two major phases. The first phase (**Initiation**) involved seven steps of which the head-teacher was involved in the first two.

The seven steps are:

- identifying existing problems with teaching-learning materials;
- developing ideas to solve the problems;
- reporting on the rationale of choosing the idea;
- identifying possible solutions;
- planning the new system;
- developing a conceptual model for the new system (refer to chapter 4 for the results);
- planning the general requirements of the new system.

The second phase (**Construction**) was iterative and consisted of many mini-projects<sup>3</sup>. This method was adopted from Uden and Dix (1999) with some modifications to fit EBoChi purposes. To help elicit users' requirements and discover a system specification, each iteration contained all the usual steps in the system development life cycle: analysis, design, development and evaluation. Each iteration tackled a small objective and was completed with an evaluation to confirm that each mini-project had met its objective. As an example, the objective of mini-project 1 could have been to produce an interface layout and icons, mini-project 2 could have involved creating the flow and structure of the system, and mini-project 3 could have been used to develop multimedia assets such as graphics, audio, video and animation.

In EBoChi, the objective of mini-project 1 was to propose a front-end interface for the proposed e-book and it involved users in various ways. To start with three interface design ideas were electronically posted to all partners and they were asked to make comments on the layout, placement of icons, choice of icon



designs, metaphors used to describe icons, and size of icons. The second stage (i.e. mini-project 2) involved asking them to produce their own design ideas and each design was then posted to all partners for comments. Finally, in mini-project 3, the design partners were asked to choose one design. The most suitable design was then selected as the proposed front-end interface design. While children were involved as informants and testers (mainly about icon metaphors and design), the head teacher and teacher proposed content and instructional strategies (such as how to teach a certain topic and what type of activity should be included).

In order to verify the design that was agreed among design partners, the initial interface was shown to ten children aged between 7 and 9. Five were novice users (no previous experience in using educational CD-ROMs or digital content) while the rest had some experience in learning using multimedia CD-ROMs. They were asked about the meaning of each icon (particular attention was focused on finding whether the metaphor used in each icon was easily understood). The suitability of the front-end interface layout was also observed. The results of this stage are further described in section 5.4.1.1.

To achieve sub-objective 2 as outlined in Figure 3.1, that is specifying design requirements, modelling techniques were utilised to represent the entire requirements. The next section thus discusses the application of modelling techniques in EBoChi.

### **3.5 Modelling Techniques**

Requirements specification is usually presented by using a non-technical means of communication and is considered as the model of the specification (Benyon et al., 1990). The aim is to make key aspects of the proposed system visible to users so that they can provide feedback for the designers to consider. A number

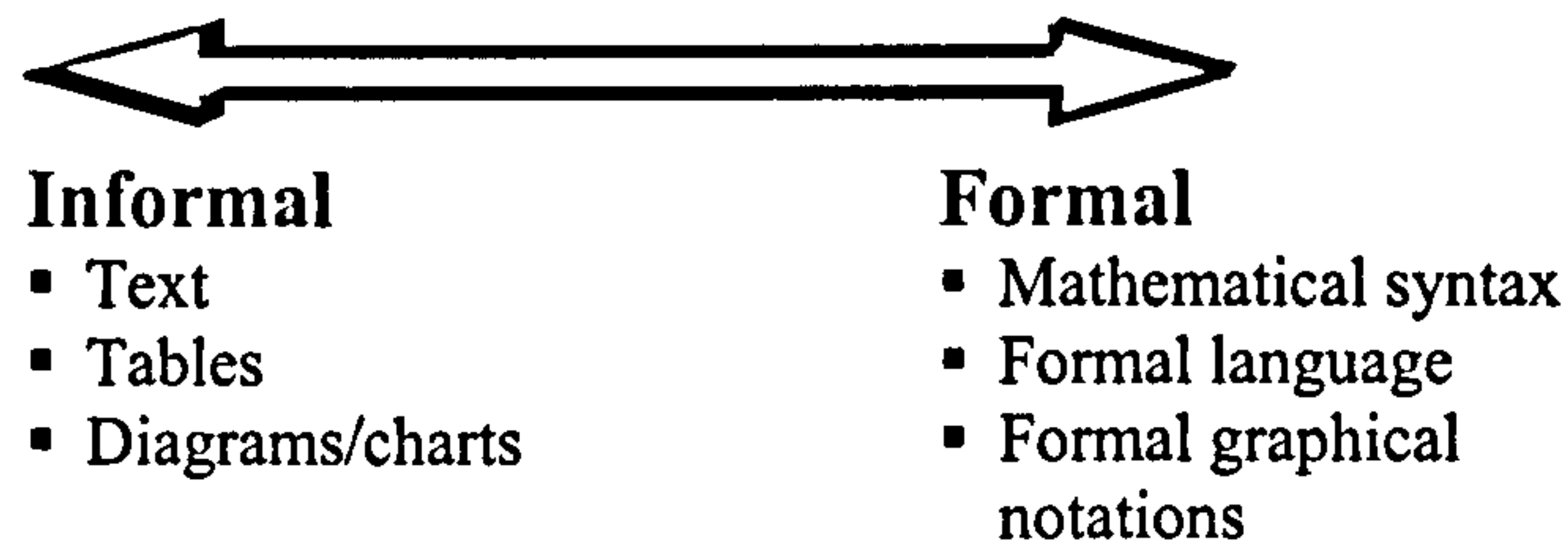
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<sup>3</sup> Mini projects can either be performed in parallel or sequentially. In EBoChi however, they were conducted sequentially since one project depended on the outcomes of another.

of approaches to modelling requirements can be utilised (Sommerville, 1996; Dix et al., 1998; Benyon et al., 1990):

- natural language;
- structured natural language;
- tabular;
- graphical notations;
- mathematical specifications.

These approaches can be categorised on a formality spectrum (see Figure 3.3). Approaches that use text, diagrams/charts and tables fall at the informal end of the spectrum. Mathematical syntax or any formalised language and graphical notations, on the other hand, fall at the formal end.




**Figure 3.3:** *Formality spectrum*

A requirements specification which is written in natural language is prone to misunderstanding because it relies on how readers interpret the sentences. To overcome this problem, structured languages which use standard forms and templates have been created. Robertson and Robertson at Atlantic Systems Guild<sup>4</sup> have developed a requirements specification template that is used as a basis for software specifications. The template provides sections for each of the types of requirement appropriate to software systems development (see Figure 3.4).

<sup>4</sup> For more information on the product visit their Web site at <http://www.atlsguild.com/GuildSite/Robs/Template.html#anchor805616>



Requirement #: 75	Requirement Type: 9	Event/use case #: 7, 9
Description: The product shall record all the roads that have been treated		
Rationale: To be able to schedule untreated roads and highlight potential danger		
Source: Arnold Snow - Chief Engineer		
Fit Criterion: The recorded treated roads shall agree with the drivers' road treatment logs and shall be up to date within 30 minutes of the completion of the road's treatment		
Customer Satisfaction: 3	Customer Dissatisfaction: 5	
Dependencies: All requirements using road and scheduling data	Conflicts: 105	
Supporting Materials:	Work context diagram, terms definitions in section 5	
History: Created February 29, 2000	 <small>Copyright © Atlantic Systems Guild</small>	

**Figure 3.4:** A template for requirements specification by Atlantic Systems

Another linguistic based model is formal modelling such as GOMS (Goals, Operators, Methods and Strategies rules), Backus-Naur-Form (BNF) and Task-Action-Grammar (TAG). GOMS was developed by Card, Moren and Newell (1980). The purpose of this model is to provide reasonably accurate predictions of human behaviour while interacting with the system interface (Booth, 1991). To show an example, consider a user goal which is to edit text. A GOMS description might look like:

- Goal: Edit-Text
- Goal: Select-Word-Method
  - • Delete-Word-Method

The dots on the left indicate the goal position. Here the Select-Word-Method is a sub-goal of Edit-Text. The Delete-Word-Method is an operator, in this case an action performed to edit text.

BNF is a formalism which can be used for a number of purposes. It can represent the user's actions or outline rules which govern the interaction with a system (Dix et al., 1998; Booth, 1991). It uses symbols such as ::=, + and | to represent the meaning "defined as", "followed by" and "choice" respectively. Thus in:

<Page type> ::= <text | graphic | text + graphic>

this rule says a page in a book may consist of text only or graphic only or text and graphic.

Mathematical specifications such as Z, Petri nets and VDM use mathematical notations such as sets, functions, schema calculus and predicate logic. It reduces misinterpretations, but is very difficult for users or even inexperienced designers to understand. This approach is also more time consuming as there is a steeper learning curve involved in using it.

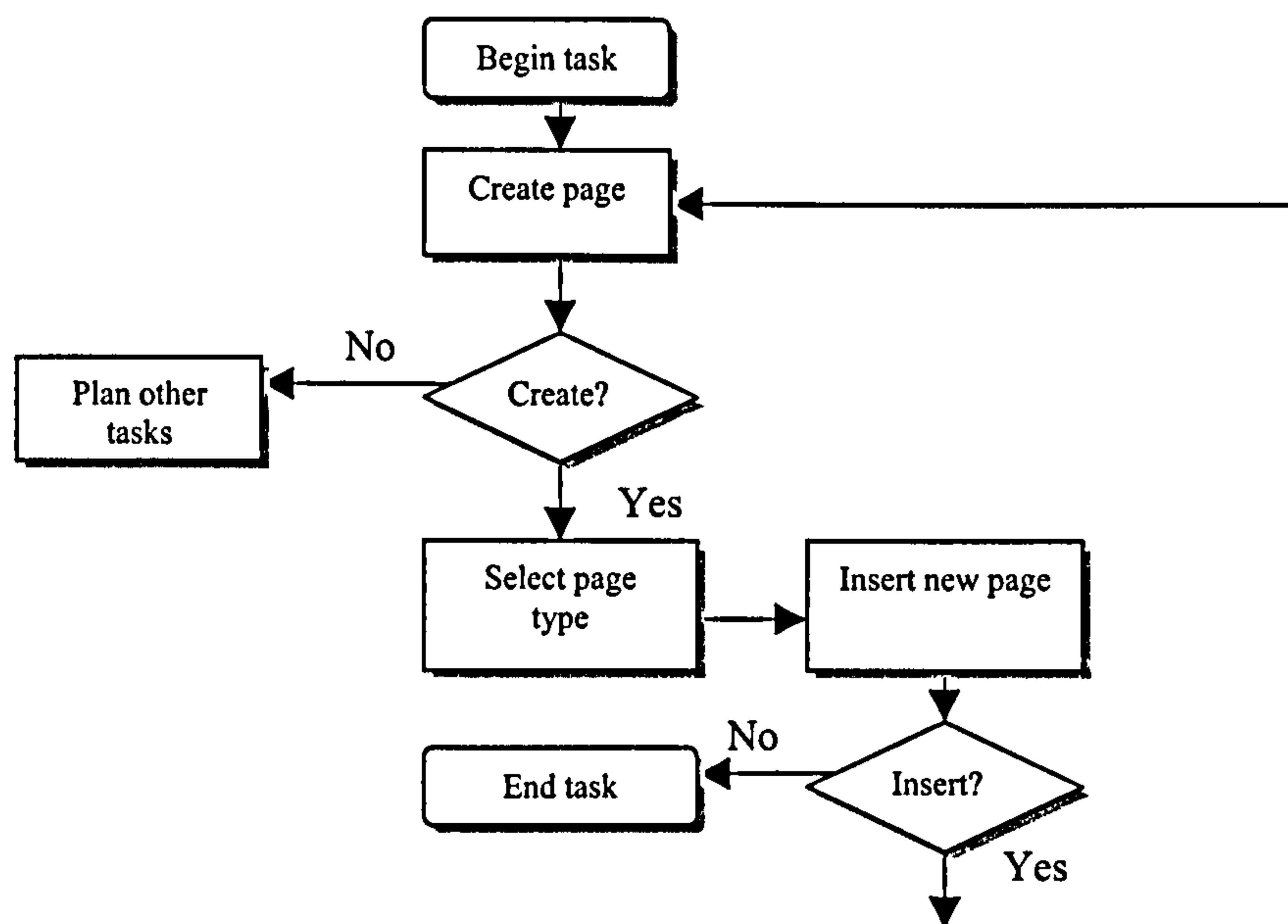
The most commonly used informal specification technique is the use of graphical notations such as flow charts (see Figure 3.5), data flow diagrams, behaviour diagrams and state transition diagrams. However, these too, can sometimes result in a large and confusing flow of information because it can quickly become unwieldy as system complexity grows (Shneiderman, 1998). Graphical modelling notations are divided into a number of categories according to the purpose of modelling. There are notations to:

- characterise system environments – Context Diagrams, Use Case Diagrams;
- identify system functions and data flow – Flow charts, Data Flow Diagrams;
- define system states – State Transition Diagrams, Statecharts;
- express relationships between data – Entity Relationship Diagrams, Data Structure Diagrams, Sequence Diagrams;
- illustrate sequences of functions and define user behaviour – Behaviour Diagrams;
- show synchronically and parallelism – Petri nets<sup>5</sup>.

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<sup>5</sup> Petri nets also use graphical representations, so can also be categorised into formal graphical notations.





**Figure 3.5:** *Example of a flow chart*

As stated earlier, there are various techniques for requirements specification, and each has its advantages and disadvantages, and can be viewed from either Software Engineering or Human-Computer-Interaction perspectives (see Table 3.2). Since this project covers only the early stages of the system development cycle, the internal workings of the e-book system are not of interest, nor are the cognitive aspects of the interaction between users and the e-book (i.e. the sequence of actions to achieve tasks).

This research is concerned only with specifications of functionality and the sequence of functions used in creating e-books - particularly books that provide users with activities. Consequently, formal linguistic-based models such as GOMS have not been adopted because they are more appropriate for representations of cognitive aspects or users' behaviour or command line systems (i.e. non-graphical user interface) (Dix et al., 1998). In view of this, a mixture of graphical representations and mathematical notations has been chosen for all the EBoChi models including the conceptual model which will be presented in chapter 4.



**Table 3.2:** *Specification techniques*

Software Engineering Perspective		Human Computer Interaction Perspective	
Functional	Non Functional	Social & Organisational Context	Users' Cognitive Context (Mental Process)
<p>1. Natural language – prone to misunderstandings.</p> <p>2. Structured natural language – using forms and templates.</p> <p>3. Tabular – using tables.</p> <p>4. Graphical notations:</p> <ul style="list-style-type: none"> <li>▪ <u>Data flow models</u> – show the flow of data, e.g. DFD.</li> <li>▪ <u>Compositional models</u> – show how some entities are composed of other entities, e.g. ERD.</li> <li>▪ <u>Decomposition models</u> – show the breakdown of functions into sub-functions, e.g. Tree diagrams, Hierarchical diagrams, Warnier diagrams.</li> <li>▪ <u>Procedural Representation models</u> – show procedure to accomplish tasks, e.g. Flowcharts.</li> <li>▪ <u>Behavioural models</u> – describe the dynamic parts of system, e.g. State-transition diagrams.</li> <li>▪ <u>Formal notations</u> – Structured Analysis &amp; Design (SADT), SSADM, Object Oriented Analysis (OOA), OMT, UML</li> </ul> <p>5. Mathematical specifications (formal methods):</p> <ul style="list-style-type: none"> <li>▪ Little impact on industrial practice, have not been widely used;</li> <li>▪ Used normally during software specification NOT requirements specifications;</li> <li>▪ Difficult to represent graphical interfaces and interactive systems;</li> <li>▪ Used specialised notations and symbols (e.g. sets, functions, predicate logic) which require significant learning effort;</li> <li>▪ Examples include: <ul style="list-style-type: none"> <li>• Z – uses schema calculus and set theory;</li> <li>• Petri nets – based on graph theory. Usually used for concurrent systems such as client-server networks and distributed databases.</li> <li>• VDM – used set theory.</li> </ul> </li> </ul>	<p>1. Natural language – prone to misunderstandings.</p> <p>2. Structured natural language – using forms and templates.</p> <p>3. Tabular – using tables.</p>	<p>1. Soft Systems Methods</p> <ul style="list-style-type: none"> <li>▪ More appropriate to derive requirements within organisations;</li> <li>▪ Concerned with socio- technical systems;</li> <li>▪ More effective to understand problems in organisational situation.</li> </ul> <p>2. Formal methods which use a mixture of natural language and graphical notations:</p> <ul style="list-style-type: none"> <li>▪ User Skills and Task Match (USTM);</li> <li>▪ Open System Task Analysis (OSTA);</li> <li>▪ Effective Technical and Human Implementation of Computer System (ETHICS).</li> </ul>	<p>Concerned with the representation of users as they interact with an interface.</p> <p>Describe user's tasks at the interface.</p> <p>1. Formalised Grammar:</p> <ul style="list-style-type: none"> <li>▪ Goals and Tasks – e.g. Goals, operators, Methods and Solutions (GOMS), Task-Action Grammar (TAG), Backus-Naus-Form (BNF), Hierarchical Task Analysis (HTA).</li> <li>▪ Physical and Devices – e.g. Keystroke Level model, Three State model</li> </ul>



To verify the design requirements, which were specified in the models, evaluation of prototypes was carried out. Some evaluation methods were first studied in order to select the ones that would be most suitable for EBoChi and these are discussed in the following section.

### **3.6 Evaluation Methods**

According to Clark (1995) evaluation is the process of determining the value and effectiveness of a program with several benefits such as correcting errors, seeing the users' point of view and reducing the number of unsupportable design issues (Allen, 1994; Chin et al., 1988; Commer & Geissler, 1998; Hubona & Blanton, 1996). In EBoChi, evaluation methods were used as a means of assessing the perceived usefulness and ease-of-use of the functionalities of the e-book and e-book builder in order to validate the requirements that had been specified (see chapter 6).

This section considers some general issues relating to evaluation processes and then discusses the specific approaches used in the EBoChi project.

#### **3.6.1 General Issues**

Two types of evaluation are often mentioned in the literature: **formative** and **summative** (Northrup, 1995; Draper et al., 1996; Georgiadou & Higgett, 1998; Biraimah, 1993, Barker & King, 1993; Geissinger, 1997; Reiser & Kegelman, 1994; Henderson, 1996; Norshuhada & Landoni, 2001a, 2002). Formative evaluation is an ongoing process conducted along every step of the development process with the aim of obtaining data to increase the effectiveness of the design and has become an essential part of developing software (Dick & King, 1994; Laurillard, 1994). Summative evaluation, on the other hand, is an evaluation performed on the finished product. When evaluating educational software, instead of the above two types of evaluation, Reeves (1993; 1994) suggests five sub-types depending on the purpose to be achieved:

evaluating a newly developed program ( $New_p$ ), selecting from among alternative programs ( $Sel_{ap}$ ), implementing a program ( $Imp_p$ ), deciding to continue using existing programs ( $Cont_p$ ) or modifying existing programs ( $Mod_{ep}$ ).

Therefore, it could be seen from the above paragraph that when evaluating new or modifying existing educational software, formative evaluation is performed<sup>6</sup>. Summative evaluation is used to select, implement and continue using existing educational software<sup>7</sup> (Norshuhada & Landoni, 2001a; 2002).

Again, whenever formative evaluations are discussed in the literature, they are associated with system usability measures, whereas summative evaluations are usually linked to the evaluation of the impact or effect of the system. As EBoChi's aim was to propose a new system, usability was evaluated.

Usability is a very broad concept in computer system design (Keinonen, 1998; Lee, 1999; Shackel, 1991). However, the word 'usability' suggests that it is related to how usable a system is for a user. According to the WWWebster Dictionary (1999), usability is concerned with designing software applications which people find convenient and practicable for use. Usability is part of a larger issue of system acceptability and is often defined as a measure of the ease with which a system can be learned or used, its safety, effectiveness, efficiency, usefulness and attitudes of its users towards it (Nielsen, 1993; Preece et al., 1994; Booth, 1991).

In formative evaluation, usability is mostly concerned with evaluating the software applications interface by using approaches such as usability

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<sup>6</sup> These notations summarise the paragraph:

$\{New_p, Mod_{ep}\} \in$  Formative evaluation

$\{Sel_{ap}, Imp_p, Cont_p\} \in$  Summative evaluation



inspections or expert reviews (Nielsen & Mack, 1994; Shneiderman, 1998). Examples of expert reviews are heuristic evaluations, guidelines, walkthroughs, and consistency inspections (Nielsen & Mack, 1994; Shneiderman, 1998; Karat, 1994; Dix et al., 1998; Lin et al., 1997). Other methods are simulation trials (where a system is tested by using mock-ups of the intended system) and field studies (where a system is placed within the intended environment prior to its formal release). Usability testing (i.e. laboratory testing with real users using a prototype) and surveys can also be used in both formative and summative evaluations.

The above inspection methods are also used to evaluate new or modify existing educational applications (Allen, 1994; Reeves & Harmon, 1994; Mulholland et al., 1998; Landoni, 1997; Catenazzi, 1993). In contrast, when performing summative evaluation on educational applications, methods such as pre- and post-testing, media comparison, test of users' level of knowledge and surveys are utilised (see Table 3.3).

**Table 3.3:** *Comparison of types of evaluation*

<b>Evaluation type</b>	<b>Computer system</b>	<b>Educational system</b>
Formative evaluation {New <sub>p</sub> , Mod <sub>ep</sub> }	<ol style="list-style-type: none"> <li>1. Expert reviews (e.g. heuristic, walkthroughs)</li> <li>2. Simulation trials</li> <li>3. Field studies</li> <li>4. Laboratory testing</li> </ol>	<ol style="list-style-type: none"> <li>1. Expert reviews (e.g. heuristic, walkthroughs)</li> <li>2. Simulation trials</li> <li>3. Field studies</li> <li>4. Laboratory testing</li> </ol>
Summative evaluation {Sel <sub>ap</sub> , Imp <sub>p</sub> , Cont <sub>p</sub> }	<ol style="list-style-type: none"> <li>1. Laboratory testing</li> <li>2. Surveys</li> </ol>	<ol style="list-style-type: none"> <li>1. Pre- and post-tests</li> <li>2. Media comparison</li> <li>3. Test of users' level of knowledge</li> <li>4. Surveys</li> </ol>

It should be noted that selecting an evaluation method depends on the purpose and conditions of the evaluation (Nielsen & Mack, 1994). Each method has its advantages and disadvantages. For example, a heuristic method will usually involve a small set of experts who examine the system interface and judge its compliance with recognised usability



principles. Since only a small number of experts (normally around 5) are involved and no real users participate, this method tends not to find usability problems associated with real users. Expert evaluators are likely to overlook usability problems if the system is highly domain-dependent and the experts have little domain expertise (Nielsen & Mack, 1994). This method however is very good at finding major usability problems as well as producing quick results at a minimum cost.

All the above methods are also applicable to the evaluation of usability by children - as shown in Hanna et al. (1999), Druin et al. (1999) and Druin (1999). They suggest the following techniques should be used during the development stages of children's educational applications:

- expert reviews;
- site visits;
- surveys;
- card-sorting tasks;
- paper prototype tests;
- laboratory tests;
- longitudinal tests.

While site visits (better known as field studies) are appropriate for forming the concept of a product in context, card-sorting tasks and paper prototype tests are used in the preliminary design (Druin et al., 1999). Some of the other applicable methods are as listed in Table 3.4.

**Table 3.4:** *Summary of evaluation methods with children*

Formative {New <sub>p</sub> , Mod <sub>ep</sub> }	<ol style="list-style-type: none"> <li>1. Site visits</li> <li>2. Card-sorting tasks</li> <li>3. Paper prototype tests</li> <li>4. Expert reviews</li> <li>5. Laboratory tests</li> </ol>
Summative {Sel <sub>ap</sub> , Imp <sub>p</sub> , Cont <sub>p</sub> }	<ol style="list-style-type: none"> <li>1. Surveys</li> <li>2. Laboratory tests</li> <li>3. Longitudinal tests</li> </ol>



What is the best evaluation method to use? It is widely accepted that testing with real users in a controlled experiment is the preferred way of evaluating applications which are under development or completed (Nielsen & Mack, 1994). It is considered to be one of the most powerful methods of evaluating design aspects (Dix et al., 1998). Expert reviews should not be used to replace traditional empirical testing because empirical testing still produces the richest data (Desurvire, 1994). Nonetheless, its main advantage is that comments and criticisms are made from a position of knowledge (Booth, 1991). Taking this into consideration, the next section describes the evaluation methods which were chosen to validate the third sub-objective of the EBoChi project (see Figure 3.1).

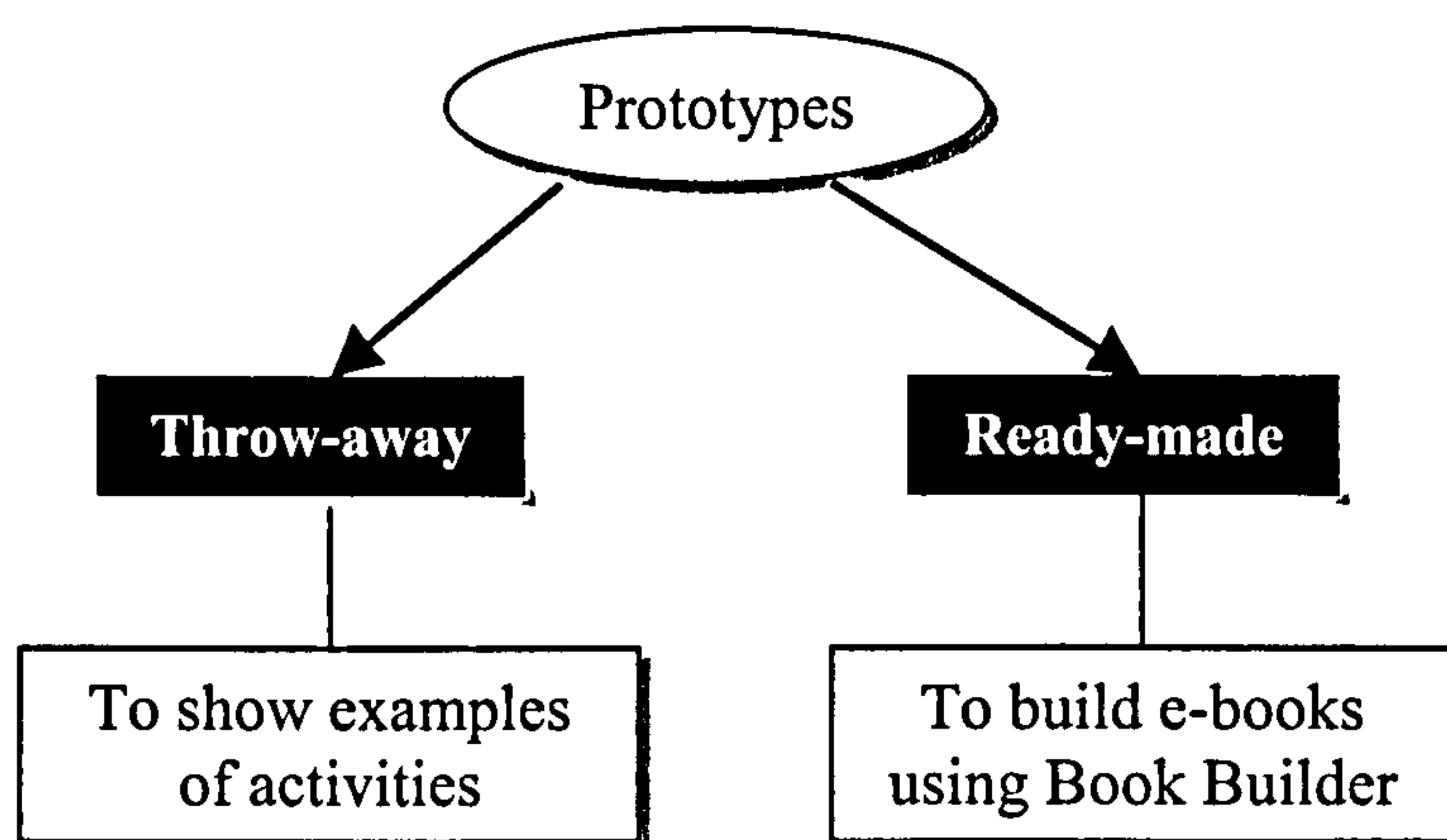
### **3.6.2 EBoChi Evaluation Methods**

The evaluation phase was divided into two parts: an evaluation of e-book delivery (i.e. e-books on reading devices) and of the prototypes. Two types of devices were used for e-book delivery: a children's laptop and a dedicated reader. Ten children were involved in the evaluation. They were asked to use both devices for a certain duration (the duration varied depending on each child's reading or using skill) to perform specified tasks (i.e. read books and solve problems in activities). Results of these observations are presented in section 6.3.

The prototypes evaluation process started with a review of Book Builder heuristically. Its functionalities were noted and compared with other e-book builder initiatives to establish its relative strengths and weaknesses (the results are presented in section 5.2.2). The outcomes of the comparison, along with the results of the first sub-objective, formed the basis of two sets of questionnaires (see Appendices F and G) which were then used to measure teachers' and experts' perceptions of the proposed e-book concept and e-book builder's perceived usefulness and ease-of-use.

In analysing the perceived usefulness and ease-of-use of the proposed e-book and e-book builder functionalities, **expert reviews**<sup>7</sup>, **empirical testing** and **prototyping** approaches were selected. No method of data collection is without limitations, and as a result more than one method is often needed to supplement the limitations of the other methods (Nachmias & Nachmias, 1981). Consequently, to overcome the limitations of expert reviews (such as overlooking problems and difficulties that hinder naive users), an empirical method was also selected (i.e. testing with real users).

A prototype is an initial version of the intended system. In this project, prototypes were divided into **throw-away**<sup>8</sup> and **ready-made**<sup>9</sup> (see Figure 3.6). The first type (the throw-away) was used to analyse the activity examples and would be discarded when the final system has been successfully developed. The latter (i.e. the ready-made) was actually the first version of Book Builder, which was used to verify the functional aspects of the requirements.



**Figure 3.6:** *Two types of prototype*

<sup>7</sup> In EBoChi, expert reviews involved experts evaluating the Book Builder program based on their personal experiences.

<sup>8</sup> A throw-away prototype is produced to help discover requirements or problems and is then discarded. This term is commonly used in the software engineering area.

<sup>9</sup> Because EBoChi was using an existing e-book builder, the term “ready-made prototype” was introduced.



This project adopted the prototype technique for the following reasons:

- it allows users to experiment and at the same time develop an understanding of how the system can be used to support their work;
- it may also help to establish the overall feasibility and usefulness of the system before high development costs are incurred;
- since front-end interface requirements were one of the main concerns in the non-functional requirements, prototyping was seen as the only effective way to show users the proposed interface of an e-book containing features of the suggested model.

### **3.6.2.1 The Throw-away Prototype**

The throw-away prototype was developed using an Internet-based development tool: Dreamweaver™ from Macromedia. This tool was selected because the prototype was required to be on-line for easy access to participants, and to incorporate many hyperlinks to other on-line activity initiatives. In addition, the tool allowed a fast way of developing front-end interfaces through visual editing, thus reducing design time by as much as 20 times compared to powerful code-based programming languages (Shneiderman, 1998). Furthermore, users can make changes easily without having to deal with HTML code.

The development of the throw-away prototype started with the design of its screen layout and icons. When these were finalised, existing program initiatives available from other studies and resources relevant to EBoChi were linked to the prototype. So, for example:

- to illustrate what a colouring program is, a program by Coloring.com, a site dedicated for children, was linked to the painting icon in the prototype;

- to show, what a jigsaw puzzle is, a program found at Kids carnival.com, a site dedicated for children, was linked to the appropriate icon in the prototype;
- to teach children how to read music notes they were shown a site at Familygames.com;
- to show what a sing along activity is, a program at Kiddonet.com was linked to the appropriate icon in the prototype.

In short, all the programs which illustrated activities which were included in the throw-away prototype were adopted from other initiatives. It was believed that for the purpose of just showing to teachers and children what an activity program is (which is the intention of this early design stage), it would be more convenient and beneficial simply to adopt existing initiatives. This was convenient in the sense that it would save time and resources, and beneficial in that EBoChi could collect and group other initiatives into an environment, thus promoting them to the end-users (Norshuhada & Landoni, 2001a; 2002). These programs, however, would need to be individually developed by teachers using tools provided by the proposed e-book builder.

Table 3.5 shows the activity programs and their source selected for the purpose of this study (see Appendix A for descriptions of each source). Please note that some of the Web sites might now be outdated and missing from the appropriate servers.



Table 3.5: Source of activity programs

Description of activity	Program source
Drawing program for children	<a href="http://www.cs.ruu.nl/~markov/kids/draw/">www.cs.ruu.nl/~markov/kids/draw/</a>
Colouring program	<ul style="list-style-type: none"> <li>▪ <a href="http://www.coloring.com/working/begin.cdc?img=summer">www.coloring.com/working/begin.cdc?img=summer</a></li> <li>▪ <a href="http://www.coloringpage.org/">www.coloringpage.org/</a></li> </ul>
Clip-art program	<a href="http://www.awesomeclipartforkids.com/">www.awesomeclipartforkids.com/</a>
Jigsaw puzzle	<a href="http://www.kidscarnival.com/Jig01.html">www.kidscarnival.com/Jig01.html</a>
Guitar playing	<a href="http://www.4kids.org/funstuff/music/instruments/guitar/">www.4kids.org/funstuff/music/instruments/guitar/</a>
Keyboard music making	<a href="http://www.kidsdomain.com/brain/music/games/keyboard.html">www.kidsdomain.com/brain/music/games/keyboard.html</a>
Sing-along and recording program	<ul style="list-style-type: none"> <li>▪ <a href="http://www.niehs.nih.gov/kids/musicchild.htm">www.niehs.nih.gov/kids/musicchild.htm</a></li> <li>▪ <a href="http://www.kiddonet.com/kiddonet/kidsOnBoard/studio/index.htm">www.kiddonet.com/kiddonet/kidsOnBoard/studio/index.htm</a></li> </ul>
Music listening activity	<a href="http://www.wubbiesworld.com/playwubbiesound.html">www.wubbiesworld.com/playwubbiesound.html</a>
Learn to read music notes	<a href="http://www.familygames.com/free/notecard.html">www.familygames.com/free/notecard.html</a>
Music games	<a href="http://www.playmusic.org/percussion/index.html">www.playmusic.org/percussion/index.html</a>
Dancing tunes activity	<ul style="list-style-type: none"> <li>▪ <a href="http://www.isy.vcu.edu/~paiken/creativity/dogs/wftmsong/indexwftmsong.htm#Anchor-I've-23094">www.isy.vcu.edu/~paiken/creativity/dogs/wftmsong/indexwftmsong.htm#Anchor-I've-23094</a></li> <li>▪ <a href="http://judyanddavid.com/cma.html">judyanddavid.com/cma.html</a></li> </ul>
Write with word processor	<a href="http://www.spasoft.co.uk/writeon.html">www.spasoft.co.uk/writeon.html</a>
Read interactive storybook	<a href="http://www.antelope-ebooks.com/CHILDPIX/pickle1.html">www.antelope-ebooks.com/CHILDPIX/pickle1.html</a>
Word puzzle	<ul style="list-style-type: none"> <li>▪ <a href="http://kidsdomain.funschool.com/current/games/xw1_ds1,1">kidsdomain.funschool.com/current/games/xw1_ds1,1</a></li> <li>▪ <a href="http://www.kidsdomain.com/holiday/fall/games/word2.html">www.kidsdomain.com/holiday/fall/games/word2.html</a></li> </ul>
Maths solving or maths games	<a href="http://kidsdomain.funschool.com/current/games/ag1_ds1,1">kidsdomain.funschool.com/current/games/ag1_ds1,1</a>
Strategy games	<a href="http://www.familygames.com/free/ptt.html">www.familygames.com/free/ptt.html</a>
Mystery games	<ul style="list-style-type: none"> <li>▪ <a href="http://www.w3c2.com.au/onthejob/game/">www.w3c2.com.au/onthejob/game/</a></li> <li>▪ <a href="http://www.thecase.com/kids/aol">www.thecase.com/kids/aol</a></li> </ul>
Interactive arcade games	<a href="http://www.funschool.com/current/games/arcade_sk2_skigame,k">www.funschool.com/current/games/arcade_sk2_skigame,k</a>
Physical activity	<ul style="list-style-type: none"> <li>▪ <a href="http://www.sikids.com/games/breakaway/breakaway.html">www.sikids.com/games/breakaway/breakaway.html</a></li> <li>▪ <a href="http://www.sikids.com/games/index.html">www.sikids.com/games/index.html</a></li> </ul>
Drill and practice program	<ul style="list-style-type: none"> <li>▪ <a href="http://kidsdomain.funschool.com/current/games/fgk_1bgd,mg">kidsdomain.funschool.com/current/games/fgk_1bgd,mg</a></li> <li>▪ <a href="http://kidsdomain.funschool.com/current/games/plk_ds1,k">kidsdomain.funschool.com/current/games/plk_ds1,k</a></li> </ul>
Digital diary	<a href="http://www.ajebe.com">www.ajebe.com</a>
Concentration games	<ul style="list-style-type: none"> <li>▪ <a href="http://kidsdomain.funschool.com/current/games/cnk_ds4,1">kidsdomain.funschool.com/current/games/cnk_ds4,1</a></li> <li>▪ <a href="http://www.parentinghumor.com/cgi/games/concent2/concentration.cgi">www.parentinghumor.com/cgi/games/concent2/concentration.cgi</a></li> </ul>
Email for children	<a href="http://www.headbone.com/friends/mail">www.headbone.com/friends/mail</a>
Voice chat for children	<a href="http://www.talkme.com">www.talkme.com</a>
Multiplayer games	<ul style="list-style-type: none"> <li>▪ <a href="http://www.kidsdomain.com/games/multi.html">www.kidsdomain.com/games/multi.html</a></li> <li>▪ <a href="http://play.yahoo.com/games/yahooligans.html">play.yahoo.com/games/yahooligans.html</a></li> </ul>

### 3.6.2.2 The Ready-made Prototype

In order to develop e-books that contain the types of activities listed in Table 3.5, an e-book builder that supports the creation of such features was required. Initially, this e-book builder was planned to be developed as part of the EBoChi project. However, half way into the project, a product that fulfils part of this study idea was put on the market by Software Production Associates (SPAsoft). It was then decided that in order to address issues such as lack of time, budget and manpower, the Book Builder would be used instead to assist in fulfilling part of the system requirements.

Book Builder enables children to put together multimedia books containing text, pictures, sounds and videos with very little effort. When the book is completed, other children can view, use and hear it with simple navigation controls (SPAsoft, 2000). 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, and a video (see Figure 3.7). They then add content by 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. Write On for Windows is a good example of a children's word processor (see Figure 3.8).



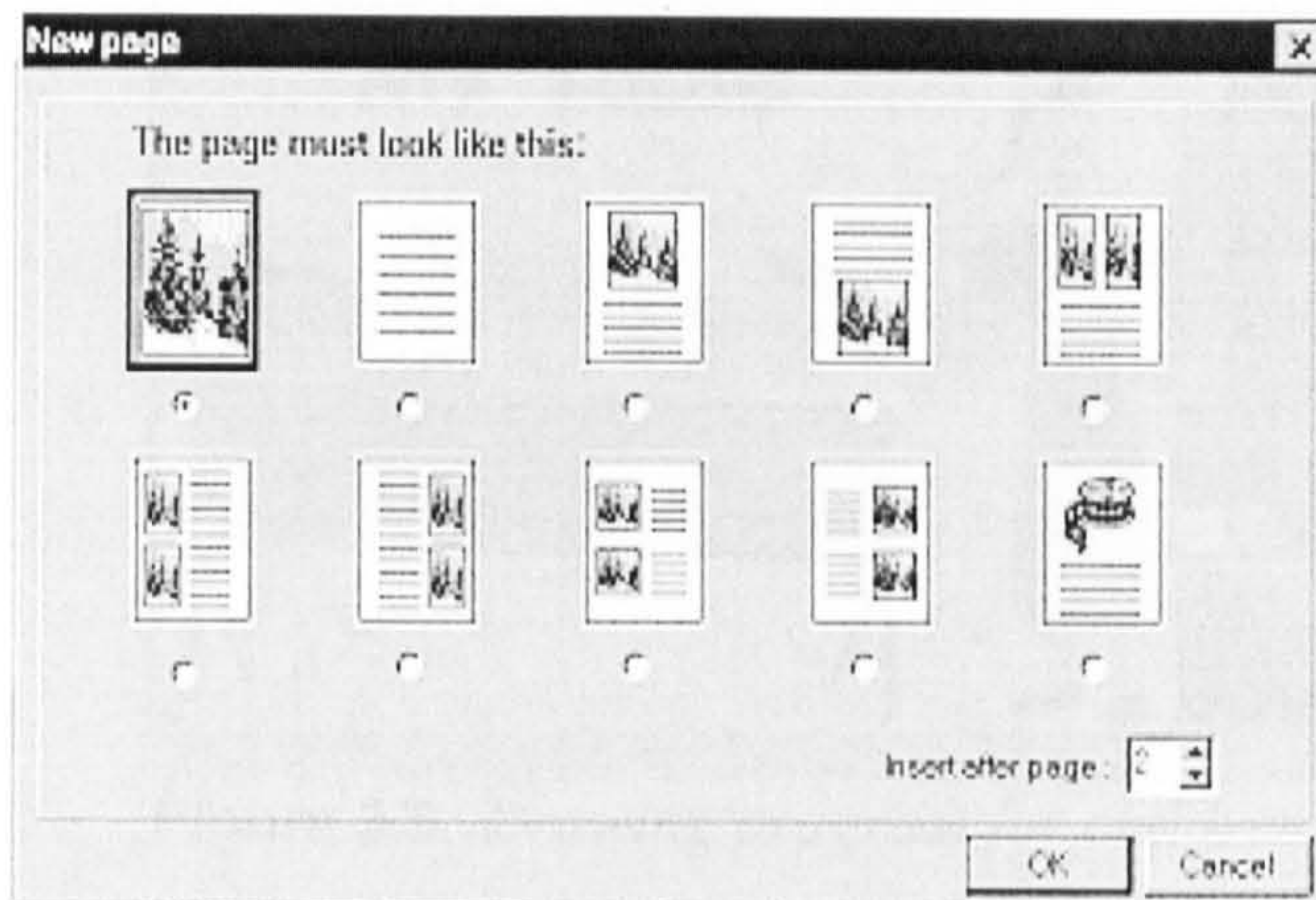


Figure 3.7: Page type in Book Builder

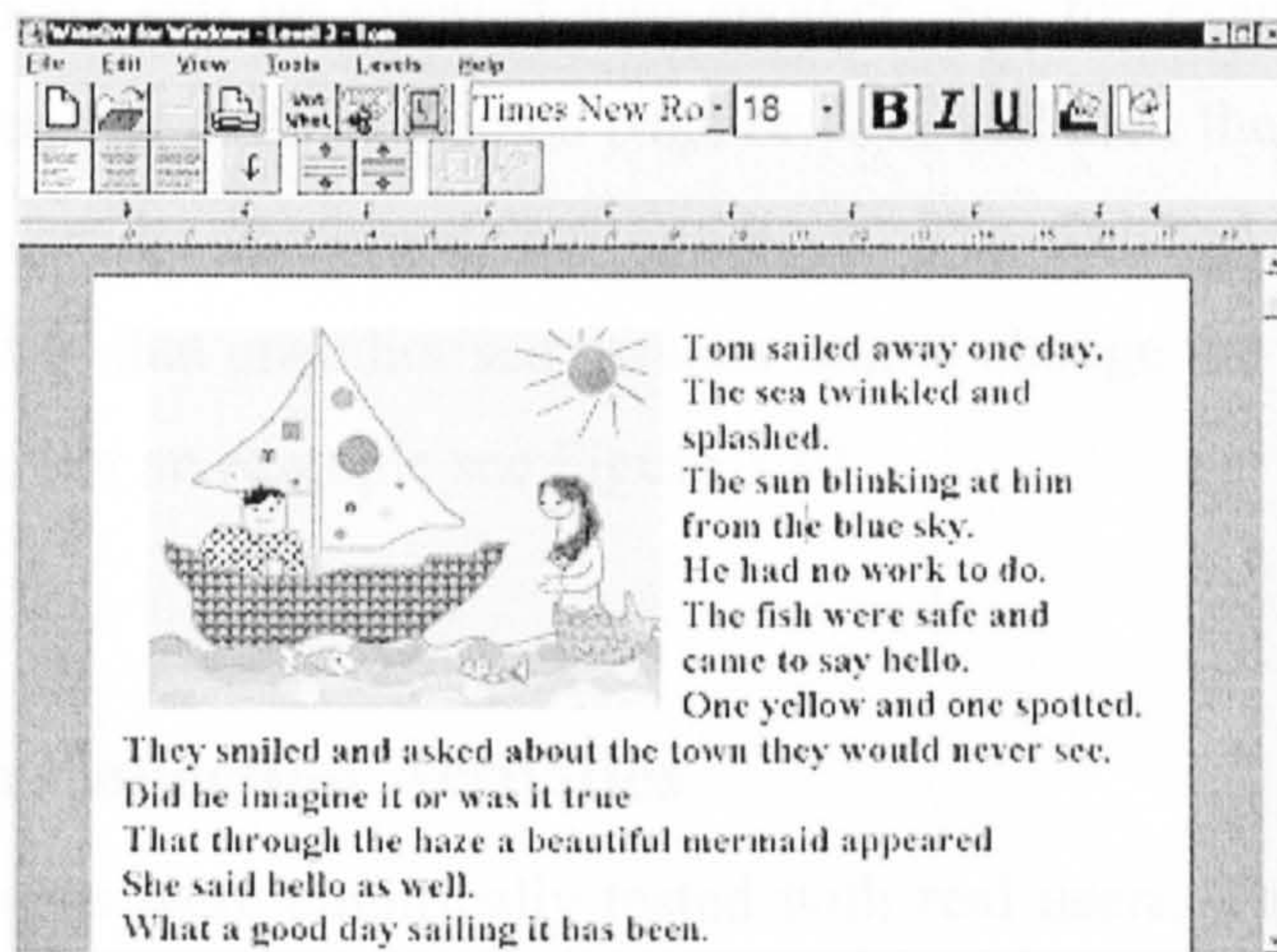
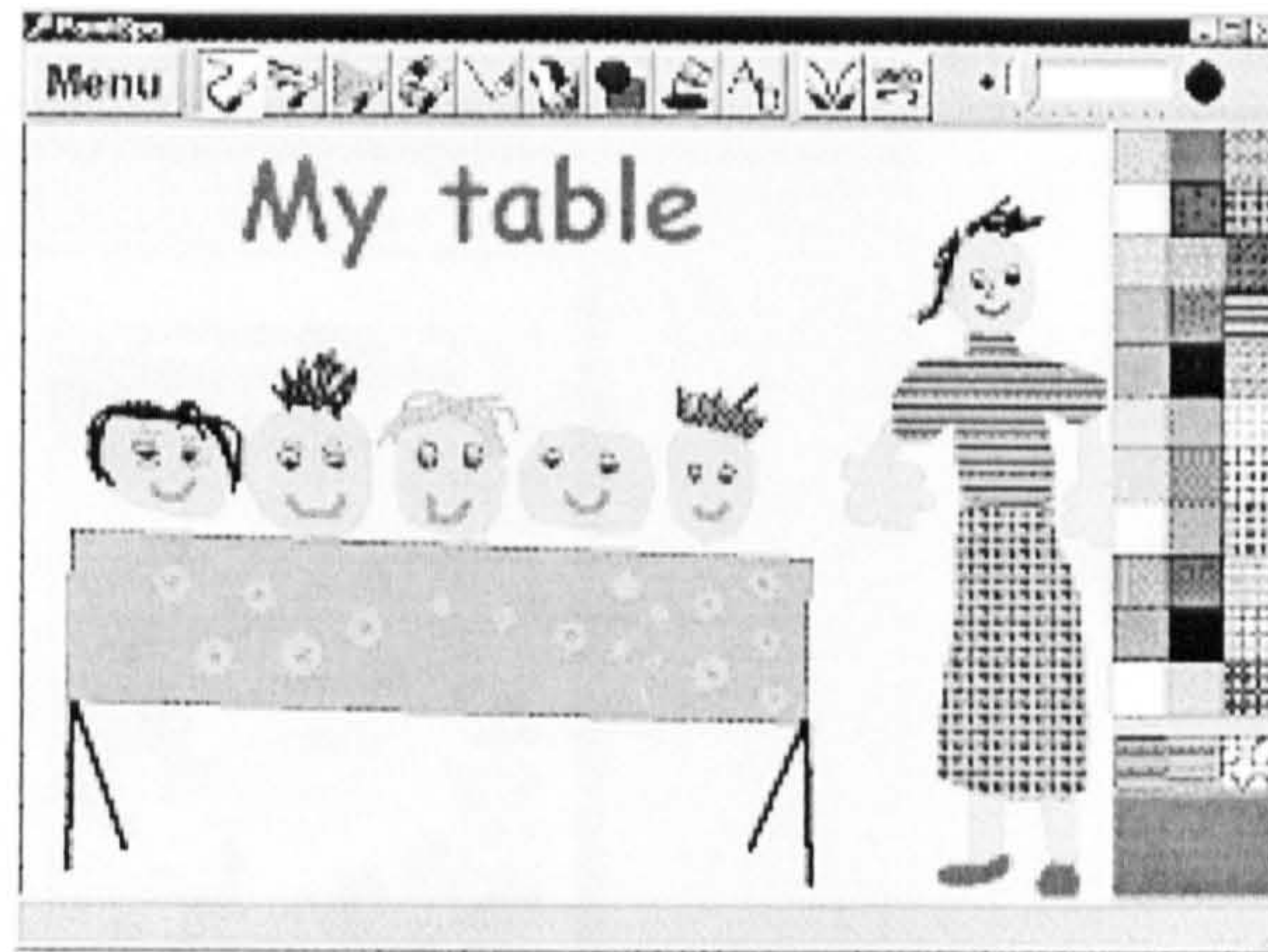


Figure 3.8: Write On for Windows

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. PaintSpa is an example of such a drawing and painting program for children (see Figure 3.9). On top of this, users can easily record a sound-track or insert a video to be included on a page.





**Figure 3.9:** *Drawing program for children*

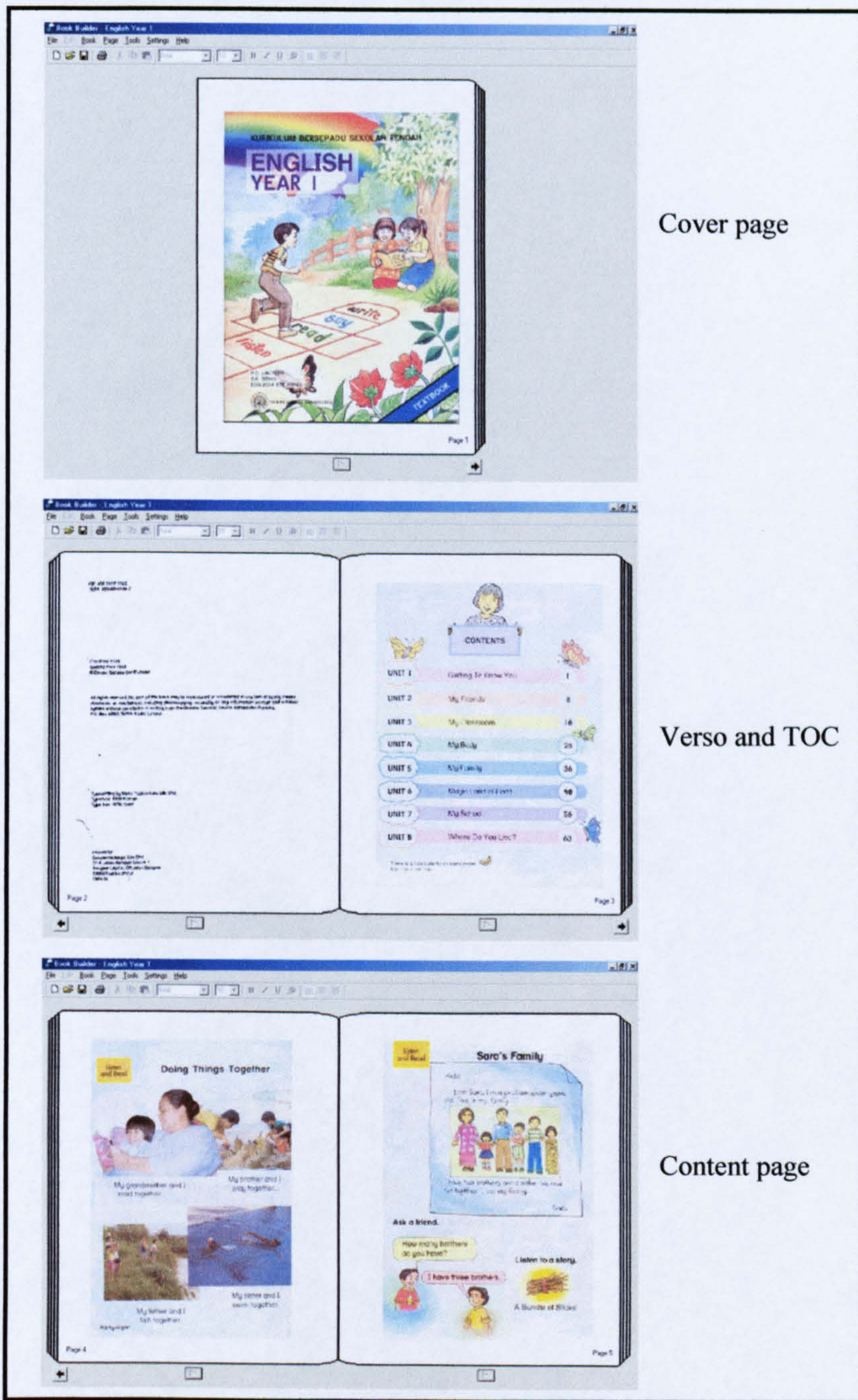
Book Builder also supports collaborative work between children. One book can be inserted into another. So, for example, pairs of children can each work on a page or two, and then the whole class's pages can be combined into one book. The finished books can be locked so that unauthorised persons cannot change the content of the books. For an example see Figure 3.10.

### 3.6.3 Data Collection Activities

Both prototypes were empirically tested with real users. The participants in this study were samples of real users who could have been teachers, school children and parents. However, since this study was restricted to a school environment, it was assumed that parents are not directly involved in class activities. Thus only teachers and children were used as subjects.

Data for teachers and children were collected in July and August 2001. Two one-day workshop sessions were conducted for the teachers. Each session started at 9.00 a.m. and ended at 5.00 p.m. The first three hours were spent on training teachers to use both prototypes. The rest of the time was used for teachers to complete specified tasks and answer the questionnaire.





Cover page

Verso and TOC

Content page

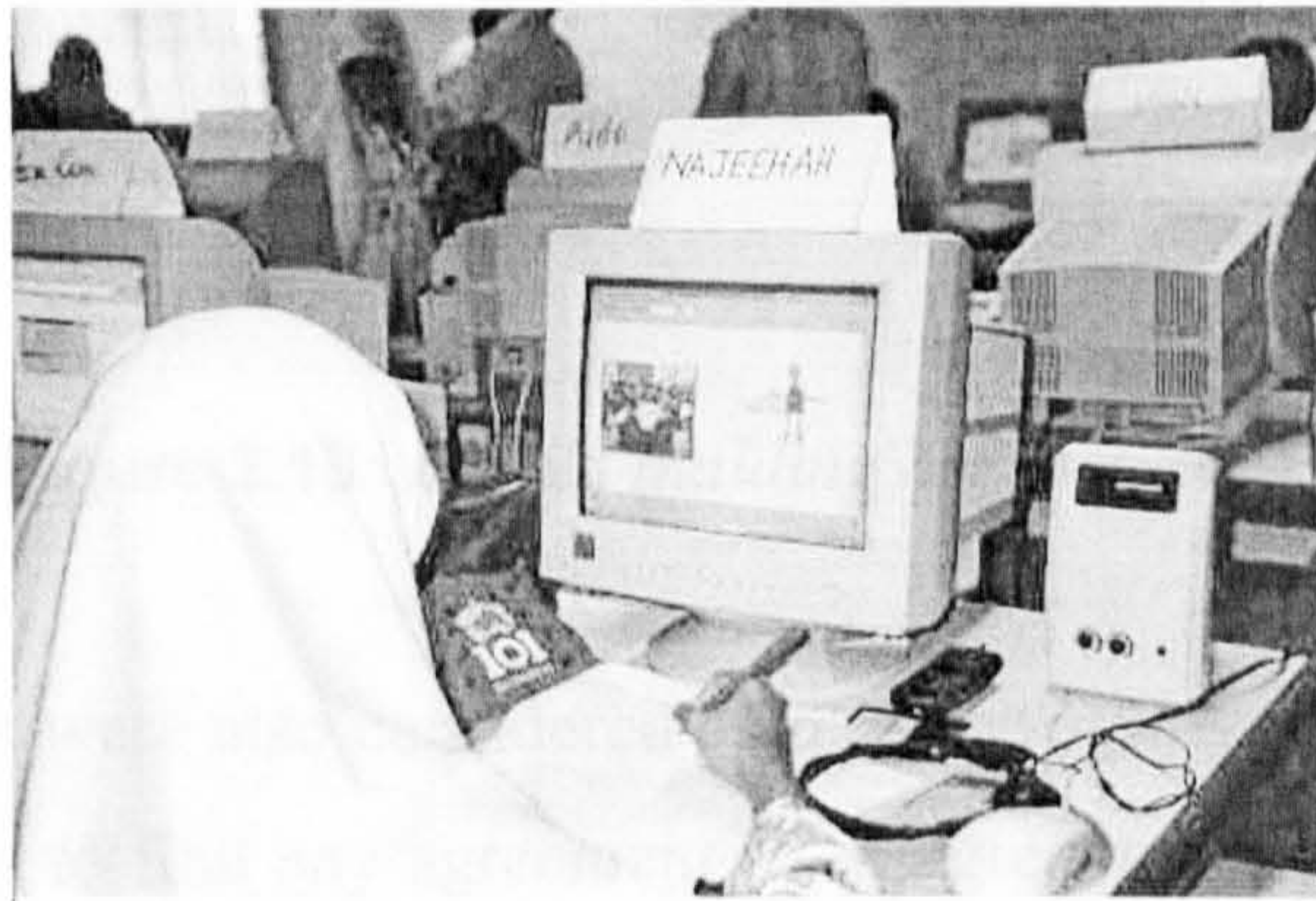
**Figure 3.10:** An example of a completed book

The Kedah State Education Department (one of the states in Malaysia) selected the participants<sup>10</sup> for the first workshop which was conducted in the State Resource Centre computer laboratory (PSPN Alor Setar). The second workshop was conducted in collaboration with a Kedah Teacher

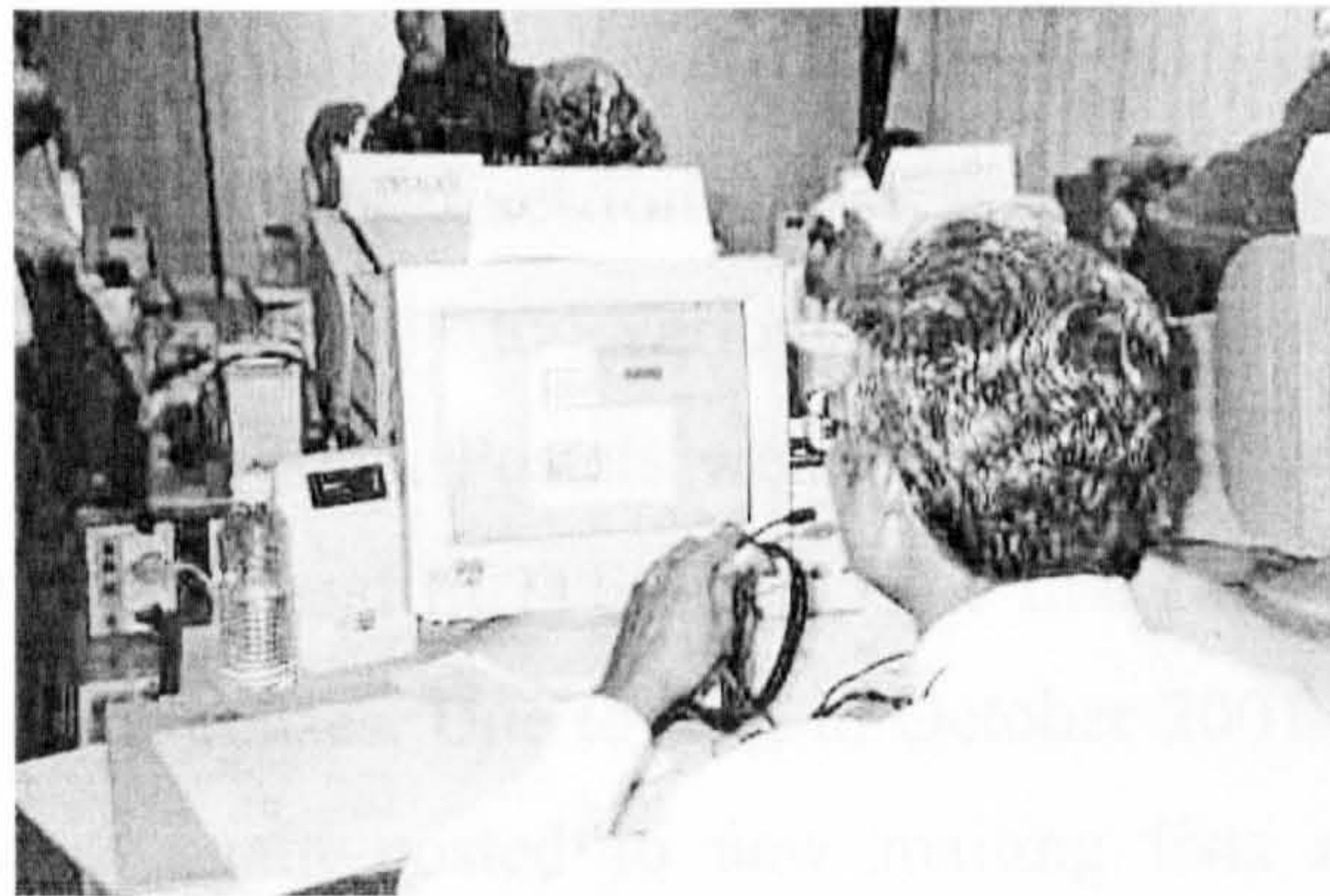
<sup>10</sup> Selection was conducted according to EBoChi criteria (see chapter 6).



Training College (Maktab Perguruan Sultan Abd. Halim, Sungai Petani). At that time, the college<sup>11</sup> was running a computer course for selected in-service teachers, and the researcher was allocated a one-day slot to perform the evaluation. At the end of each workshop, participants were presented with “thank-you certificates” (see Appendix B) from the Department of Information Science, Strathclyde University. A total of 58 teachers (see Figures 3.11 and 3.12) from the schools listed in Appendix C participated in the evaluation.



**Figure 3.11:** *A teacher trying one of the e-books*



**Figure 3.12:** *A teacher recording his voice for his e-book*

Children aged 7 to 9 were selected randomly from the attendance lists by the head teachers whose schools were visited and sometimes by the class teachers. Interactions with children were conducted face-to-face, one at a time (see Figure 3.13). Each child was first trained to use both prototypes.

<sup>11</sup> EBoChi appreciates and thanks the Head of Computer Department for his collaboration.



After gaining confidence, they were asked to use Book Builder to build a 5-page book. In addition, they were also asked to try activities provided in the throw-away prototype. Since interaction with each child was very time consuming, and data collection time was limited, only 15 children were sampled.

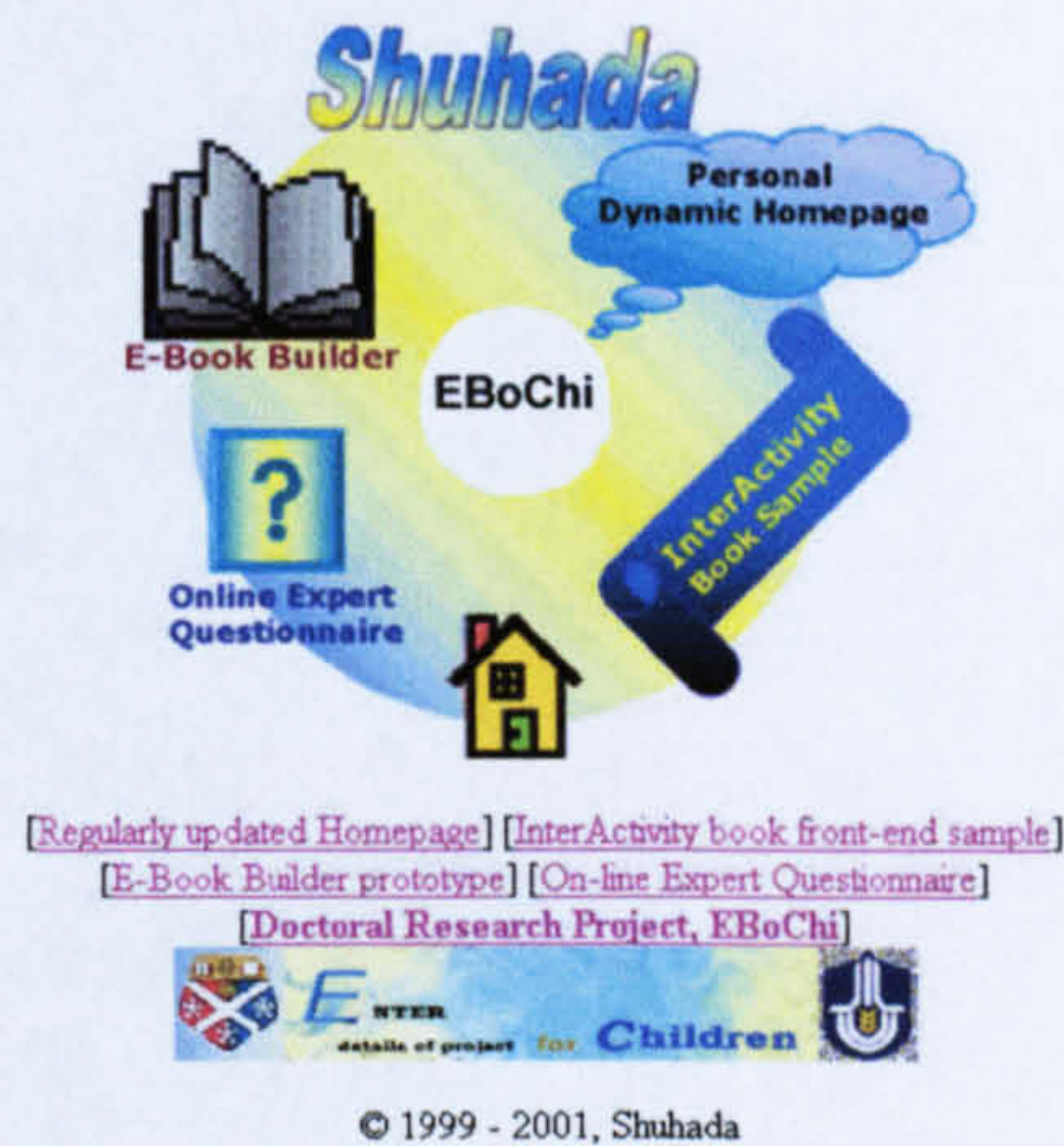


**Figure 3.13:** *A child building her own book*

E-book experts were also considered as research subjects since this study was also trying to find any agreement or disagreement between teachers' and experts' perception. Experts were asked to download Book Builder (see Figure 3.14 for the Web site developed specifically for EBoChi) and then perform the same tasks as the teachers before answering the questionnaire. The experts' questionnaire was put on-line and calls for participation were posted to various mailing lists (e.g. e-book community<sup>12</sup>) in June 2001. Posters were also distributed in conferences (e.g. ED-MEDIA 2001 and ECITE 2001). The first calls for participation received only 13 responses. Due to this, in October 2001 second calls for participation were again posted to new mailing lists and individuals. Another 8 experts responded making a total of 21.

<sup>12</sup> See the call for participation at <http://www.planetebook.com/ebooks/ebook-list/ebook-list-12685.html>





**Figure 3.14:** *Index Web page for EBoChi*

### 3.6.4 EBoChi Data Collection Techniques

Data for evaluation purpose were collected using two techniques: questionnaire and co-operative enquiry. Questionnaires were used to collect data from the teachers and experts and were adopted because it is a technique which is particularly useful when large numbers of participants are expected (in this case 50 teachers were expected and more than 30 experts were targeted). Additionally, part of the data (i.e. perceived usefulness and ease-of-use of computer applications) that was needed to prove some of the hypotheses, could be acquired by adopting a well-validated instrument in the form of questionnaire, which is readily available in Davis (1989; 1993) and Adams et al.(1992). Davis (1989) developed the questionnaire to measure the level of technology acceptance of the potential users.

When designing a questionnaire, it is necessary to conduct a pilot study to identify any ambiguous and inaccurate (or irrelevant) questions, the appropriateness of the content of the questions, and the appearance and length of the questions. In EBoChi, five teachers participated in the pilot and changes to the questionnaire were made according to their responses (see Appendix D).



Since it is seen as the most appropriate technique for working with children, the co-operative enquiry technique was used to gather data from them (Druin, 1999). Co-operative enquiry was developed by Professor Allison Druin and it 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 includes three crucial steps:

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

However, in EBoChi, instead of the definition used by Druin (1999), the word "co-operative enquiry" was adopted but defined as a data collection technique with children while in their environment. It differs from Druin's definition in that children were employed as testers not design partners who have voices during development. The researcher became a participant observer with an observation form (see Appendix E) and a notebook, talking naturally to the children as they were using both Book Builder and the throw-away prototype, and the reading devices. At the same time any questions asked during the sessions were answered.

### **3.7 Conclusions**

The main aims of EBoChi were to propose features for e-books and e-book builder. To achieve these aims the literature suggests that requirements engineering should be performed. Therefore, the primary methodology for this study was based on the activities involved in requirements engineering. Three stages were involved, namely elicitation, specification and validation. For each stage, a number of methods were selected based on their appropriateness to meet the EBoChi's objectives (see Figure 3.15).



A comprehensive study prior to the selection of methods revealed that the most suitable modelling techniques to specify the proposed requirements were graphical notations, tables and set formalism. In addition, in order to validate the proposed requirements three main methods, that is, prototyping, empirical testing and expert reviews were selected. Two prototypes were utilised to collect data with the potential users. For this purpose, a number of schools were visited and two workshops were conducted.

The main data collection techniques for EBoChi should measure teachers' and experts' perception, and also involve children while they were in their school environments. For such purposes, questionnaire and co-operative enquiry techniques were used to collect the data.

In conclusion, this chapter has described the activities and processes involved in achieving all the research objectives. It has also described the various theories, definitions, methods, advantages and disadvantages, which are relevant to the EBoChi project. Table 3.6 shows the number of participants involved in this study and Figure 3.15 shows how the activities contributed to the realisation of the outcomes of each objective.

**Table 3.6:** *Number of participants involved in the study*

Activities	Number of participants involved
DCD Approach: Initiation Phase	1 head-teacher
DCD Approach: Construction Phase (Initial interface design)	1 head-teacher, 1 teacher, 2 children, 2 designers
Validation of icons and metaphors	10 children
Pilot study	5 teachers
Initial review of Book Builder	1 researcher, 3 children
E-Books on hardware testing:	
1. Laptop	6 children
2. Dedicated reader	4 children
Prototype and empirical testing	58 teachers, 15 children
Expert reviews	21 e-book experts



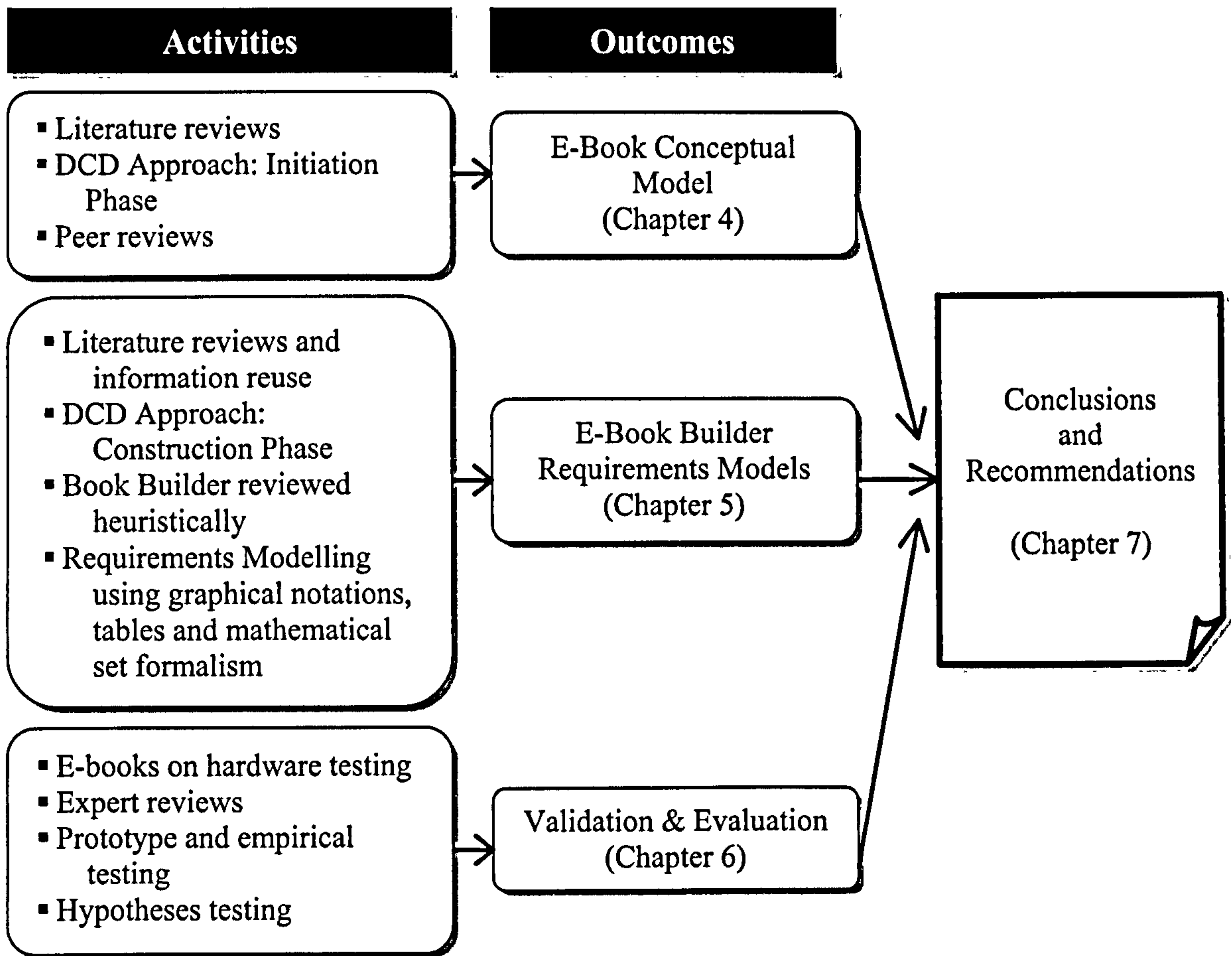


Figure 3.15: Activity-Outcome summary

Having described and discussed the methodology of this study, the following chapter outlines the outcomes of the literature review, the Initiation phase of the DCD approach and peer reviews. Chapter 4 will introduce the concept behind the proposed e-book, which EBoChi calls the **InterActivity<sup>13</sup> Book** to represent the inclusion of interactive educational activities in children's e-books.

<sup>13</sup> InterActivity = Interactive + Activity

Throughout this thesis, interactive is defined as responses of the e-book to users' control.



# Chapter 4

## InterActivity Book Conceptual Model

### 4.1 Introduction

This chapter presents the conceptual model of the proposed e-book and it serves to validate the first sub-objective of this research. This has been achieved through careful consideration of related literature, input from stakeholders and feedback from peer reviews.

In most software development, the first and foremost stage is to build ideas and present them in the most effective ways. This is accomplished by building a conceptual model. This phase is often referred to as the concept development phase.



It involves the task of inventing and evaluating ideas and is normally practised more in the development of interactive multimedia programs (Stansberry, 1998). Since e-books are an example of interactive programs, the conceptual model has first to be built.

Formal models that describe the structure of e-books already exist (see Barker & Manji, 1991; Barker & Giller, 1991; Richards et al., 1991; Barker, 1999). Functional aspects and their definitions are also available and described in detail by Catenazzi (1993) and Landoni (1997). However, none of these models discuss the presentation of content and activities involved in book pages. Because EBoChi was concerned with children's multimedia electronic textbooks, a significant emphasis needs to be placed on the content of each page and the activities involved in making sure interaction and learning occur.

As mentioned earlier in section 2.5, one of the main problems of current learning tools for children is that they do not provide various activities which exhibit children's daily activities (i.e. most initiatives involve only drill and practice programs, drag and drop activities, or hotspots clicking). Therefore, the proposed e-book model gives particular attention to designing activities which are seen as appropriate for children.

The following section describes the conceptual model of the proposed e-book (i.e. the InterActivity Book) which has been constructed to cater for the seven intelligences identified in Gardner's theory (Gardner, 1991; 1993). This model is defined in terms of structure and content presentation (see Figure 4.1) and based on the paper book metaphor.



**E-Book = structural components + content presentation components**

**Figure 4.1:** *InterActivity Book components*



## 4.2 Structural Components

EBoChi defines the following minimal requirements for recognising a program as following a book metaphor: front and back covers, a number of content pages and forward and backward navigation. The InterActivity Book is intended to maintain the essential features of a paper book while at the same time adding new ones by taking advantage of computer technology.

Maintaining book metaphor features such as a table of contents, indexes, page numbers, has proved to be helpful in lessening the cognitive load of end users (Barker, 1993; Barker et al., 1994; Catenazzi & Sommaruga, 1994a, 1994b; Catenazzi, 1993; Landoni, 1997; Crestani & Melucci, 1998; Landoni et al., 2000; IBM Guidelines, 2001). Henke (1999, 2001) conducted a study to find how satisfied or dissatisfied users were with the use of the book metaphor. He concluded that e-book design should mimic the paper book by incorporating as many paper book features as possible. Users have also shown a preference for the paper book metaphor to navigate and find information (Henke, 2001). It is assumed here that even if young children have prior experience only with card books and flip books, this condition also applies. However as a suggestion, a proper study of this issue should also be conducted on children<sup>1</sup>.

Nonetheless, this study recognises that some researchers such as Nielsen (1998), Shneiderman (1998), Rowland, Bell & Falcon (1997) and Woodward et al. (1997) do not share the same view. They reject the theory that use of a paper book metaphor in e-books is necessary. They also claim that the book metaphor limits the potential of e-books and leads to poor design that at best attempts to match the paper book but not surpass it. Nielsen (1998) particularly opposed the idea of mimicking paper books and stated that page turning remains a bad interface and designers should focus on using functions like search and hypertext linking to provide a more

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<sup>1</sup> This issue is outside the scope of EBoChi, therefore no further discussion will be directed at it.



powerful user experience. EBoChi does not intend to focus on this issue because it is believed the debate will continue.

Before the structure of the children's e-book could be presented, a comparison of the printed version of children's and adult's textbooks was performed. As mentioned earlier, detailed e-book models do already exist. However, most of them have been developed and implemented mainly for use by adults. The existing models are generalised models more suited to higher-level textbooks and scientific books. The InterActivity Book structure on the other hand is designed specifically for young children. Additionally, the structural components of children's e-books ought to be based on the structure of children's printed books since children aged between 7 and 9 normally have been introduced to books (at least card books and flip books) before they enter a school environment.

Figure 4.2 shows the comparison results based on a sample of five children's textbooks and five adult's textbooks covering various topics: science, mathematics, language, and geography. All the books are textbooks used in either primary schools (pupils aged 5 to 12) or university (students over 18 years old). No secondary school textbooks (students aged between 13 to 17) were taken into account because the InterActivity Book focuses on the differences between young children (aged 7 to 9) and adults (aged 18 and over).



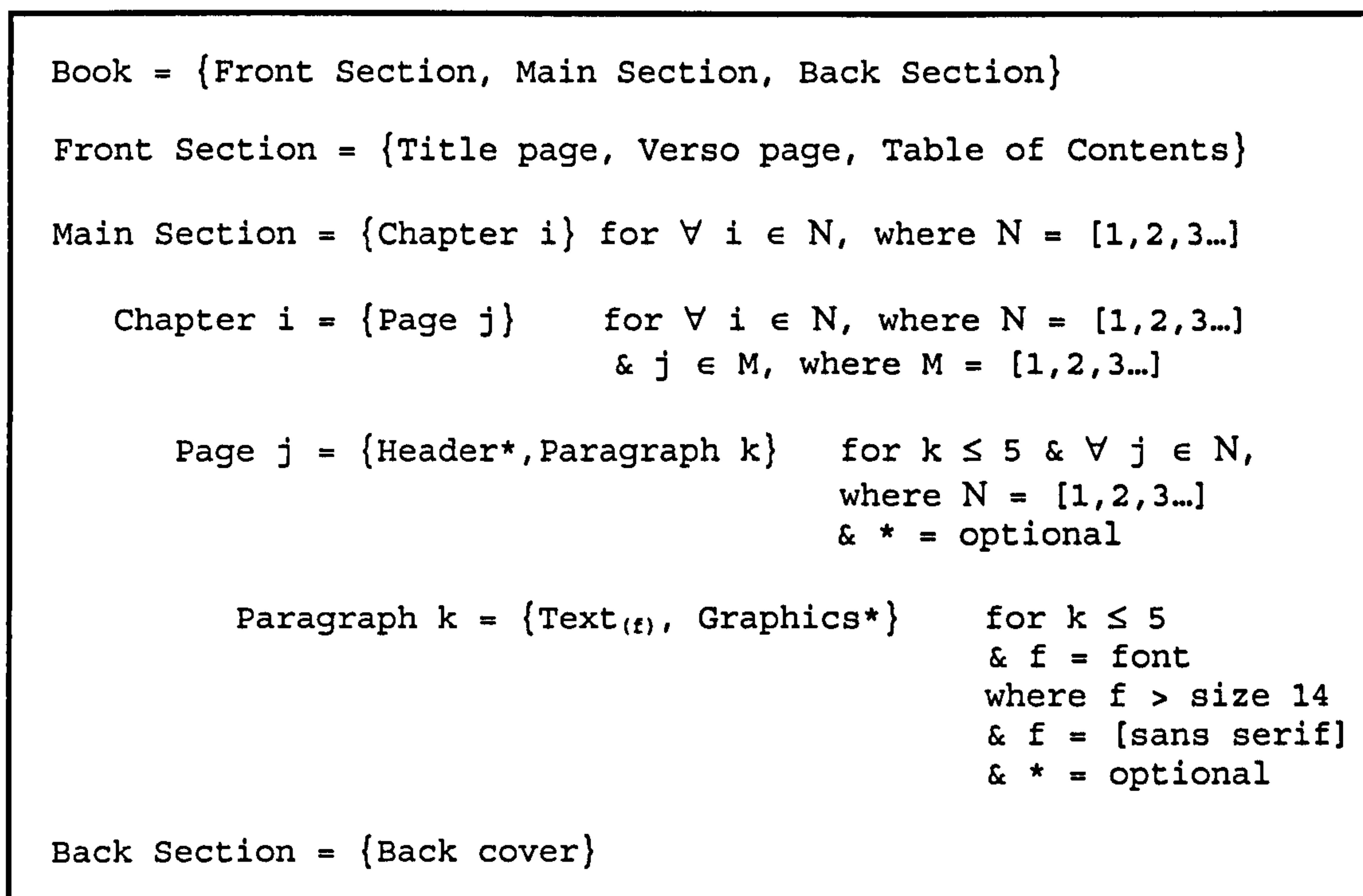
	<b>Most adult textbooks</b>	<b>Most children textbooks</b>
<b>Front Section</b>	Title page Verso page Abstract Foreword Preface Acknowledgement Dedication Table of Contents List of Tables List of Figures	Title page Verso page Table of Contents
<b>Main Section</b>	Chapters Pages Header Paragraphs Text Graphics Tables Figures Links Footnote	Chapters Pages Header Paragraphs Text Graphics
<b>Back Section</b>	Back Cover References Bibliography Index Glossary Biographical Appendices	Back Cover

**Figure 4.2:** Comparison between adult's and children's printed textbooks structure

Although Figure 4.2 shows that in each section there should be the listed components, please note that not every component must be included in a book. By



adopting mathematical sets and with reference to Figure 4.2, it can be suggested that the structural components specifically needed for a children's e-book are as specified in Figure 4.3 (Norshuhada & Landoni, 2000a; 2001a; 2001b; 2002).

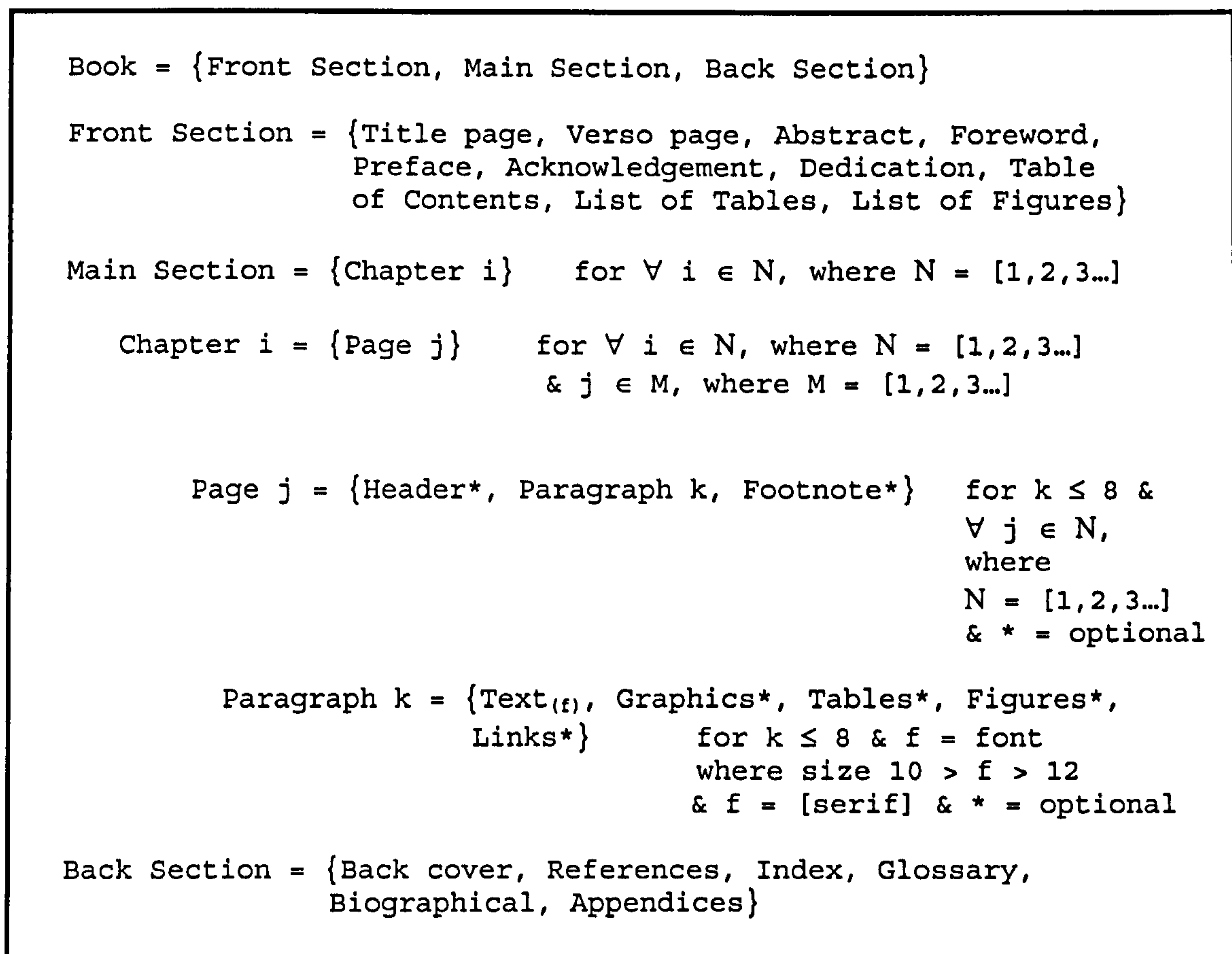


**Figure 4.3:** *Structural components of children's e-books*

In the above definitions, **main section** can have as many chapters as required and in each chapter there is no limit to the number of required pages. However, in each page, the number of paragraphs for children's textbooks (including images) is frequently less than five, with an average of three. The text used in each page should have font size larger than 14 point with types in the category of sans serif.



Structural definitions for adult textbooks entail more components as follows:



**Figure 4.4:** *Structural components of adult's e-books*

In the above definitions, **main section** can have as many chapters as required and in each chapter there is no limit to the number of required pages. However, in each page, the number of paragraphs for adult textbooks (including images, tables, and figures) is frequently less than eight. The text used in each page usually has a font size of between 10 and 12 with types in the category of serif (normally Times New Roman).

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Note meaning of the following symbols in Figures 4.3 and 4.4

$\forall$  means all

$\in$  means subset of



Having described the structural components, it is now appropriate to discuss the content components of children's e-books.

### 4.3 Content Presentation Components

Designing e-books for learning needs greater effort to be directed to the presentation of a book's contents since this will partly determine the success of the learning process. It is important to design carefully the way content is structured, organised, and presented. The types of activity in which the users will be involved play significant roles in the success of pedagogic design (Barker & Manji, 1991). Thus, studies on what kinds of activity cater for most users' needs are indeed helpful in promoting better children e-book design (Pickering, 1999).

Content presentation should be viewed in terms of three criteria (Fetherston, 1998):

- the number of separate intelligences it engages;
- the extent that each is engaged; and,
- how well content can be accessed through each intelligence.

With regard to these criteria, listed below are some of the activities, which should be included in the design of children's e-book contents so as to meet the seven intelligences suggested in MI theory (Burrell, 1998; Campbell, 1997; Winters, 1997; Dickinson, 1998; Distance Learning Resource Network, 2000; Edwards, 1996; Keith, 2000; Pickering, 1999):

(a) Activities which should be considered when meeting **verbal/linguistic** intelligence:

- Writing essays, poems, articles with word processing software;
- Annotating voice;
- Recording speech;
- Reading;



- Story telling;
- Interviewing activities;
- Article discussion;
- Listening.

(b) Activities which should be considered when meeting **visual/spatial** intelligence:

- Drawing programs;
- Painting programs;
- Using a spreadsheet to create charts and diagrams;
- Interacting with interactive maps;
- Manipulating digital images;
- Taking digital photographs;
- Building 2D and 3D models;
- Interacting with animation and motion pictures.

(c) Activities which should be considered when meeting **musical** intelligence:

- Story telling with songs;
- Sing-along programs;
- Creating music and songs;
- Playing musical instruments;
- Listening to music, rhythms and rhyme;
- Music games.

(d) Activities which should be considered when meeting **logical-mathematical** intelligence:

- Playing electronic games, puzzles, strategic games and logic games;
- Calculating and mathematics programs;
- Making estimation;
- Predicting how a story will end;
- Working with geometric shapes and patterns;

- Solving mysteries;
- Solving problems.

(e) Activities which should be considered when meeting **bodily-kinesthetic** intelligence:

- Inputting data using alternate input devices such as joy stick, mouse, touch screen and stylus pen;
- Allowing users to move objects around a computer screen;
- Including a lot of eye movement with animation;
- Providing eye-hand co-ordination games;
- Asking users to dance and act (i.e. perform physical activities);
- Providing hands-on construction kits that interface with the computer.

(f) Activities which should be considered when meeting **interpersonal** intelligence:

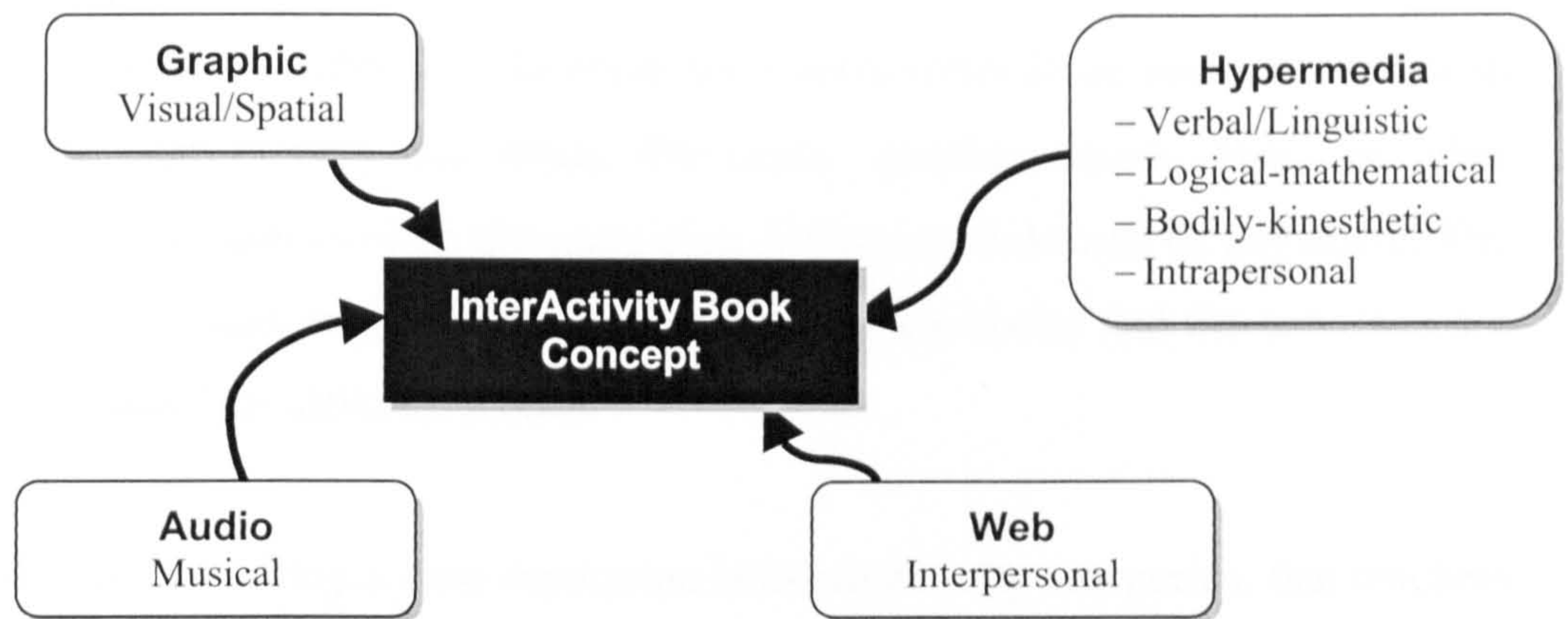
- Using email and chat programs;
- Allowing games which require two or more players;
- Providing instruction for group activities;
- Desktop conferencing/on-line discussions (probably not suitable for young children).

(g) Activities which should be considered when meeting **intrapersonal** intelligence:

- Providing drill and practice programs;
- Playing games where the opponent is a computer;
- Creating notes on daily activities/on-line diary;
- Assessing the user's own work;

The InterActivity Book groups the above activities into four modes: **graphic, audio, hypermedia** and **Web**. Each mode has activities that support at least one learning style. Figure 4.5 shows a summary of which intelligence each mode is catering for and Table 4.1 gives a few examples on how to match MI theory onto the development of the proposed e-book.





**Figure 4.5:** Summary of mode types and matching learning styles

**Table 4.1:** Matching activities with e-book concept

No.	Learning Styles	Matching Activities (i.e. possible programs that can be developed into the e-book)	Matching E-book Concept
1	Verbal/Linguistic	<ul style="list-style-type: none"> <li>Let users create essays in word processing software.</li> <li>Ask users to write stories.</li> <li>Let users read aloud.</li> <li>Include storytelling.</li> </ul>	Hypermedia page
2	Logical-Mathematical	<ul style="list-style-type: none"> <li>Include games and puzzles.</li> <li>Let users do some calculations.</li> <li>Let users solve problems.</li> </ul>	Hypermedia page
3	Visual/Spatial	<ul style="list-style-type: none"> <li>Let users draw and paint.</li> <li>Allow users to read and see information as graphics, maps, charts and diagrams.</li> </ul>	Graphic page
4	Bodily-Kinesthetic	<ul style="list-style-type: none"> <li>Include sport games.</li> <li>Let users move freely (dancing, or physical exercise).</li> </ul>	Hypermedia page
5	Musical	<ul style="list-style-type: none"> <li>Combine stories with songs.</li> <li>Let users sing along.</li> </ul>	Audio page
6	Interpersonal	<ul style="list-style-type: none"> <li>Include programs, which need two or more users at the same time.</li> <li>Include group projects or discussion.</li> </ul>	Web page
7	Intrapersonal	<ul style="list-style-type: none"> <li>Include games in which the opponent is the program.</li> <li>Let users solve problems on their own.</li> </ul>	Hypermedia page



The embedded components that make up children's e-books should include the activities depicted in Table 4.1. However, the InterActivity Book does not restrict an information type to only one mode. Obviously, graphic, music, video or other information types can exist on the same page. Of course links can be anywhere. The model merely concentrates on activities in children's e-books and the activities are categorised into four different modes.

It is believed, by making a clear separation between activity categories, that teachers can easily detect or measure which intelligence has or has not been addressed in any particular page. So, for instance, if a teacher has been executing activities in only one or two categories, he/she could then change his/her strategy to include activities in other categories. This indirectly nurtures other intelligences.

Children too can benefit from the classification. If children prefer a particular mode over the others, they could then learn to use the selected mode, thus providing them with more flexibility. Additionally, the definition in this model can also serve as a checklist of whether or not designers have included appropriate learning activities in their e-book development.

In order to produce the final content definition model, the definition of Page  $i = \{ \text{Header}, \text{Paragraph } j \}$  in Figure 4.3 needs to be changed to the definitions as shown in Figure 4.6 (Norshuhada & Landoni, 2000a; 2001a; 2001b; 2002).



Page  $i = \{\text{Contents, Objects}\}$  for  $\forall i \in \mathbb{N}$ ,  $N = \text{Num of pages} = [1, 2, 3, \dots]$

Contents =  $\{\text{Header, Paragraph } j\}$  for  $j \leq 5$

Paragraph  $j = \{\text{Text, Activity}\}$  for  $j \leq 5$

Activity =  $\{\text{Graphic-m, Audio-m, Hypermedia-m, Web-m}\}$

Graphic-m =  $\{\text{Program } G_i\}$  for  $\forall i \in GP$

where  $GP = \{\text{animation, draw and paint programs, spatial problem solving games, clip-art programs, and so on}\}$

Audio-m =  $\{\text{Program } A_i\}$  for  $\forall i \in TP$

where  $TP = \{\text{story telling, sing-along activities, making music, music listening, and so on}\}$

Hypermedia-m =  $\{\text{Program } H_i\}$  for  $\forall i \in HP$

where  $HP = \{\text{word processing software, typing tutors, desktop publishing, interactive storybooks, word games, mathematical skills tutorials, logic games, science programs, critical thinking programs, hands-on construction kits, motion-simulation games, eye-hand co-ordination games, any self-paced program, digital diary, and so on}\}$

Web-m =  $\{\text{Program } W_i\}$  for  $\forall i \in HP$

where  $HP = \{\text{email software, desktop conferencing, electronic bulletin boards, one-one games, many-many games, chat programs, and so on}\}$

Objects =  $\{\text{Text, Graphic, Audio, Video, Animation, Hyperlink}\}$

**Figure 4.6:** *Content components of children's e-books*

**\*\* Note:**

- Program refers to the kind of technology appropriate for an activity
- G = graphical, A = Audio, H = Hypermedia, W = Web, m = mode

The above definition describes each page as containing contents plus a combination of any of different multimedia elements: graphic, audio, video and animation. The content will consist of the header and the paragraphs, which usually consist of text. The contents are also supported and reinforced by using graphic, audio, hypermedia and/or Web mode. In addition, in each of these four different types of modes, a collection of appropriate activities that match the seven intelligences may also be included. Each activity is presented in the form of a program. The higher the value of  $i$ , in the definition Program  $G_i/T_i/H_i/W_i$  the more activities are provided in a page.

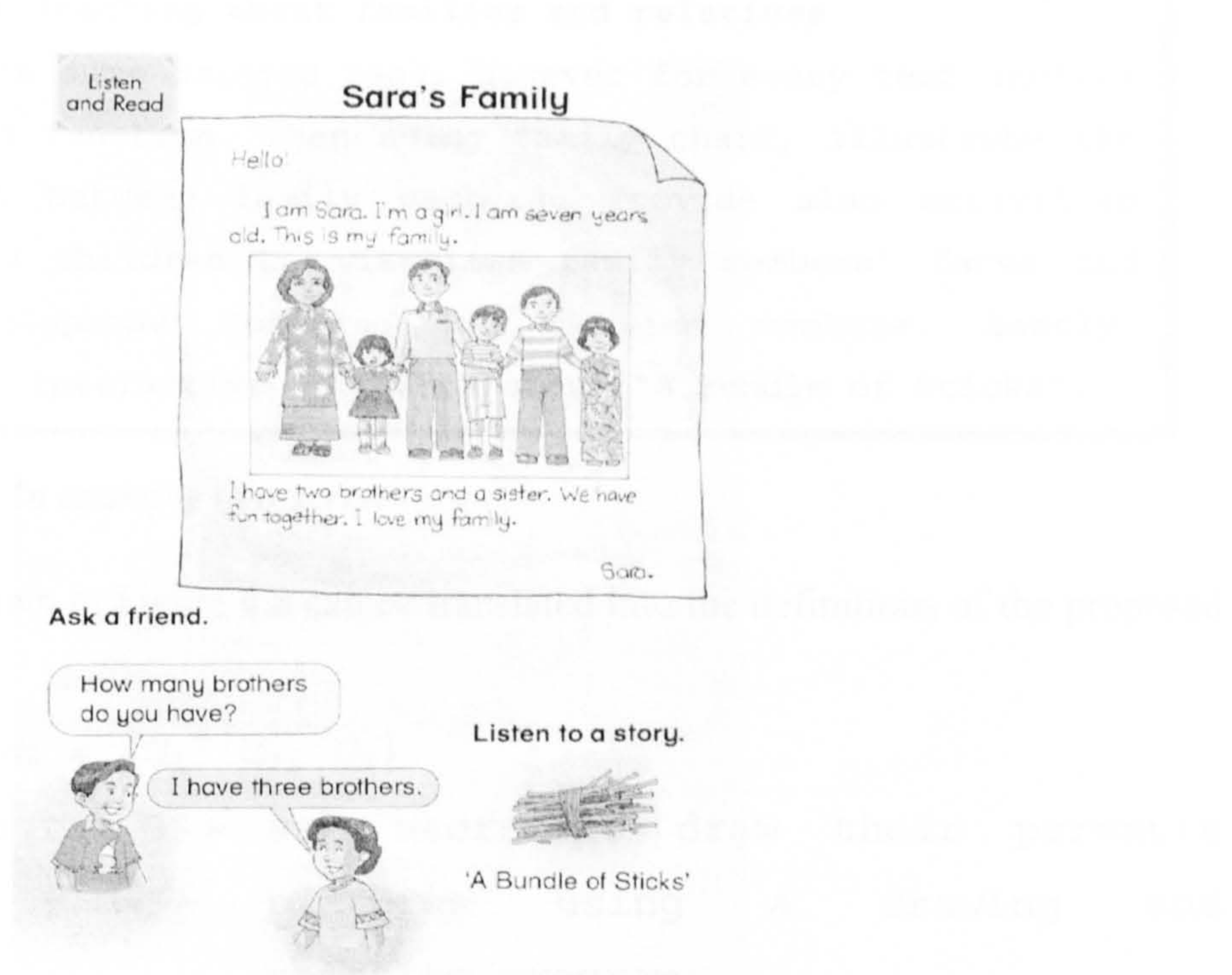
#### **4.4 Applying the E-Book Model**

Teachers in the Smart School model are required to develop their own electronic teaching tools and materials with the support of design experts and technical staff. They are expected to produce high quality materials that can be readily used by school children. As such, suggestions on designing teaching materials are seen as possible ways to assist the teachers. Bearing this in mind, the e-book model can be adopted as a kind of assistance or guideline when design takes place. In this section, examples on how the e-book model could be applied to the design of textbook pages are presented.

As the design of the InterActivity Book is very similar to the design of multimedia products, a multimedia production cycle is adopted (Hillman, 1998; Stansberry, 1998). Part of the first multimedia production phase (pre-production) is the design of a storyboard. A storyboard is a representation (often in the form of hand-drawn sketches) of what each screen will look like and how the screens are linked (Shuman, 1998). It serves multiple purposes - such as providing an overview of the project, guiding programmers, describing links among screens and illustrating the functionality of the various objects. It is also an extension, in the form of graphical view, of the written script. In giving an example on how to apply the model for converting a paper book to an e-book, one begins by choosing a particular page



from a textbook. Figure 4.7 displays an example of a printed textbook (page 39) taken from a Malaysian-English textbook for Primary level 1 children.



**Figure 4.7:** An example of a printed textbook page

Before presenting the storyboard associated with the page depicted in Figure 4.7, the script associated with this page will be examined (see Figure 4.8). Multimedia development programs use the term "script" to mean a sequence of instructions (TechTarget, 1999) that are entered to indicate how a multimedia sequence of files will be presented (for example the sequence of images and sounds, their timing, and the possible results of user interaction). From a series of scripts, designers can build a flow of programs.

## Script page 39

**Objective: Teaching about families and relatives**

Display the same printed page, however for every text include read aloud function. Then using family chart, illustrate the connection between family members. Provide also activities that allow children to visualise family members' faces and record telephone conversations between members. Lastly, include an interactive storybook about "A Bundle of Sticks".

**Figure 4.8:** *An example of a script*

The script shown in Figure 4.8 can be translated into the definitions of the proposed model, thus:

Graphic-m = {G<sub>1</sub>, G<sub>2</sub>, G<sub>3</sub>}

Program G<sub>1</sub> = ask users to draw their parent's pictures using a drawing and painting program.

Program G<sub>2</sub> = allow children to build a family chart using a drag and drop technique.

Program G<sub>3</sub> = provide a family picture and ask users to paint it.

Audio-m = {A<sub>1</sub>, A<sub>2</sub>, A<sub>3</sub>}

Program A<sub>1</sub> = provide a read-aloud function for all text.

Program A<sub>2</sub> = let users record their voice by making them believe they are talking to their grandparents on a telephone.



Program A<sub>3</sub> = include a song about family values and ask users to sing-along.

Hypermedia-m = {H<sub>1</sub>, H<sub>2</sub>}

Program H<sub>1</sub> = include interactive storybook about "A Bundle of Sticks".

Program H<sub>2</sub> = ask children to solve word puzzle on members in a family.

By applying the above definitions, the storyboards are then designed. Figure 4.9 is an example of the proposed storyboard.

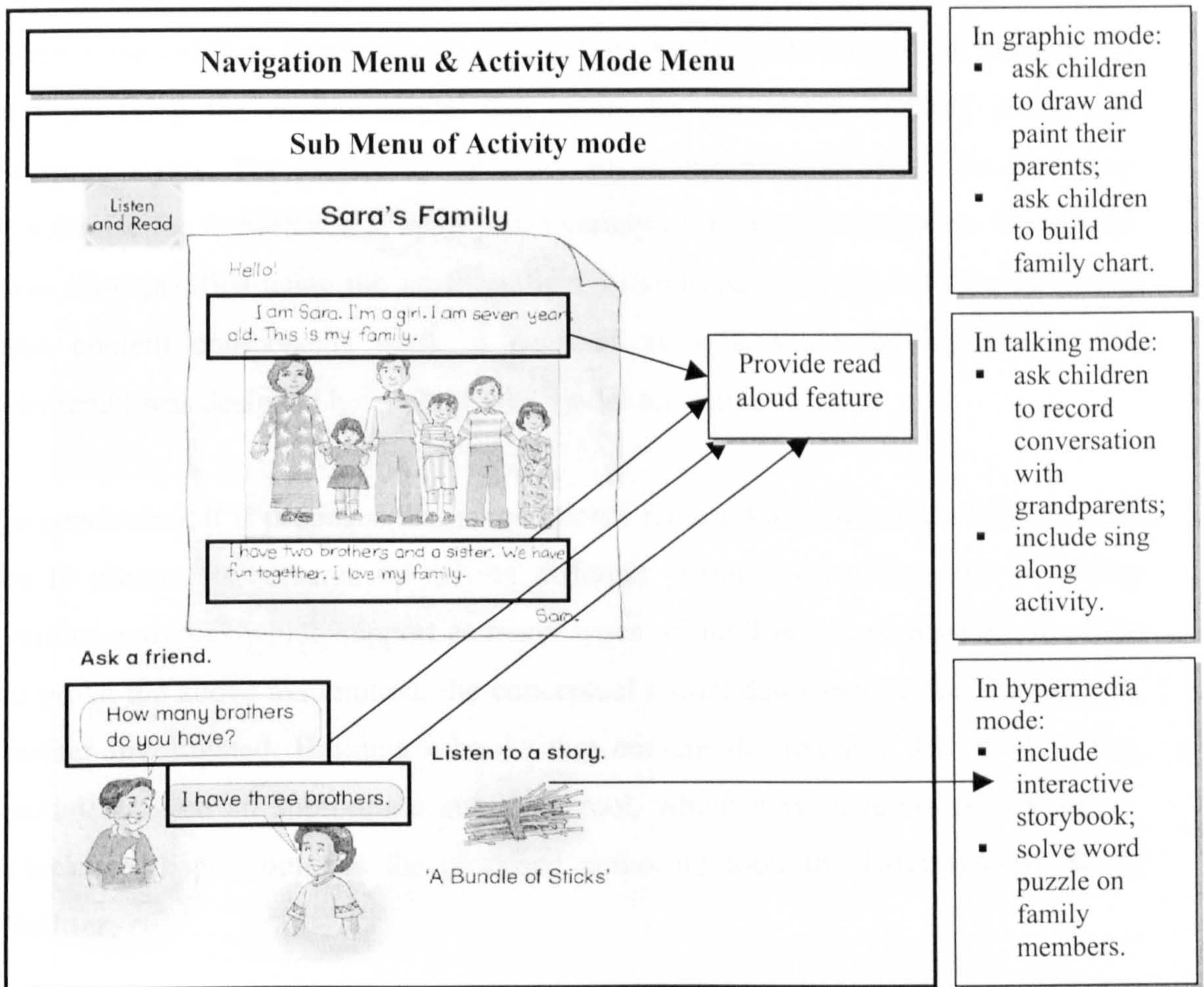


Figure 4.9: Storyboard for page 39



## 4.5 Conclusions

This chapter discussed how the first sub-objective was achieved. It has shown that the conceptual model for children's e-books should be viewed in structural and content components.

In order to propose the structural components, a comparison of different types of books in children's and adult's environments was conducted. A number of similarities and differences were noted and then specified using the set formalism. Among the main differences were the fewer structural components, the lesser number of paragraphs in each page and the larger font size utilised for presenting the children's book content. The content components listed some activities which were extracted from Gardner's MI theory. Four modes were formed for the purpose of specifying the content model that caters for children's different needs and learning styles. The modes are graphic, audio, hypermedia and Web, and they emphasise the importance of appropriate variety of interactive activities. The model was also specified using the set formalism. In addition, to show how the structural and content components work, a page of an e-book (containing multimedia elements) was designed by applying the model formalism.

In conclusion, it is proposed that an additional feature for children's e-books would be to present its contents by mixing different presentation modes and including various activities which support as many types of intelligence as possible. In order to prove the above assumption, the conceptual model described in this chapter was further investigated. Building e-books that contain the features described in this model required an appropriate authoring tool, which was currently not available. The next chapter outlines the proposed authoring tool: the **InterActivity Book Builder**.



# Chapter 5

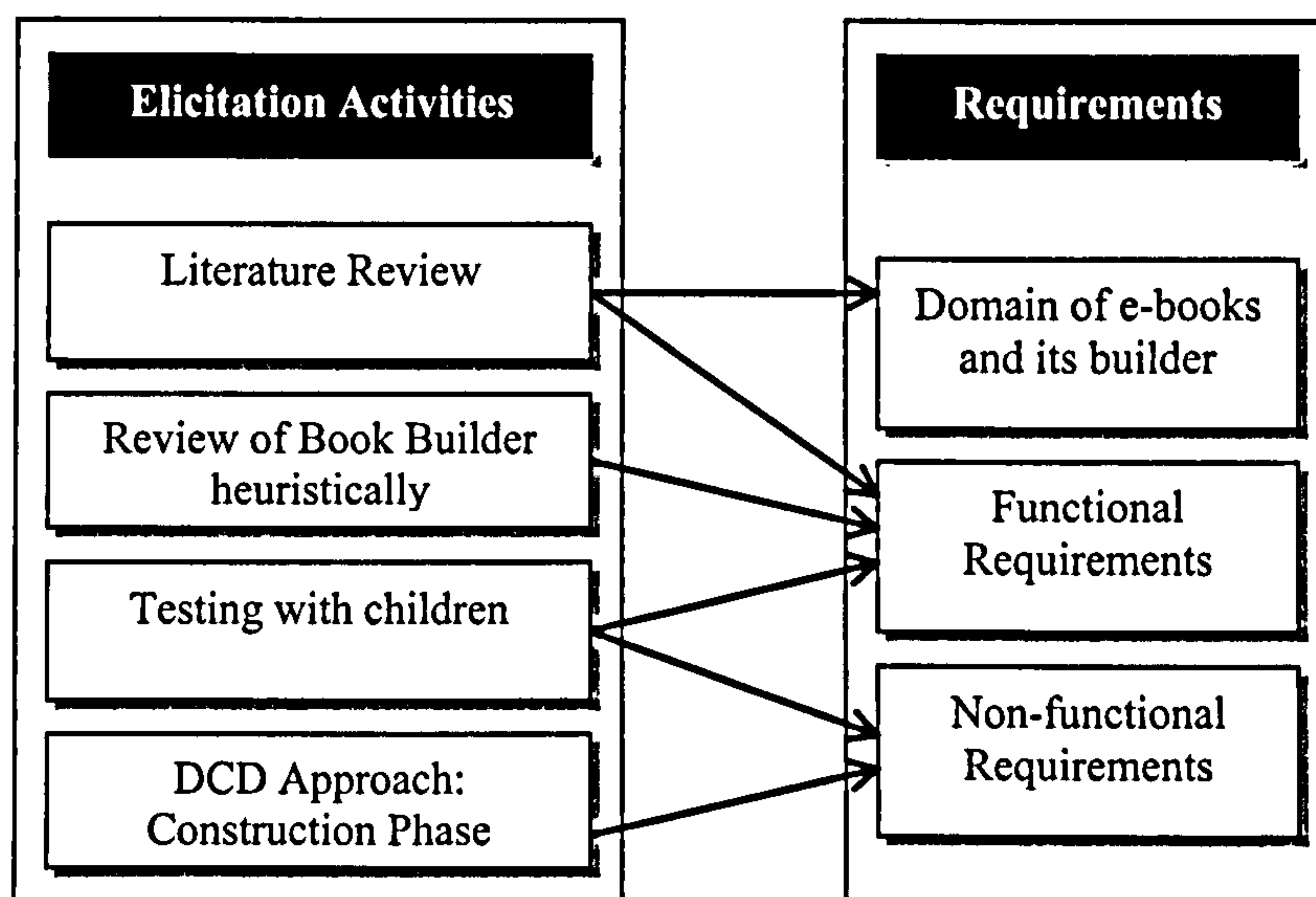
## InterActivity Book Builder

### 5.1 Introduction

This chapter presents the requirements for the InterActivity Book Builder (i.e. the program which will allow users to build books that exhibit features as described in chapter 4). It validates EBoChi's second sub-objective, which is specifying requirements in terms of the following three aspects:

- i. environment/domain - i.e. the context in which the e-book and its builder will function;
- ii. functional requirements - descriptions of system functions (in two categories: Create-mode and Read-mode) to support users' needs;
- iii. non-functional requirements - in terms of interface requirements.

This chapter begins by describing the context in which the InterActivity Book and its builder will function – Smart Schools (see section 5.2). However, before the functional and non-functional requirements are presented, this chapter outlines the results of the elicitation process. Elicitation involved comparing the Book Builder features with results from the literature, the author’s subjective review and an evaluation of the Book Builder with a small number of children. In addition, it also involved the DCD Approach: Construction Phase (see chapter 3). The outcomes of the elicitation process were then used as the basis for specifying requirements. In general, Figure 5.1 shows how each activity relates to the formation of requirements.



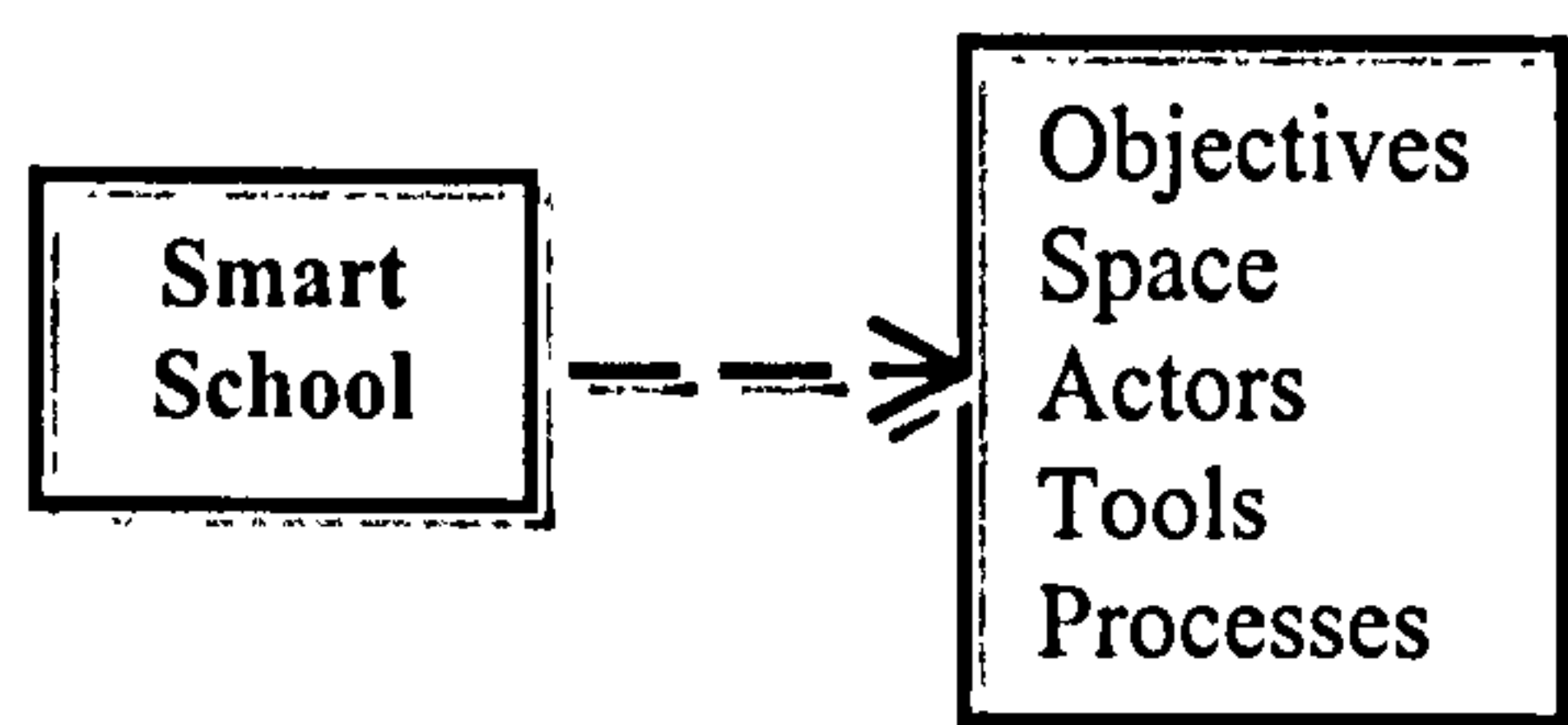
**Figure 5.1:** *Relation between elicitation activities and requirements*

## 5.2 Domain of InterActivity Book and Book Builder

Having described the concepts and components of the Smart School in chapter 2, it is appropriate to build a conceptual model of this school for easier reference. This model<sup>1</sup> will also act as the context in which the e-book and its builder will function. The Malaysian Smart School consists of five key components: Objectives, Space, Actors, Tools and Processes, as shown in Figure 5.2.

<sup>1</sup> Although this model is Malaysian specific, it could be generalisable to other countries.





**Figure 5.2:** *High-level model of Smart School*

Each component consists of sub-components. The following sections further explain each component using a set formalism.

### 5.2.1 Definition of Objectives

Objectives refer to the overall objectives. For the Malaysian Smart School concept it can be summarised as:

Objectives = {ARD, OtESA, TTL, IPS, DE}

where

ARD = provide **All-Round Development** for each student

OtESA = provide **Opportunities To Enhance Strengths and Abilities**

TTL = produce a **Thinking and Technologically Literate** student

IPS = **Increase Participation of Stakeholders**

DE = **Democratise Education** to provide equal learning opportunities and cater for different styles and paces of learning

### 5.2.2 Definition of Space

Space = {Section T, Section C, Section Lib,  
Section Lab, Section A}

where

T = Teachers' Room, C = Classroom, Lib = Library, Lab = Laboratory, A = Administration

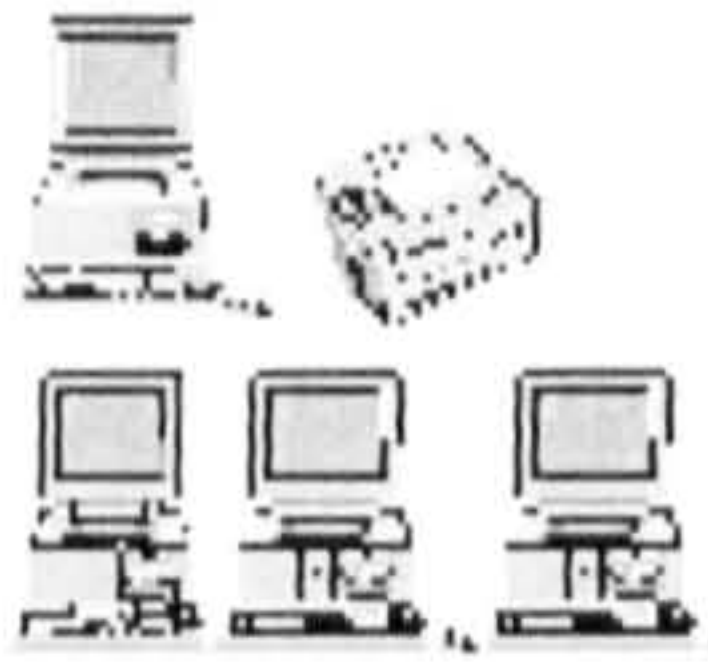
and

Section T = {Troom, Studio, Courseware Sector}

where Troom = Teachers' private spaces

Section C = {Multimedia Personal Computers (MPCs), portable devices, printer, projector, television, Internet access}

#### Classroom



Each classroom should be equipped with networked multimedia personal computers and portable devices (e.g. dedicated readers, laptops, Personal Digital Assistants) for teachers and students, a printer, a projector, a television, and access to the Internet.

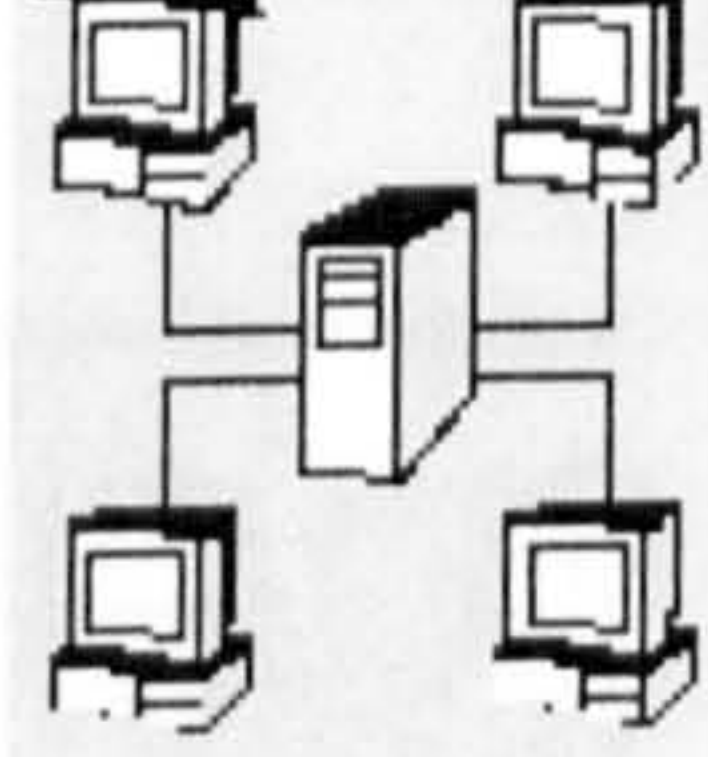
#### Library



Section Lib = {Paper books, e-books on portable devices and CD-ROMs, MPCs, printers, Internet access}

The library should be supplied with networked multimedia personal computers, printers, collections of CD-ROMs and e-books, and access to the Internet.

#### Computer Lab

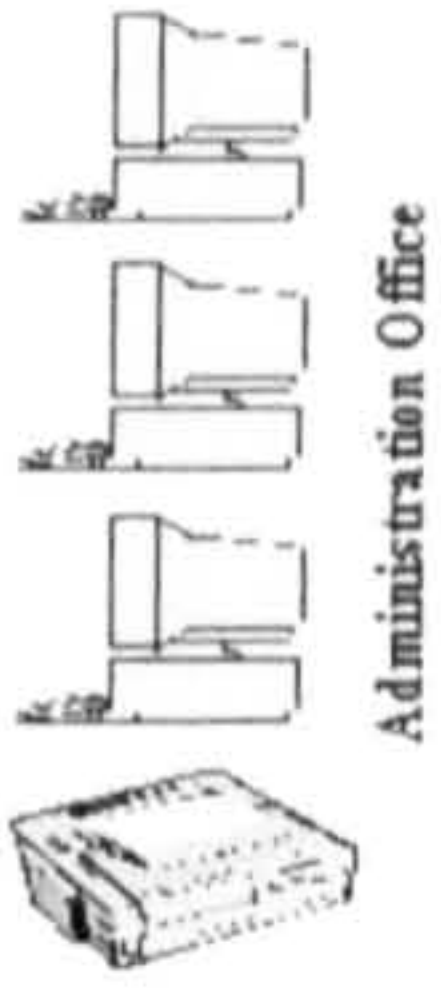


Section Lab = {MPCs, headphones, printer, projector, Internet access}

The computer laboratory should be equipped with networked multimedia personal computers for teachers and students, headphones, microphones, a printer, a projector, and access to the Internet. The latest idea of a wireless lab is an alternative that should also be considered.



Section A = {MPCs, printer, office equipment, Internet access}



The administration office should have networked personal computers, printer, access to the Internet and other office hardware.

Troom = {MPCs, printer, Internet access}

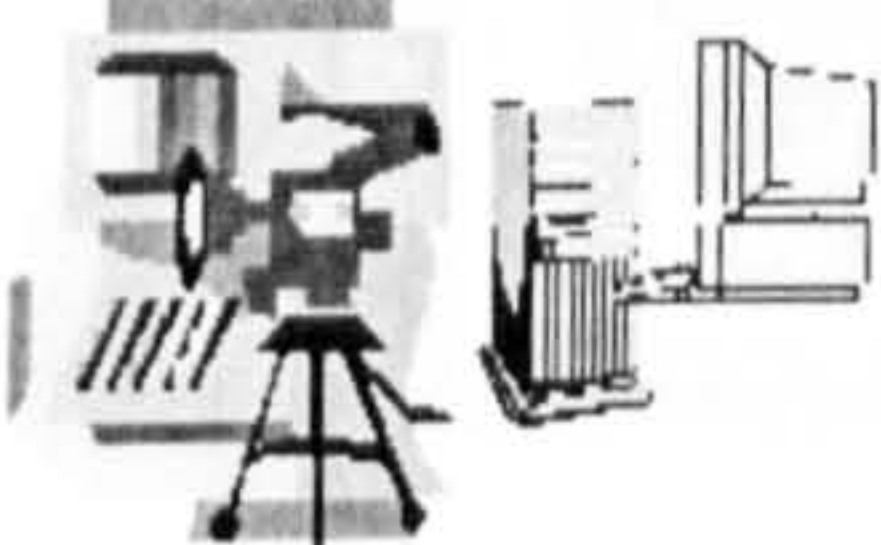
**Teachers' Room**



Apart from tables, chairs, other office equipment, the teachers' room should be supplied with networked multimedia personal computers which have access to the Internet and a printer.

Studio = {servers, video conferencing, audio-video equipment, networked access}

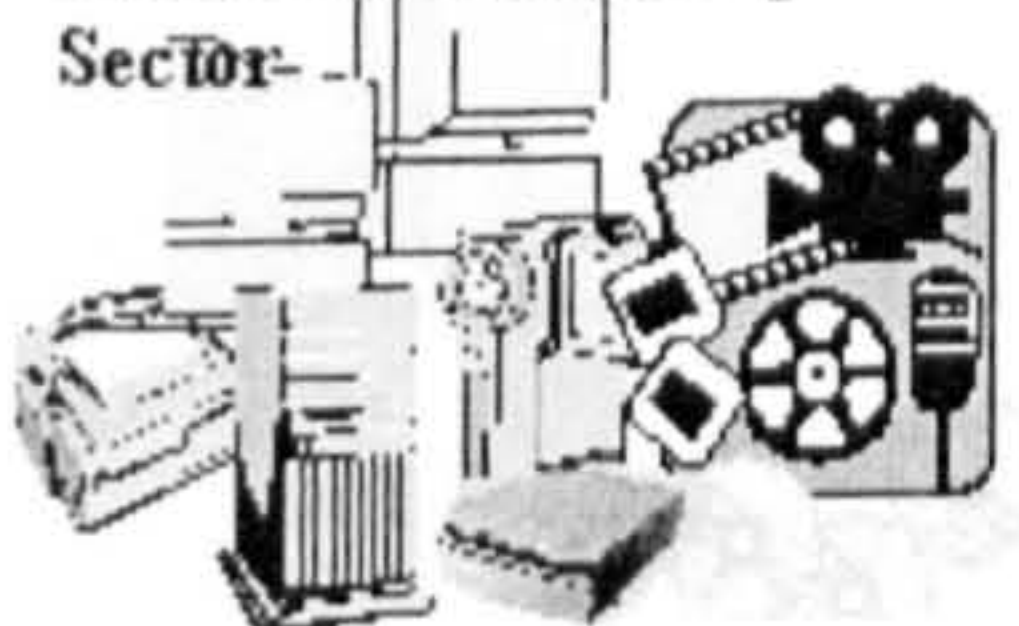
**Studio & Server Sector**



The studio and server room should have video conferencing facilities, video camera, audio-video equipment, and Web, application and proxy servers.

Courseware Sector = {workstations, PCs, scanners, printers, CD-writers, digital cameras, video camera, software}

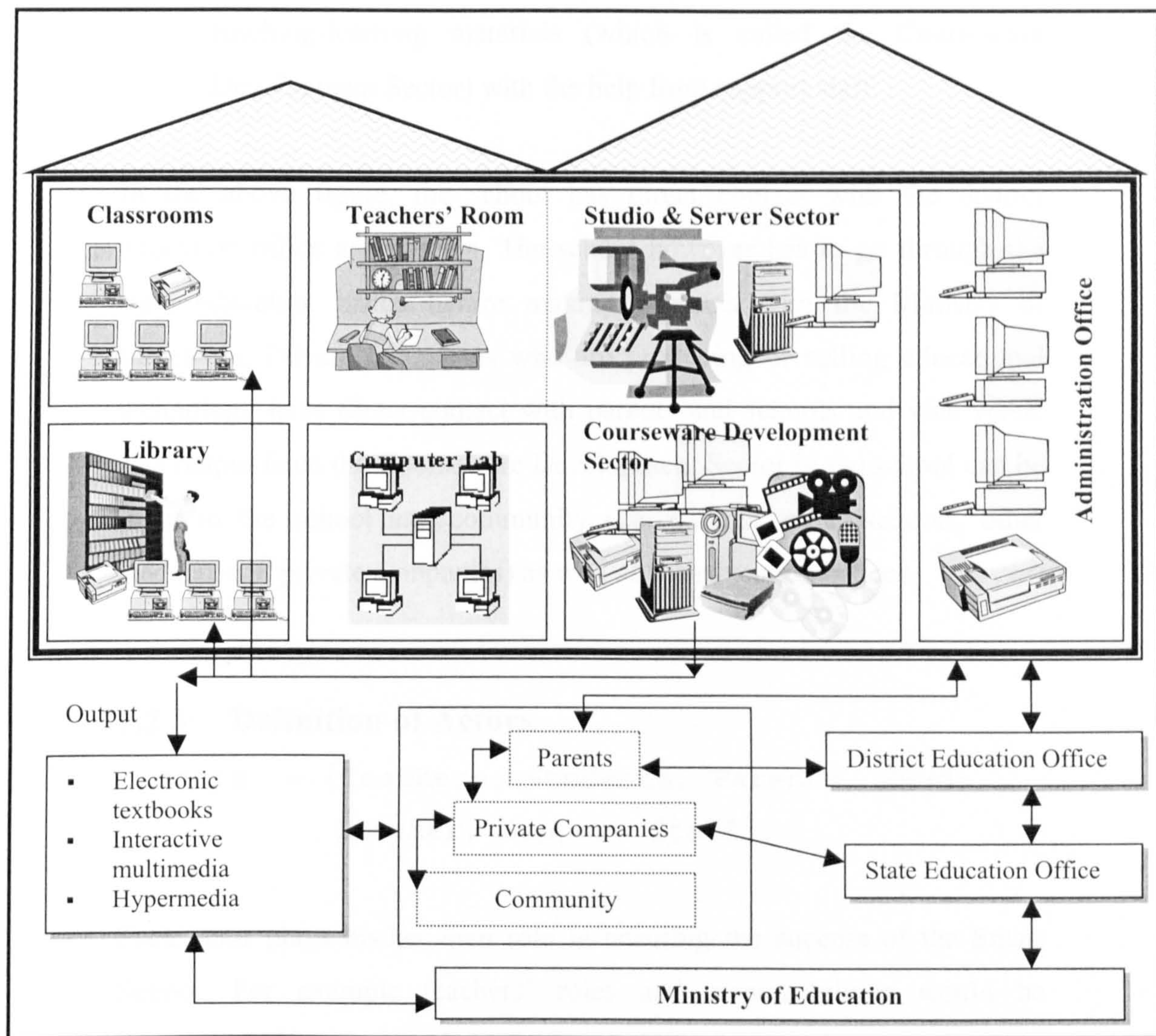
**Courseware Development Sector**



The courseware development sector should at least be equipped with workstations, personal computers, scanners, printers, CD-writers, digital cameras, video camera and authoring software.



Figure 5.3 summarises the space involved in the proposed Smart School. The figure also shows possible relationships between the school and offices of education, parents, private companies and the community at large.



**Figure 5.3:** *Space of the Smart School*

It is in the author's opinion that an ideal Smart School space should consist of five main sections, which are connected with either networking or wireless technology: Administration, Classroom, Teachers' Room, Library, and Laboratory. In addition, the teachers' room should be further divided into three sections:



- a room where each teacher is provided with some space and facilities (such as a desk, and a chair) to do his/her daily work or to rest;
- a studio where on-line lectures are delivered;
- a section where teachers can develop their own high-technology teaching-learning materials (which is called the Courseware Development Sector) with the help from support staff.

In the above figure, the school has direct contact with the district education office and parents. The school however has to go through the state education office before making contacts with the Ministry of Education. Private companies who are producing or selling educational technology have direct contact with parents and schools and vice versa. The output from the Courseware Development Sector in the school can be input to the school and community (i.e. parents, other schools, other students and private companies) as well as the education offices.

### 5.2.3 Definition of Actors

Actors = {Teachers, Students, Parents, Head-  
Teacher, Support Staff}

Each actor plays his/her own role in ensuring the success of the Smart School. For example teachers' roles and responsibilities would be planning and preparing the learning activities, managing a technology enriched classroom, and delivering effective instruction. Students' roles are to concentrate in class and to do work given to them by teachers and to respect teachers and peers. On the other hand, parents should take personal charge of their children's learning experiences by monitoring their progress, and guiding, motivating and counselling them, and supporting school activities. The head-teacher will set attainable school goals to meet the needs of students, parents, and the nation, plan programmes for the

constant upgrading of school administrators' skills, develop staff development plans, and have ongoing discussion with teachers on ways to improve teaching strategies.

Support staff can be divided into:

Support Staff = {clerical, technical}

Clerical staff maintain student and staff records, school finances, school communications, and school inventory. They also manage matters pertaining to student and staff welfare. Technical staff responsibilities are troubleshooting technical problems, responding to teachers' requests for help in technology integration in classrooms, training teachers in developing electronic teaching and learning materials, and maintaining technical equipment. The technical staff should also be experts who give advice to teachers regarding the development process for electronic teaching materials.

#### 5.2.4 Roles of Actors in E-publishing

The main roles of those who are involved in the domain are authors (e.g. teachers, children), internal editors (e.g. head teachers, other teachers, designers), external editors (e.g. independent companies), publishers and distributors (e.g. district education department, state education department, Ministry of Education) and end-users (i.e. children, teachers).

##### **Definition:**

- Authors, write and plan content of the books;
- Internal editors, check content accuracy and suitability. If children are the authors, teachers will act as editors. If teachers are the authors, head-teachers and other teachers can act as content editors, and designers can act as visual or interface editors;



- External editors, are responsible for editing content and layout presentation if the book is to be commercially published;
- Publishers, are responsible for selecting T/L materials. If a school wishes to publish any of its teachers' books, district offices will be responsible for the selection and approval. All approved books, however, have to get approval from the state offices and Ministry of Education. In addition, if teachers wish to publish independently, they can use the independent publishers;
- Distributors, are responsible for circulating books. They can be any of the state offices, the Ministry of Education, libraries and book shops;
- Users, utilise the published books.

The following figure shows the relationships between these actors in terms of the publishing process.

<b>Authors</b>	<b>Children</b>	<b>Teachers</b>			
<b>Editors</b>	<b>Teachers</b>	Teachers	Head teachers	Designers	Independent Companies
<b>Publishers</b>	-	District offices	State offices	Ministry of Education	Independent Companies
<b>Distributors</b>	-	State offices	Ministry of Education	Libraries	Book Shops
<b>Users</b>	Children				
	Teachers				

**Figure 5.4:** *Relationships between actors*

Figure 5.4 indicates that when a teacher builds books to be utilised in the classroom, the head teacher or other teachers can act as content editors. If he/she wishes to publish and sell the books outside the school circulation,



then the district or state education departments or the ministry of education could be the publishers as well as distributors. He/she also has the alternatives to publish with independent companies who are actively seeking e-book submissions to be considered for publication.

If children build books, the teachers can act as editors, hence ensuring the suitability and accuracy of the contents. Children too have the opportunity to share and publish their books on Web sites or digital libraries dedicated to children's development.

### 5.2.5 Definition of Tools

Tools = {Teaching-Learning(T/L) materials, Technology}

T/L materials = {Conventional, High-Technology}  
Technology = {Hardware, Software, Communication}

Conventional = {Books, Magazines, Tapes, Slides  
and so on}

High-Technology = {Courseware, On-line materials,  
Application software and so on}

And as only one element of the high-technology materials has been studied (i.e. courseware, specifically e-books), only that element is further refined:

Courseware<sup>2</sup> = {Electronic books, Computer-Aided Learning, Computer-Assisted Instruction, Computer-Based Learning, Interactive Multimedia, Hypermedia, Simulation, and so on}

Electronic books = {Electronic Textbooks, Electronic Storybooks, Electronic Encyclopaedia, Electronic Dictionaries, Electronic Diaries, and so on}

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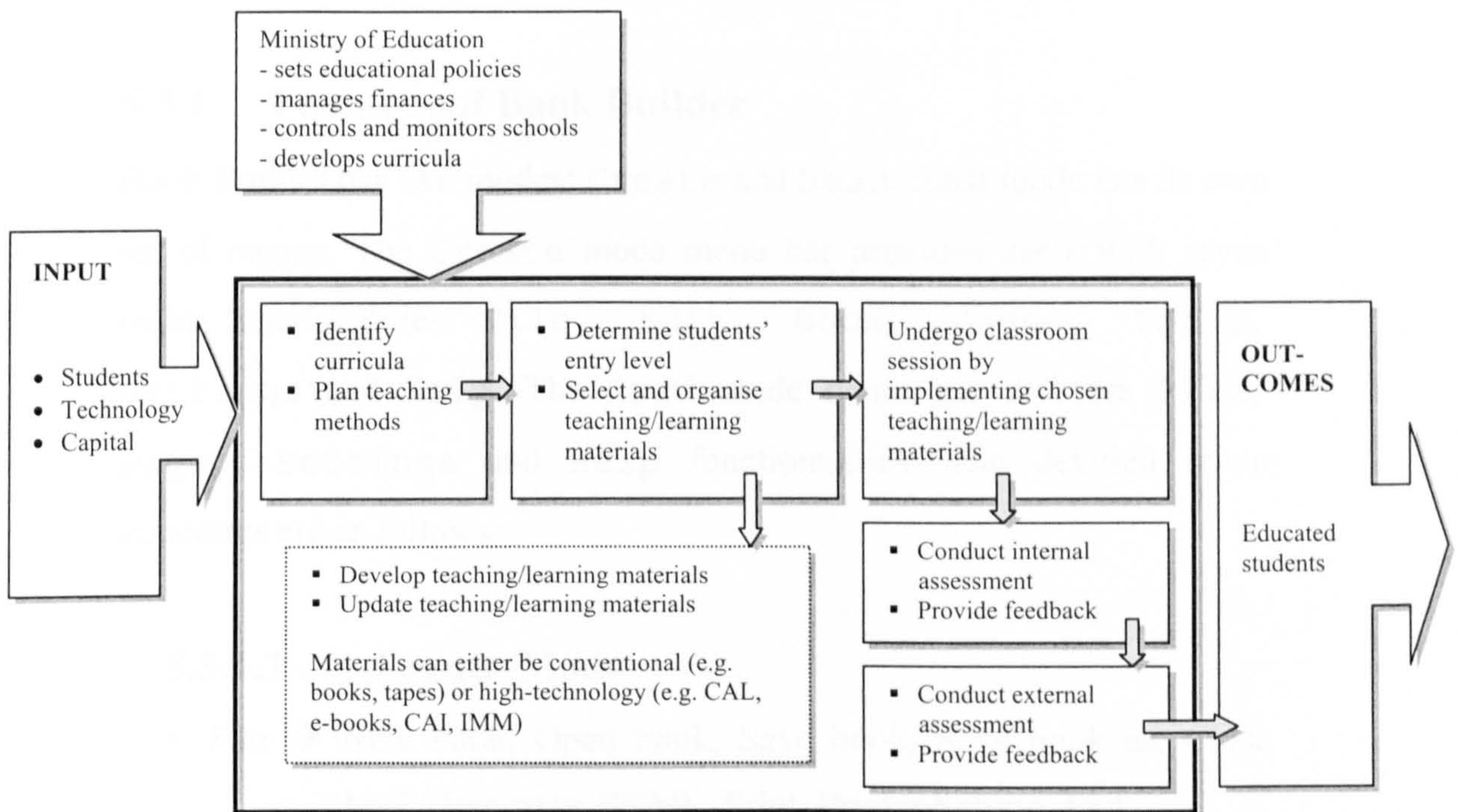
<sup>2</sup> Courseware = Educational materials + Software



### 5.2.6 Definition of Processes

Processes = {Input, Transforms, Outcomes}  
 Input = {Actors, Curriculum, Teaching/Learning materials, Assessment}  
 Transforms = {Actions required to produce outcomes}  
 Outcomes = {Educated students<sup>3</sup>}

The Smart School is viewed as a system that contains several interrelated processes. When the system is provided with inputs, the Smart School processes will work to produce the desired outputs. Figure 5.5 describes the process flow, which is involved in this system.



**Figure 5.5:** Processes involved in the Smart School

As mentioned earlier, before the functional and non-functional requirements could be specified, EBoChi first conducted an elicitation process. The outcomes of the elicitation process are discussed in the section 5.3 and 5.4.

<sup>3</sup> Regardless whether the students passed or failed, all students who have gone through the processes are considered to be educated students.



## 5.3 Functional Elicitation Outcomes

In the functional requirements elicitation process, apart from input from the literature, the researcher also reviewed the Book Builder program to study its functional strengths and weaknesses. First, its functionalities were compared with other e-books and e-book builder initiatives such as the HyperBook (Catenazzi, 1993), the Visual Book (Landoni, 1997) and the KeeBook Creator<sup>4</sup>. The Book Builder was then tested with three children. The results of these initial reviews have been divided into three parts: (a) features of the Book Builder, (b) lessons from the collected literature on e-book technology and (c) children's reactions. Each of these is discussed below.

### 5.3.1 Features of Book Builder

Book Builder has two modes: Create and Read. Each mode has its own set of menus. The Create mode menu bar provides users with seven main functionalities: File, Edit, Book, Pages, Tools, Settings and Help. The Read mode menu bar includes File, Page, Settings and Help functionalities. The detailed menu structures are as follows:

#### 5.3.1.1 Create-Mode

- File → New book, Open book, Save book, Save book as, Close book, Export as HTML, Print, Printer Setting, Exit.
- Edit → Undo, Cut, Copy, Paste.
- Book → Background music (add/remove), Show page numbers, Read book, Lock book, Insert book.
- Pages → Insert new page, Delete page (left/right/undo), First page, Previous page, Next page, Last page, Go to page, Choose sound, Choose video, Bookmark.
- Tools → Picture tool, Text tool, Sound tool, Video tool, Spell tool.
- Settings → Layout options.

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<sup>4</sup> Go to <http://www.keeboo.com/enu/index.php> for more information on the product.



### 5.3.1.2 Read-Mode

- File → Edit book, Exit Book Builder.
- Page → First page, Previous page, Next page, Last page, Go to page.
- Settings → Turn page (with arrows/space/automatic turning),  
Background music (add/remove).

In addition to the above, text that has been created can be read-aloud using the text-to-speech function and spell-checked. Read-aloud uses a voice synthesiser to speak the contents of the text box. It reads from the start of the box, or just the highlighted text. Book Builder also enables users to choose between different voices (e.g. man, woman, child).

### 5.3.2 Results of Evaluation Based on Collected Literature

Based on the literature that was discussed in chapter 2 and the conceptual model which has been developed and described in chapter 4, Book Builder was reviewed for the purpose of identifying what functionalities are not provided.

The literature suggests that an e-book should exhibit many of the characteristic features and properties of a conventional book (Barker, 1999). According to many researchers, incorporating the paper book metaphor in the design of an e-book can also reduce the cognitive load on users (Landoni & Gibb, 2000; Landoni, Crestani & Melucci, 2000; Barker et al., 1994; Catenazzi et al., 1996; Catenazzi & Sommaruga, 1994a, 1994b).

Henke (2001) listed a comprehensive list of e-book features and conducted a survey to determine which features the e-book experts would want in their own e-books. He then ranked the features and discovered that searching, annotating, audio capability, bookmarking, chapter headings, and highlighting are among the most preferred features. In addition, the



literature also suggested that features of an e-book should include customisation (e.g. users are allowed to annotate or write notes), boolean searching facility, zooming facility, hyperlinks, table of contents, title page, ISBN identifier, page numbers, thickness indicator, book cover and multimedia elements (especially if the book is intended for children).

Based on an analysis of the literature, Tables 5.1 and 5.2 list the additional functionalities that should be made available in Book Builder. The functionalities are divided into each of the Book Builder modes: book Create-Mode (in which users create their books) and book Read-Mode (which is used to read finished books).

**Table 5.1:** *Additional tools for create-mode*

<b>Functionality</b>	<b>Description</b>
Export as HTML Book	When exporting maintain book metaphor (as evident in KeeBook Creator).
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 the right mouse button.
No page number on cover page	Include an option of not wanting page numbers on cover page.
Insert cover page	Include a template for the book cover page.
Insert verso page	Include a template for the verso page.
Insert TOC (Table of Contents) page	Include a template for the TOC page.
Insert background	Provide an option to insert background for each page.
Animation tool	Tool for users to create animation.
3D tool	Tool for users to build 3D images.
Activity Tools	Tools to build interactive educational activities.



**Table 5.2:** *Additional tools for read-mode*

Functionality	Description
Read in HTML mode	Allow a 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 highlight	Allow users to highlight words.
Insert notes	Allow users to write notes.
Bookmark	Allow users to bookmark one or more pages at one time. Currently, this function is only available in create mode, which lets users 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 information.
Read-aloud icon	Make this feature easily visible to children. Currently, this function can only be activated by clicking the right mouse button.

In addition to the above descriptions, icons for tools such as first page, previous page, next page, last page, TOC, annotate, bookmark, highlight, zoom, search, read-aloud, open book, and exit book should also be made available and visible.

As Book Builder was intended for an evaluation in a school environment to test the hypotheses described in chapter 1 and thus validate the requirements proposed in this chapter 5, a preliminary evaluation with a small number of children was also conducted during the elicitation process. The reaction of the children (which is discussed in the next section) was observed. In addition, the preliminary evaluation also served as a pilot study to acquire suitable tasks to be given to children and measurements to be noted during evaluation in a school environment.

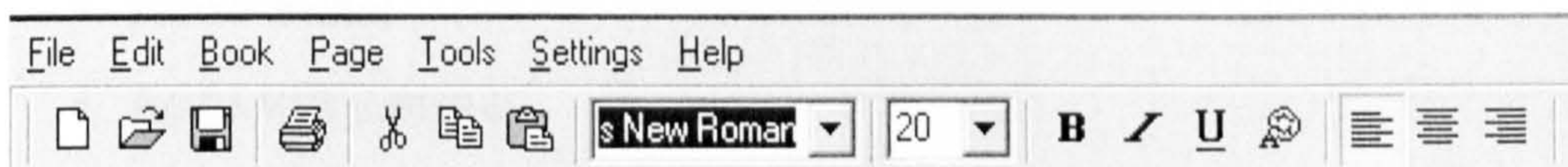


### 5.3.3 Children's Reaction

All three 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. For every word that he failed to spell, he kept asking for help without giving up so easily.

From observation, inserting graphics and audio, editing pictures and texts, and reading aloud their written texts, were the most utilised tools. Probably this is due to the fact that these functions are not available in traditional books.

It could also be deduced that the interface of Book Builder could be improved. Book Builder uses standard icons as utilised in all Windows based software (see Figure 5.6). On the one hand, introducing standard icons early in their experience is a good idea. However, on the other hand, these standard icons are too small and quite hard for young children to point at using the mouse cursor.



**Figure 5.6:** *Book Builder Tools*

For children of young ages (i.e. 7-9 years old) to be able to use the interface effectively, a menu using larger icons should be made available for all tools. It was quite difficult for all the children to use the pull-down menu mainly for the reason that they can not yet read well - especially when the size and font of the text used is small.

Having discussed the domain and functional elicitation outcomes, the next section outlines the non-functional elicitation outcomes.



## 5.4 Non-Functional Elicitation Outcomes

In order to elicit the non-functional requirements that would specify an InterActivity Book front-end interface, collaboration with users was performed using the approach detailed below.

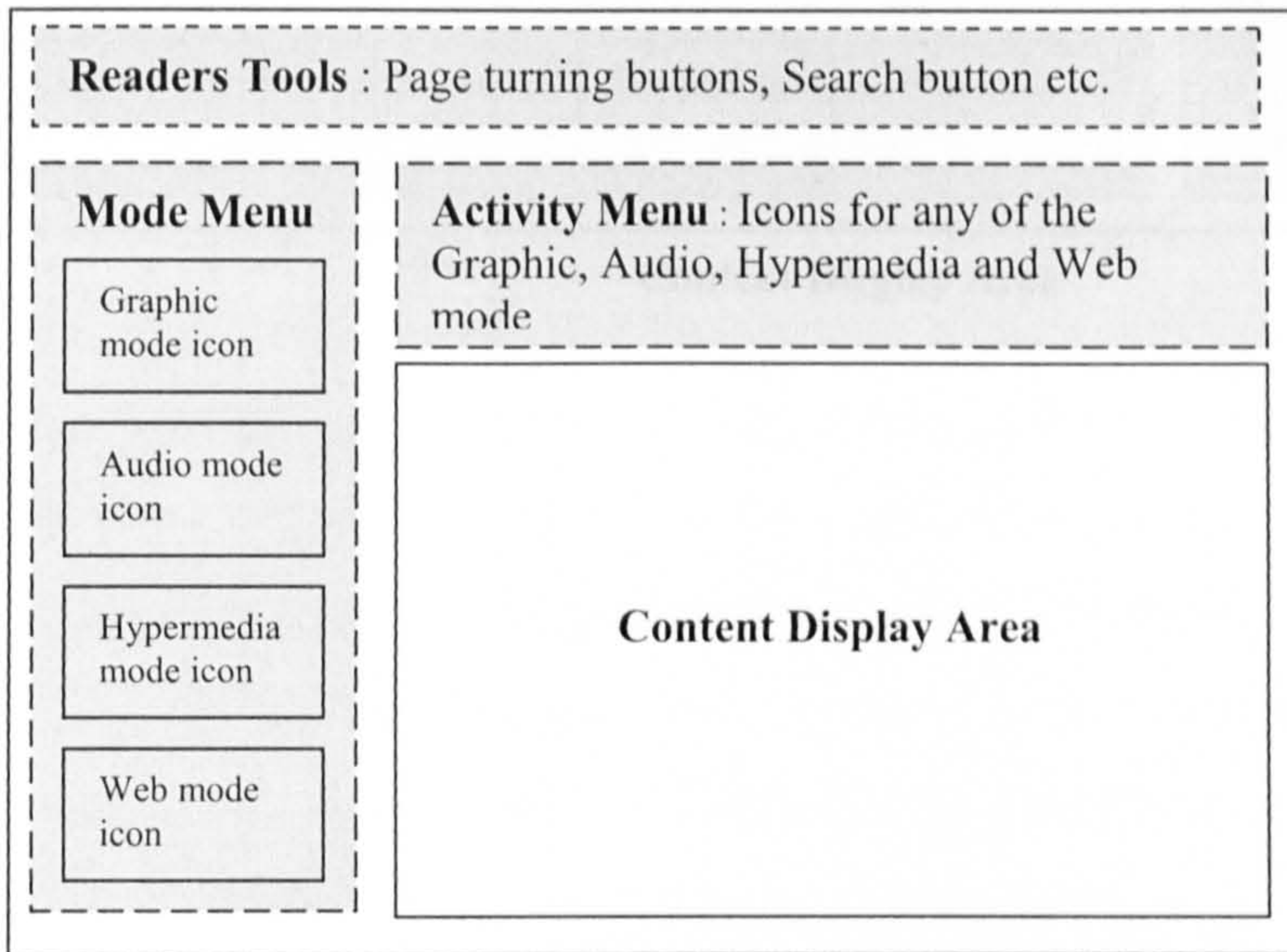
### 5.4.1 Outcomes of DCD Approach: Construction Phase

As described in section 3.4, three interface design ideas for Read-Mode were electronically posted to all partners (i.e. 1 head teacher, 1 teacher, 2 children, 2 program designers). They were asked to make comments on the layout, placement of icons, choice of icon designs, metaphors used to describe icons, and size of icons. The second stage involved asking them to produce their own design ideas and each design (i.e. layout and icons) was then posted to all partners through email attachments to be commented on. Finally, they were asked to choose, in their opinion, the most suitable design. The most popular design was selected as the proposed front-end interface design.

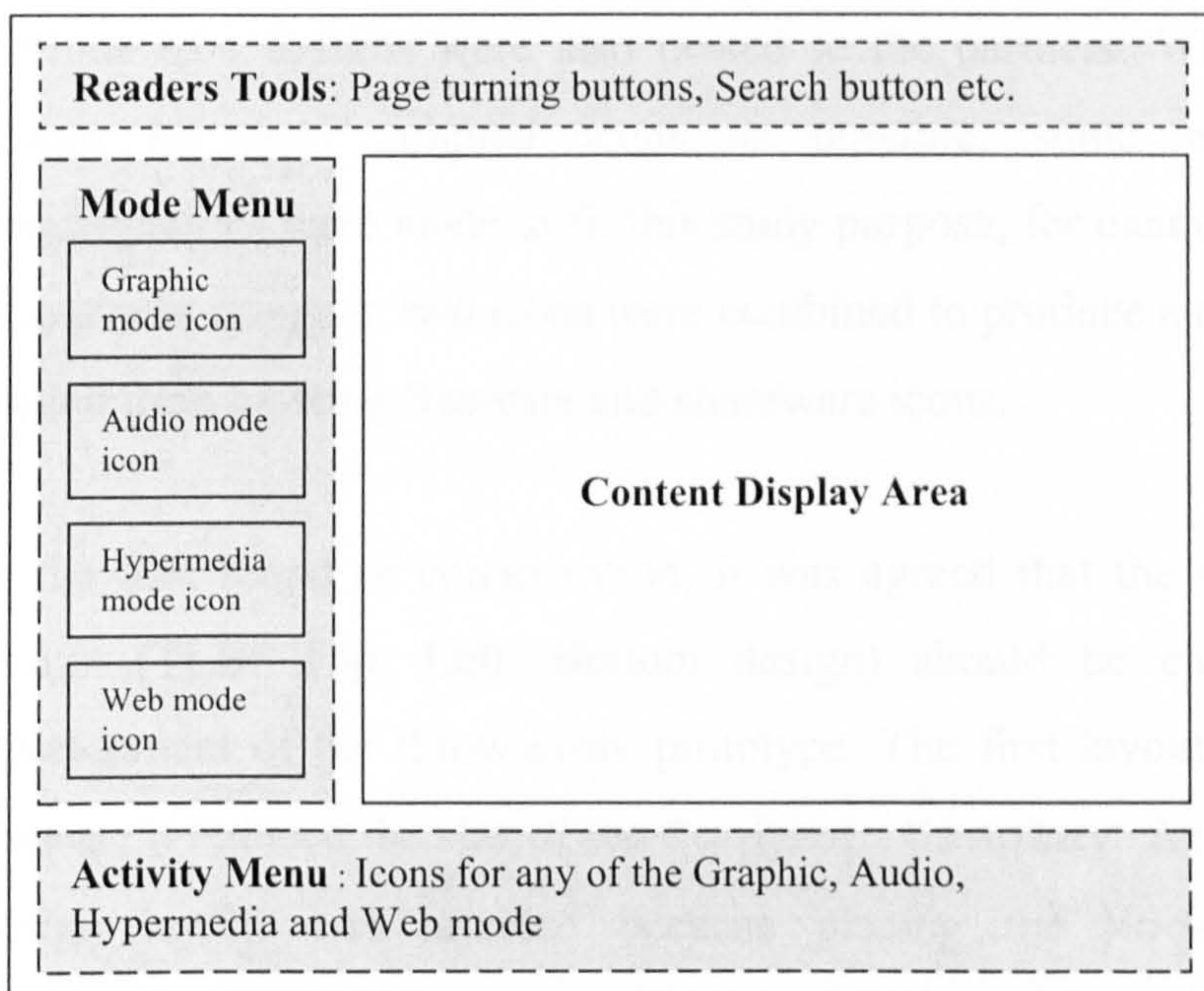
The three design layouts which were posted to all partners were divided into four sections (see Figures 5.7, 5.8 and 5.9):

- Mode menu;
- Activity menu;
- Readers' Tools;
- Content Display Area.

Mode menu and Readers' Tools are always displayed (i.e. fixed in any opened page), Activity menu and Content Display Area changes with respect to the page or program activated.

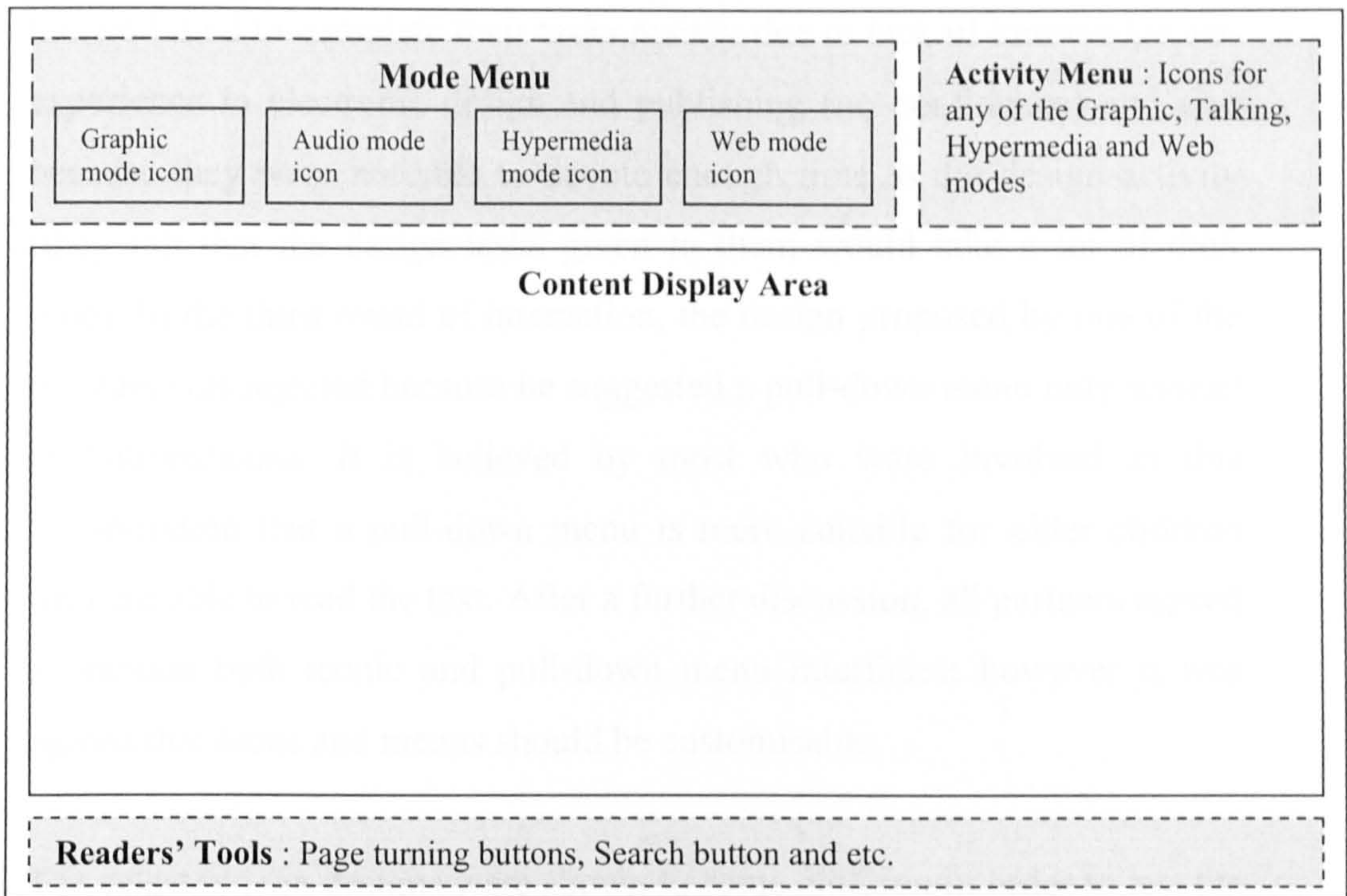


**Figure 5.7:** *First proposed front-end interface layout for read-mode*



**Figure 5.8:** *Second proposed front-end interface layout for read-mode*





**Figure 5.9:** *Third proposed front-end interface design layout for read-mode*

Various icon designs were also posted to the partners. While trying to design as many original icons as possible, some were adopted (modifications were made to fit this study purpose, for example the icon's colour was changed, two icons were combined to produce a new icon) and copied from existing freeware and shareware icons.

In the first round of collaboration, it was agreed that the second layout design (TLB: **T**op, **L**eft, **B**ottom design) should be chosen for the development of the throw-away prototype. The first layout was rejected because it reduced the size of the Content Display Area. The third design layout was rejected because placing the Mode menu and Activity menu side-by-side takes too much space. Users who use a 14" monitor would have to scroll to the right in order to be able to select the Audio or Hypermedia activities. In the second round of collaboration, where the partners were asked to propose their own designs, only one partner managed to complete the task of proposing a front-end interface design layout and design of suitable icons to represent all functions.



Others failed to complete their tasks mainly due to lack of knowledge and experience in electronic design and publishing (no confidence) and also because they were not able to devote enough time to the design activity (they felt that the design tasks given to them would take a lot of their time). In the third round of interaction, the design proposed by one of the partners was rejected because he suggested a pull-down menu only instead of buttons/icons. It is believed by most who were involved in this collaboration that a pull-down menu is more suitable for older children who are able to read the text. After a further discussion, all partners agreed to include both iconic and pull-down menu interfaces; however it was agreed that icons and menus should be customisable.

The selected icon designs were shown to some children in order to test the suitability of metaphors. The results of this test are presented in the following section.

#### **5.4.1.1 Results of Metaphor Evaluation**

Metaphors are intended as a tool to link a program to users' mental models (Wilson et al., 1998). They provide a symbolic representational framework of objects or processes (Vaughan, 1996). Hutchins (1989) distinguishes three kinds of metaphor:

- Activity metaphors – which are useful in structuring complex actions;
- Mode of interaction metaphors – which help to regulate the communication between users and computers;
- Task area metaphors – which are meant to facilitate the understanding of tasks.

In EBoChi metaphors are of the second kind. That is, mode of interaction metaphors where icons (i.e. graphic objects designed to be meaningful buttons that symbolise activities) are used as the means of communication.



The front-end interface was tested with ten children aged between 7 and 9. Five were novice users (no previous experience in using educational CD-ROMs or digital content) while the rest had some experience in learning using multimedia CD-ROMs. Icons were divided into three categories:



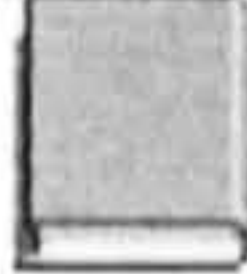









- Readers' tools;
- Mode menu;
- Activity tools.

Icons, which were easily described in terms of what they represent by both types of user (novice and experienced children), were accepted as appropriate to represent the functions they are trying to convey. Icons that were too confusing and not understood by both types of user needed to be re-designed (completely new design). Lastly, icons that were easily described by experienced children, but difficult for a novice to grasp were considered acceptable with the assumption that these icons will eventually be easily recognised by novice children when they have actually experienced the programs several times. Icons which were described correctly by both types of children, but did not quite reflect the actual intended functions were also assumed would eventually be recognised after they have experienced using the programs.

#### **5.4.1.1.1 Readers' Tools**

There were twelve icons, which were mainly used for navigation, zooming, personalising, printing and searching purposes (see Table 5.3).

**Table 5.3:** *Icons for Readers' tools*

Icon	Actual Function	Most Experienced Children's Interpretation	Most Novice Children's Interpretation	Comment
	Go to cover page	Book	Book	✓
	Open book	Open book	Open book	✓
	Close book	1. Book 2. Other side of book cover.	Book	✎
	Table of Contents	1. My house 2. Draw a house	1. Do not know 2. House	✎
	Next page	Go to next page	Arrow	✎
	Previous page	Go to previous page	Arrow	✎
	Zoom	Zoom	Magnifying glass	✎
	Annotate or write notes	Write story	Write	✎
	Bookmark	Mark unfinished page	Mark page after read	✓
	Read-aloud	Read	Read	✓
	Print	Print	Do not know	✎
	Search	1. Torch light 2. Find something because it is dark	1. Torch light	✎

*Key Symbol:*


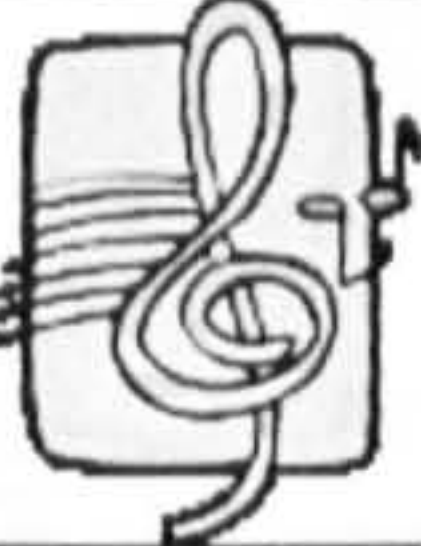


✓ (accept) ✎ (accept with assumption) ✎ (re-design)

#### 5.4.1.1.2 Mode Menu

There were four icons that were used for selecting a particular mode from these categories: graphic, audio, hypermedia and Web (see Table 5.4).



**Table 5.4:** *Icons for Mode menu*

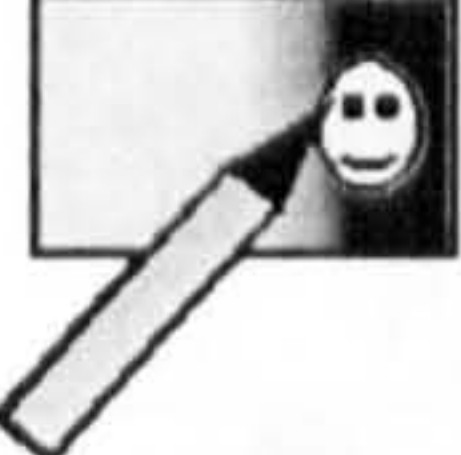
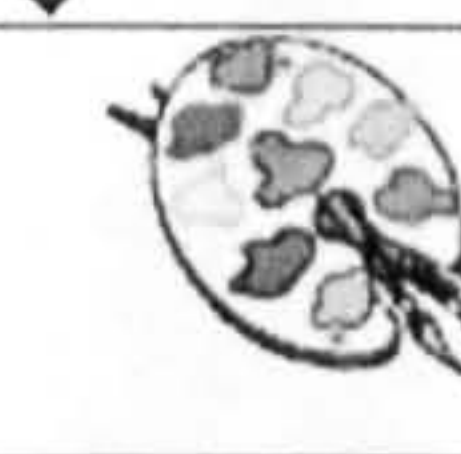

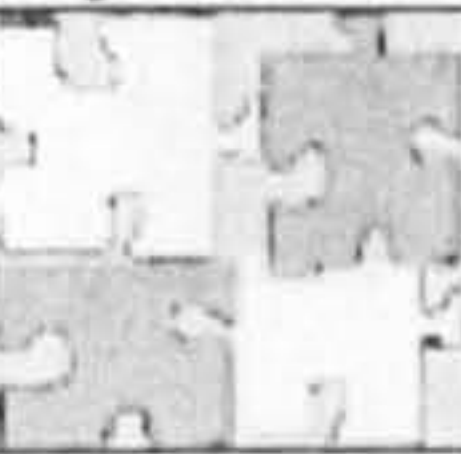
Icon	Actual Function	Most Experienced Children's Interpretation	Most Novice Children's Interpretation	Comment
	Go to Graphic Mode	Picture	Picture	✔
	Go to Audio Mode	Music	Music	✔
	Go to Hypermedia Mode	Play CD-ROM	Do not know	✔
	Go to Web Mode	Spider's web	Spider's web	✔

Key Symbol: ✔ (accept with assumption)
















#### 5.4.1.1.3 Activity Tools

There were four icons for graphic mode, seven icons for audio mode, eleven for hypermedia and three for Web mode (see Table 5.5).











**Table 5.5:** *Icons for Activity Tools*

Mode	Icon	Actual Function	Most Experienced Children's Interpretation	Most Novice Children's Interpretation	Comment
Graphic		Drawing program	Draw faces	Draw faces	✔
		Painting program	Paint	Paint	✔
		Clip art program	Cut picture	Cut picture	✔
		Electronic puzzle	Puzzle	Puzzle	✔





Audio		Music making program with guitar	Play guitar	Play guitar	✓
		Music making program with piano	Play piano	Play piano	✓
		Sing along activity	1. Sing 2. Talking with microphone	Sing	✓
		Music listening	1. Radio 2. Music	1. Radio 2. Music	✓
		Music Reading	1. Music book 2. Do not know	Do not know	✗
		Music games	1. Bear listening to music 2. Game with music	Do not know	✗
		Program that ask users to dance	Dancing	1. Do not know 2. Dancing	✓
Hyp		Word processor program	1. Pencil 2. Write	Pencil	✗
		Interactive storybooks	Book	Book	✗
		Word puzzle	Puzzle	Puzzle	✓
		Mathematics tutorials/ games	1. Do not know 2. Talking	1. Do not know 2. Playing	✗
		Strategy game	Tic-tac-toe	1. Do not know 2. Tic-tac-toe	✗
		Mystery solving program	1. Do not know 2. Ghost	1. Do not know 2. Ghost	✗
		Motion game	1. Brick game 2. Game Boy	1. Do not know 2. Game Boy	✗
		Physical activity	1. Running 2. Playing	1. Do not know 2. Running	✗



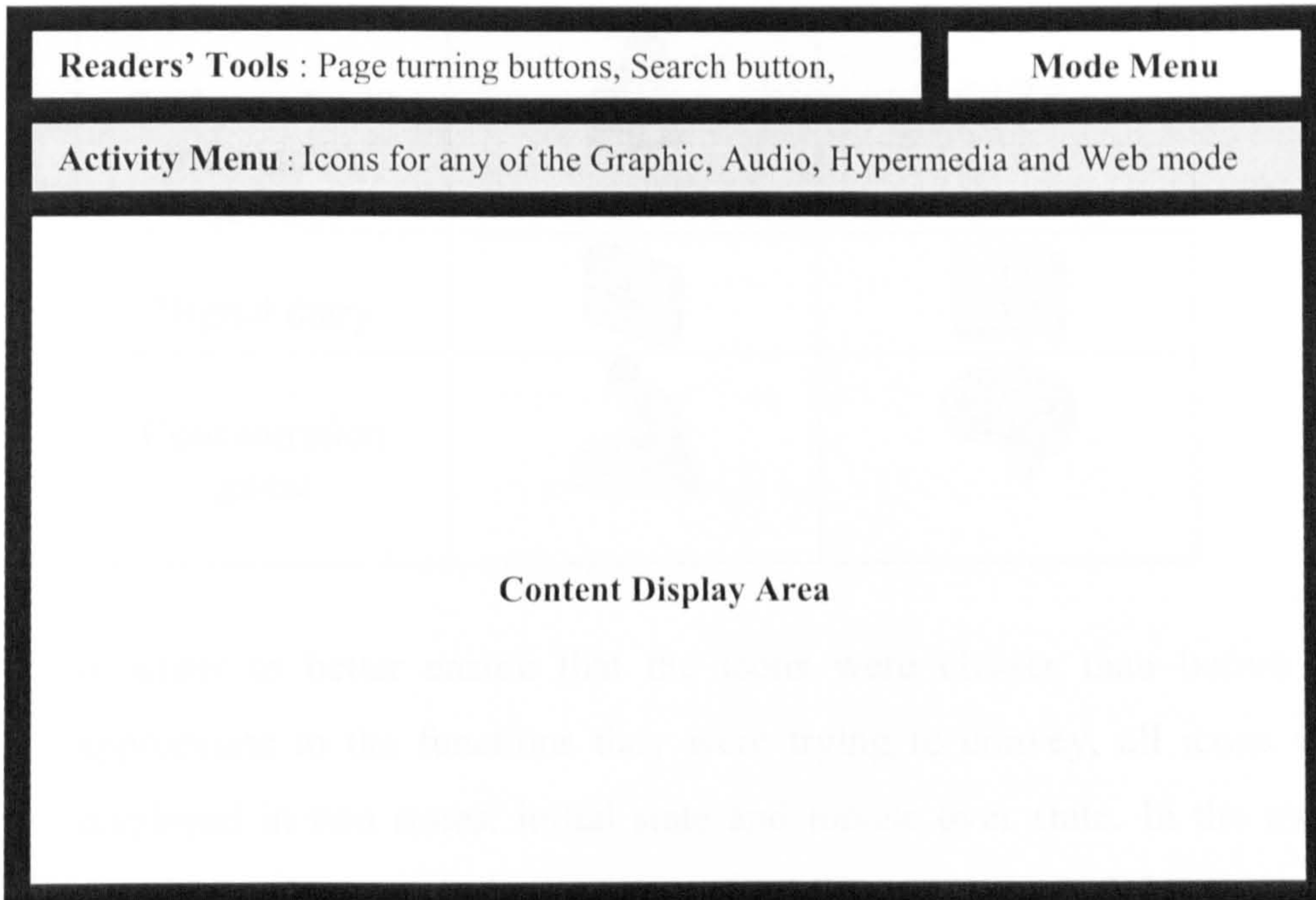
		Self-paced Drill and practice exercises	1. Reading book 2. Writing story	1. Reading book 2. Writing story	
		Digital Diary Writing	1. Present 2. Bag	1. Present 2. File	
		Concentration game	A Moslem Praying	A Moslem Praying	
<b>Web</b>		Email	1. Letter 2. Email	Letter	
		Chat program	Using telephone	Using telephone	✓
		Multi-player games	Children playing	Children playing	✓

*Key Symbol:*

✓ (accept)     (accept with assumption)     (re-design)

During the testing session the TLB layout design which had been selected during the collaboration phase, and was believed to be the best layout for interface design, appeared to be not appropriate for children's use, as they had to move the cursor around to three different sections (top, left and bottom). The icons seemed to be scattered too much for small hands to effectively deal with cursor movement. Icons therefore should be more concentrated in one place (i.e. top or bottom of screen), so that the children do not have to move the cursor in many directions. Taking this and the results of the above analysis into consideration, a new layout was produced (see Figure 5.10) and the icons which needed to be re-designed were replaced (see Table 5.6).






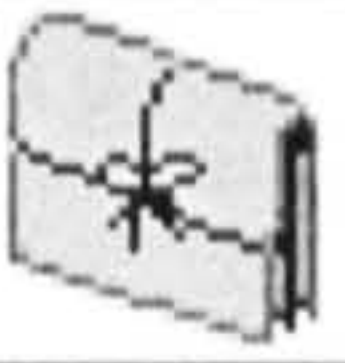



**Figure 5.10:** *Layout of InterActivity Book*

New icons to replace the icons that needed to be re-designed are shown in the following Table 5.6.

**Table 5.6:** *Re-designed icons*




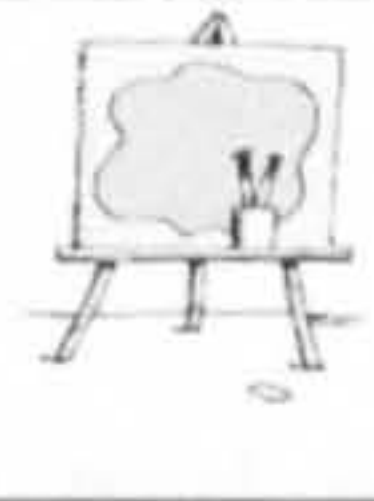


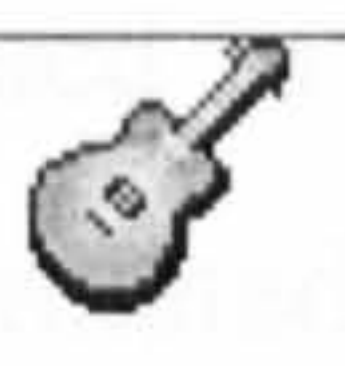




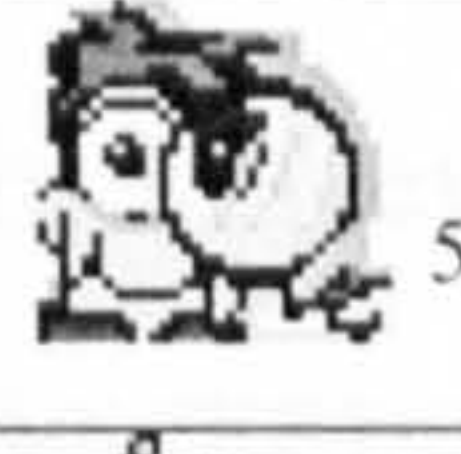


Icon description	Previous icon	New icon design
Table of Contents		
Drawing activity		
Music games		
Interactive storybook		
Mathematics activity		
Mystery solving program		



Self-paced drill and practice exercises		QUIZ
Digital diary		
Concentration game		

In order to better ensure that the icons were clearer than before and appropriate to the functions they were trying to convey, all icons were displayed in two states: initial state and mouse over state. In the mouse over state, the icon design changes according to the underlying metaphor underlying its design. Table 5.7 illustrates some of the different icon states.

**Table 5.7:** *Two states of icons*

Icon description	Initial State	Mouse over
Bookmark		
Drawing activity		
Strategy game		
Guitar playing		
Music listening		
Mystery solving program		
Physical activity		

<sup>5</sup> The picture shows a man with a magnifying glass.



Both functional and non-functional elicitation outcomes have been discussed in previous sections. These outcomes fed into the requirements of the InterActivity Book Builder as presented in the next section.

## 5.5 Requirements Specification Models

As stated in section 3.5, there are various techniques for presenting a requirements specification, and each has its advantages and disadvantages. Since this project covers only the early stages of the system development life cycle, it is concerned only with specifications of functionality and the sequence of tasks used to create electronic books - particularly books that provide users with interactive educational activities as suggested in the InterActivity Book conceptual model. Consequently, linguistic-based models such as GOMS are not quite suitable for such purpose because they are more appropriate for representations of cognitive aspects or users behaviour or command line systems (Dix et al., 1998). In view of this, a mixture of graphical representations and set syntax were chosen. Once presented using such techniques, the representations become models as outlined below.

### 5.5.1 Functional Modelling

Functional models identify system functionality and show the flow of processes. Usually Data Flow Diagrams (DFDs), Behaviour Diagrams (BDs) and flow charts are used to represent the models. The choice of a technique is more closely related to human factors than to technical attributes (Pressman, 1982). Cradle System Modelling by Structured Software System Limited<sup>6</sup> is an example of a program that enables users to draw such charts and diagrams easily. EBoChi however, adopted flow charts notation and mathematical set syntax for this purpose.

The main technique that was intended for EBoChi was flow-charting because it is normally used to show procedures to accomplish tasks, which

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<sup>6</sup> Go to their Web site at <http://dSPACE.dial.pipex.com/sss1/who3s1.htm> for more information.

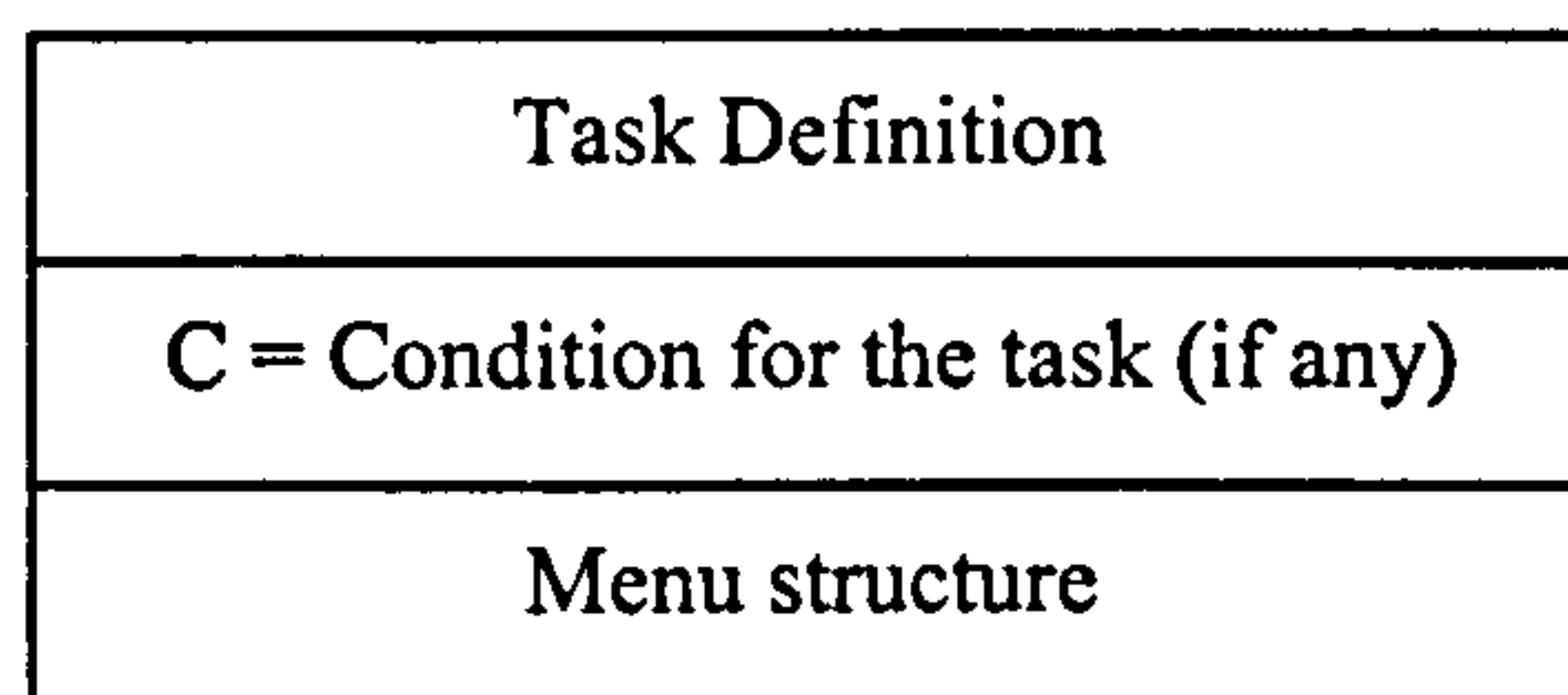


was the main intention of EBoChi's functional modelling. It usually uses six symbols:

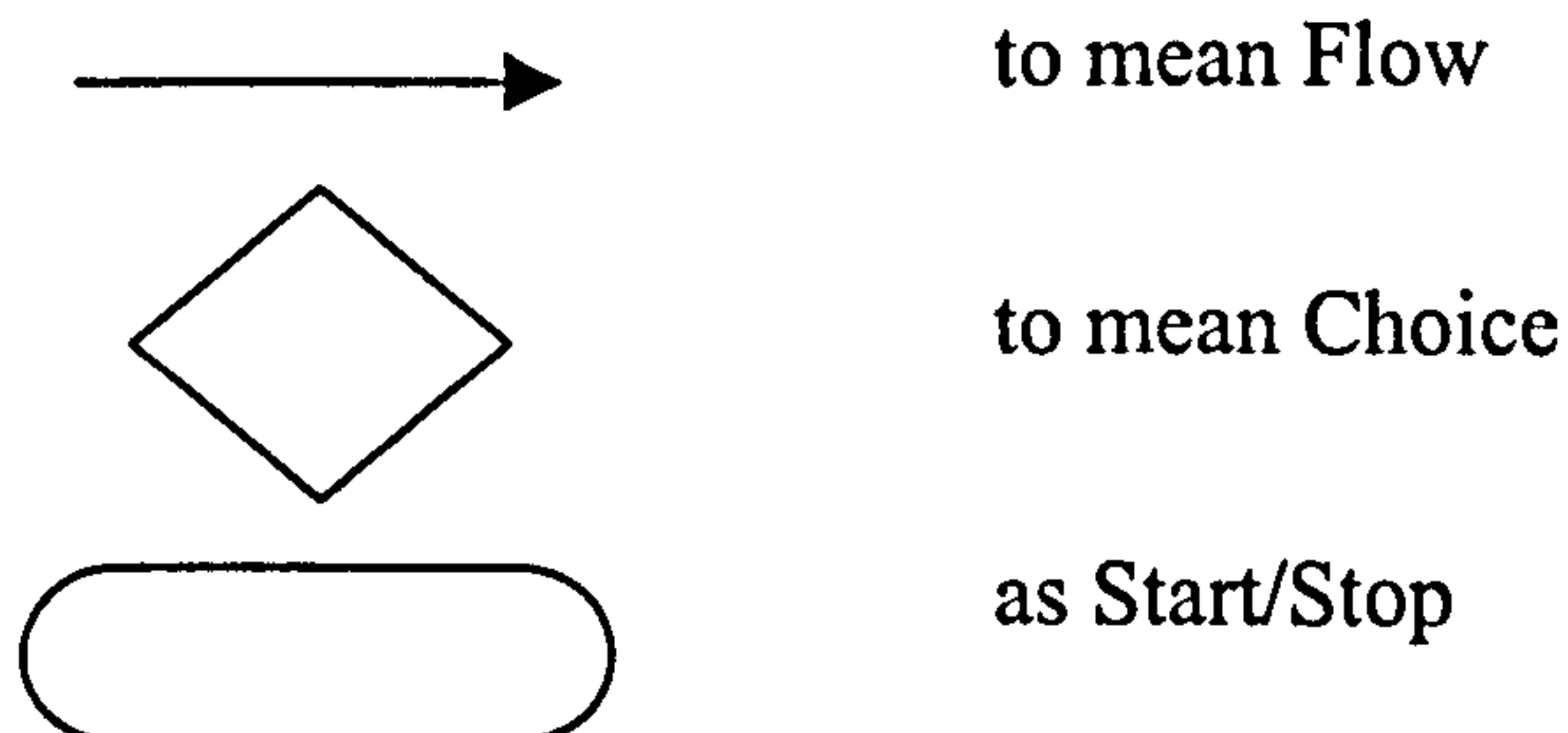
- ellipse (start/stop);
- rectangle (process);
- diamond (choice);
- line with arrow (flow);
- the letter N (negative answer);
- the letter Y (positive answer).

However, due to the limitation of not being able to show the inclusion of conditions, mathematical set syntax was also adopted in order to overcome the limitation.

EBoChi divided the process symbol into three sections: the tasks involved in creating or reading the book; conditions which may apply to each task (if there is no condition, this section will be empty); and where the function should be positioned in the menu structure. These are represented by the following process symbol:



In addition to the above symbol, EBoChi also used:



The following section outlines the functional models from level 0 to 3 using the symbols explained above.



### 5.5.1.1 Level 0: Create Book

From the top-level chart (at level 0), when users want to create a book, they select the function New Book from the File menu. While creating the book, users will perform other functions as described in level 1 (see Figures 5.11 through 5.21). When they have finished creating, the book can be saved in three choices of book format (namely .bok<sup>7</sup>, .exe or .html). Users also have options of just closing the book without saving it or printing it. A book that has been created and saved can also be read (see the level 2 model depicted in Figure 5.20) or edited (see the level 3 model depicted in Figure 5.21). Thus, at the highest level of model, i.e. level 0, the functions involved are as illustrated in Figure 5.11.

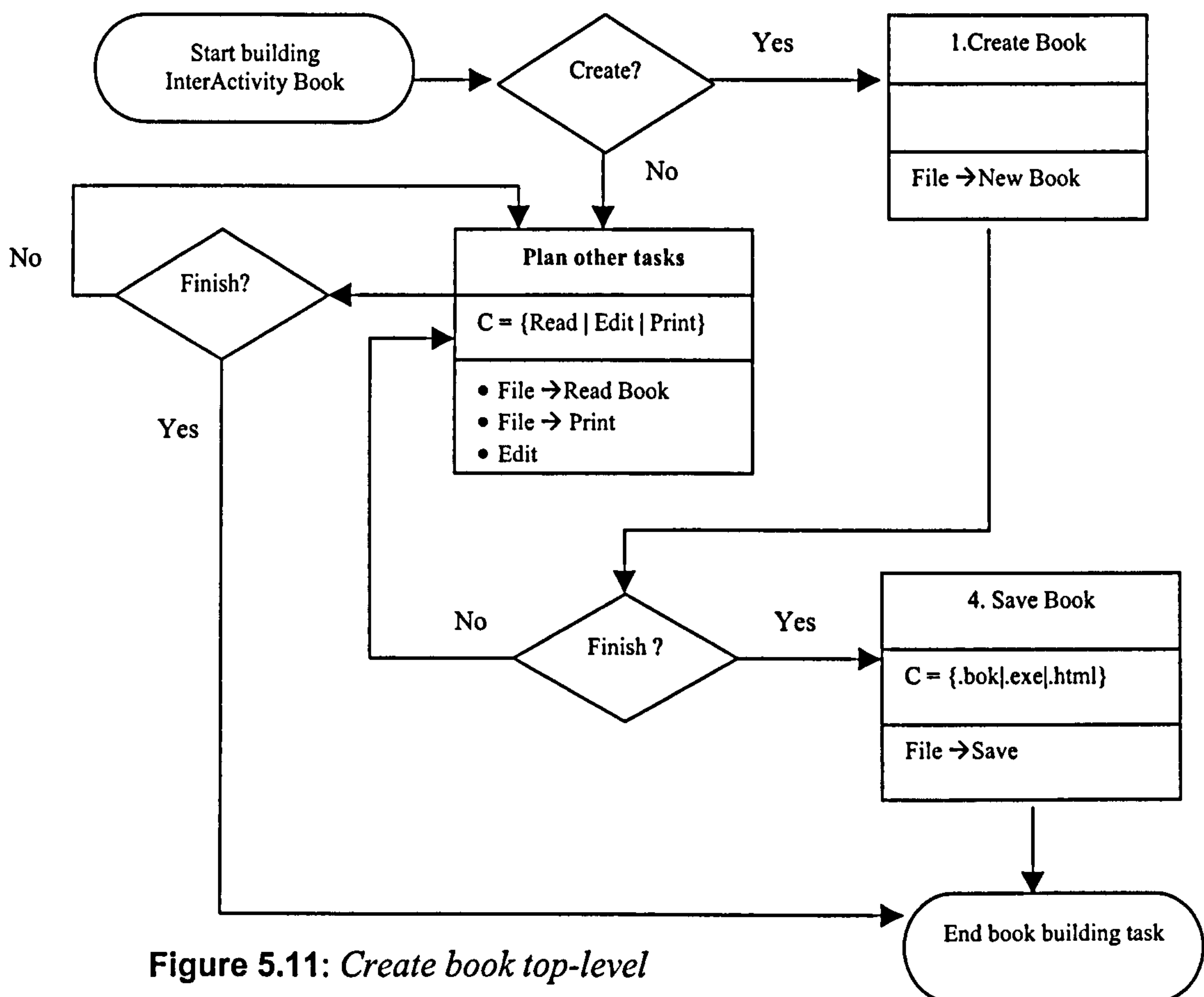


Figure 5.11: Create book top-level

Note: When planning other tasks, users have three choices of actions: to read (see Figure 5.20), or edit (see Figure 5.21), or print a book/page.

<sup>7</sup> Book Builder format.



### 5.5.1.2 Level 1: Create Book

This level outlines the tasks required to build a book. The first step is to insert a page from a selection of different types (i.e. cover, TOC, verso, content or back). For each type, there are further choices. For instance, in content page, users can create text only or text and graphics or other combinations. In each content page, users also have the option of creating activities (see Figure 5.12).

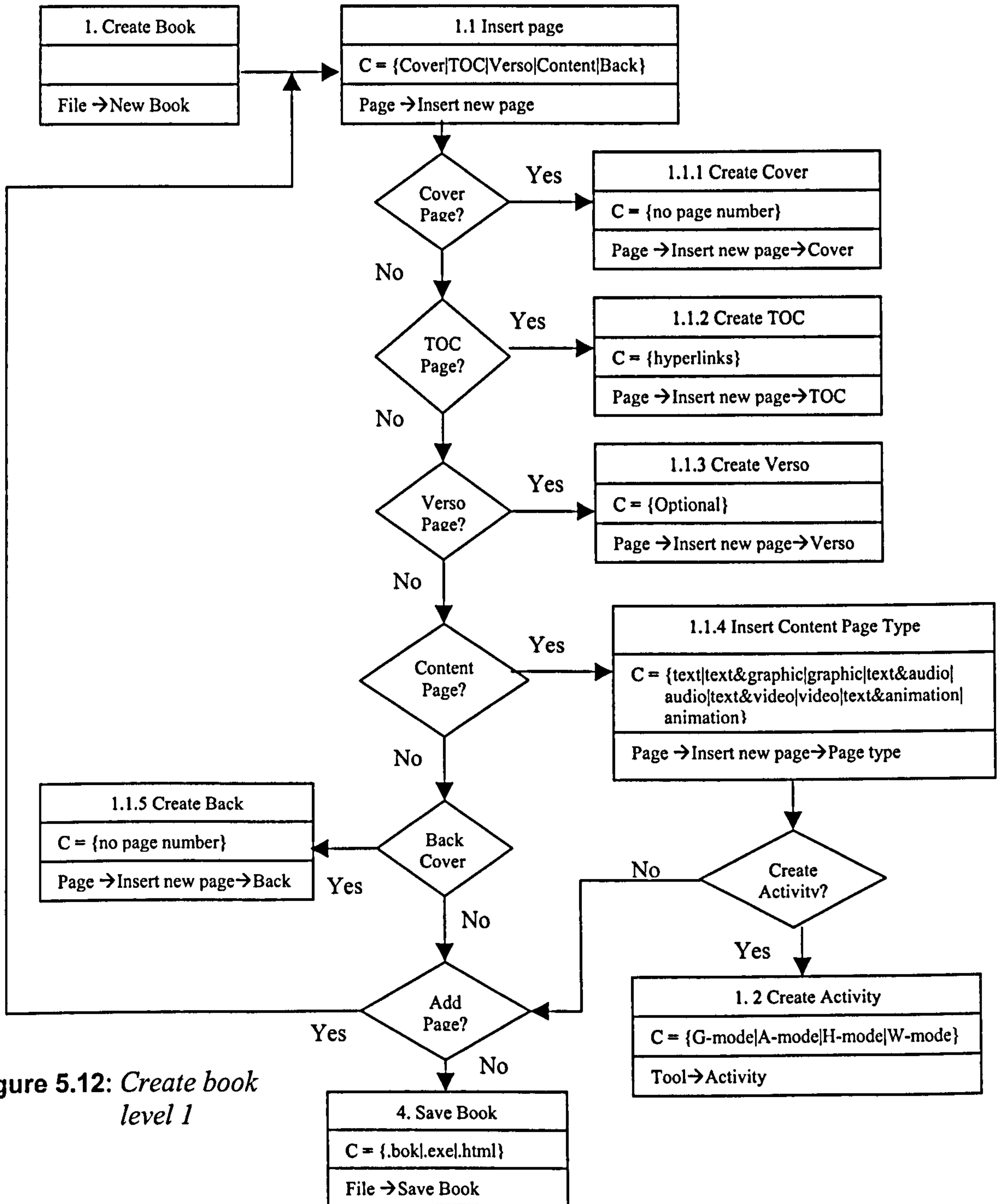


Figure 5.12: Create book level 1

### 5.5.1.3 Level 1.1.1: Create Cover

When a user selects *insert a cover page*, a choice from at least four different designs can be made. To create content, which can be in multiple information type (i.e. text, graphic, audio, video, animation), users can use the default software, select their own preferred choices or insert existing content from existing files. They can then continue to edit the content, insert new pages or save whatever has been created (see Figure 5.13).

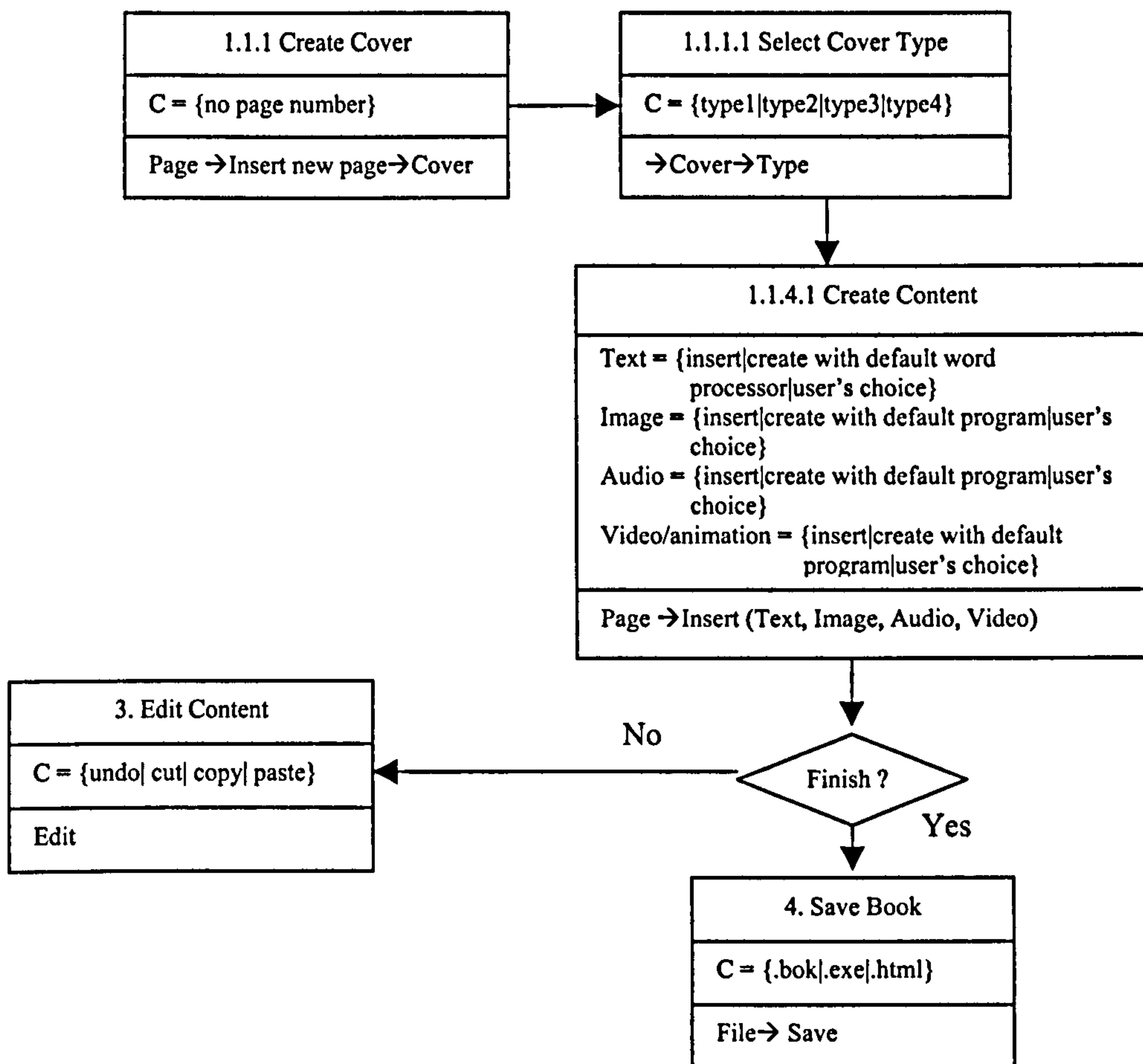


Figure 5.13: *Create front cover*



### 5.5.1.4 Level 1.1.2: Create TOC

When users select *insert a TOC page*, they can choose from at least four different designs. To create content, which can be in multiple media (i.e. text, graphic, audio, video, animation), they can use the default software, or select their own preferred choices or insert existing content from existing files. They then continue to edit the content, insert new pages or save what has been created. Finally, the completed TOC will be linked to appropriate chapters, sections or sub-sections (see Figure 5.14).

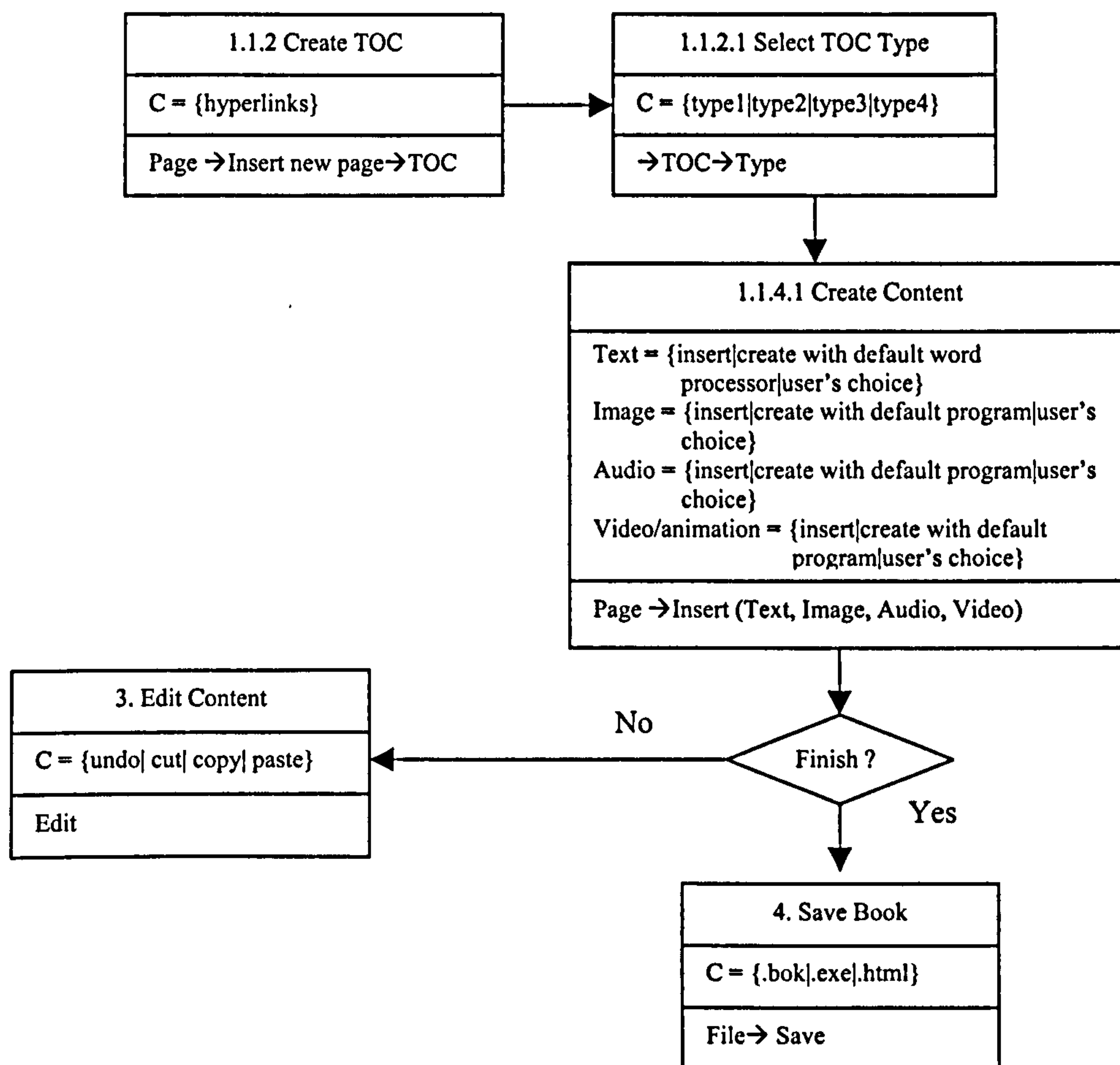


Figure 5.14: *Create TOC*

### 5.5.1.5 Level 1.1.3: Create Verso

When users select *insert a verso page*, they can choose from at least four different designs. To create content, which is usually in text, they can use the default word processor software, or select their own preferred choices or insert existing content from existing files. They then continue to edit the content, insert new pages or save what has been created (see Figure 5.15).

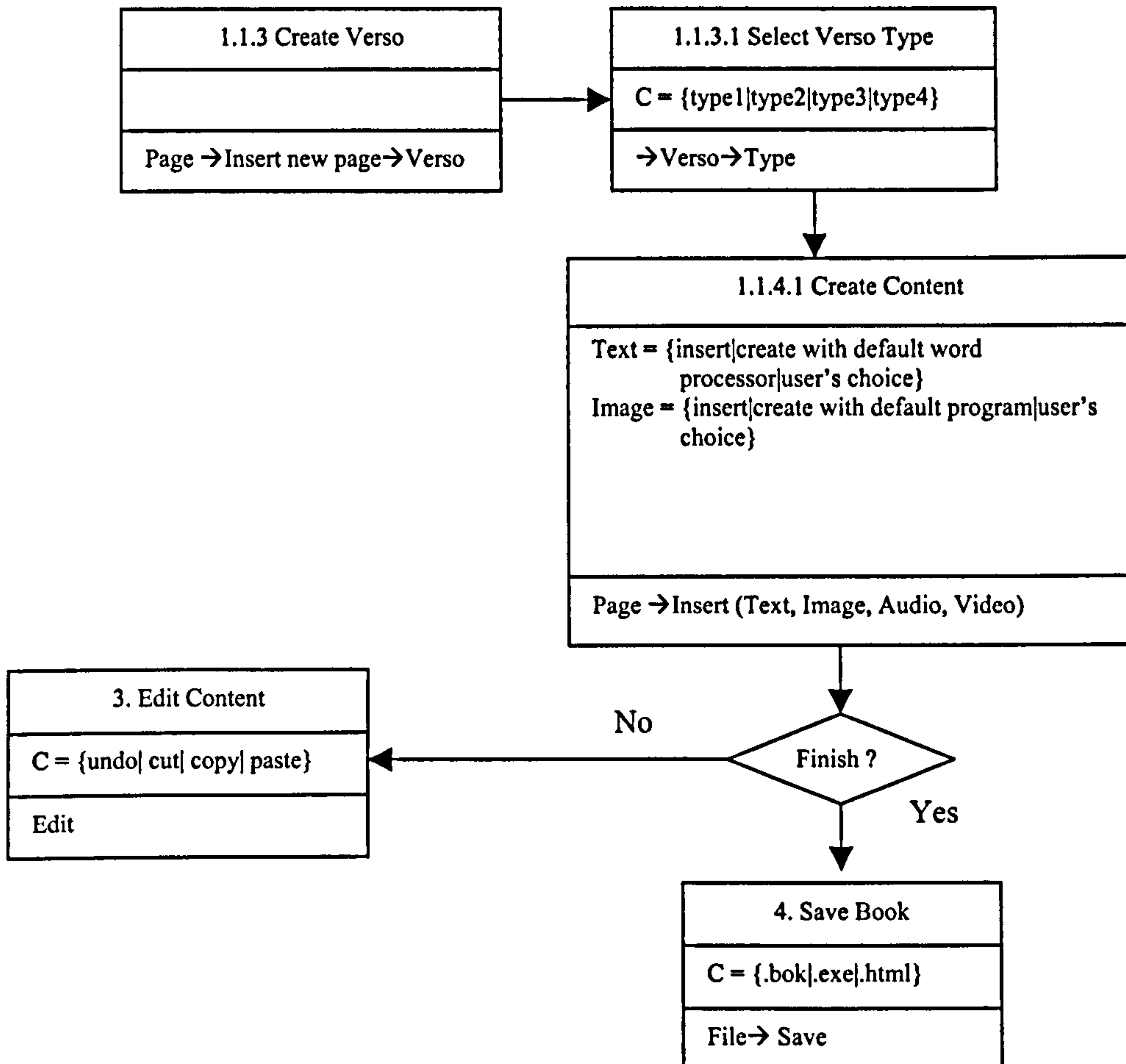


Figure 5.15: *Create verso*



### 5.5.1.6 Level 1.1.4: Create Content page

When creating a content page, users first choose from different page types (i.e. text/text and graphic/graphic/text and audio/audio/text and video/video/text and animation/animation). To create the content, they can use the default software, or select their own preferred choices or insert existing content from existing files. They then continue to edit the content, insert new pages or save what has been created. Users will also be asked whether they would like to create activities associated with the page (see Figure 5.16).

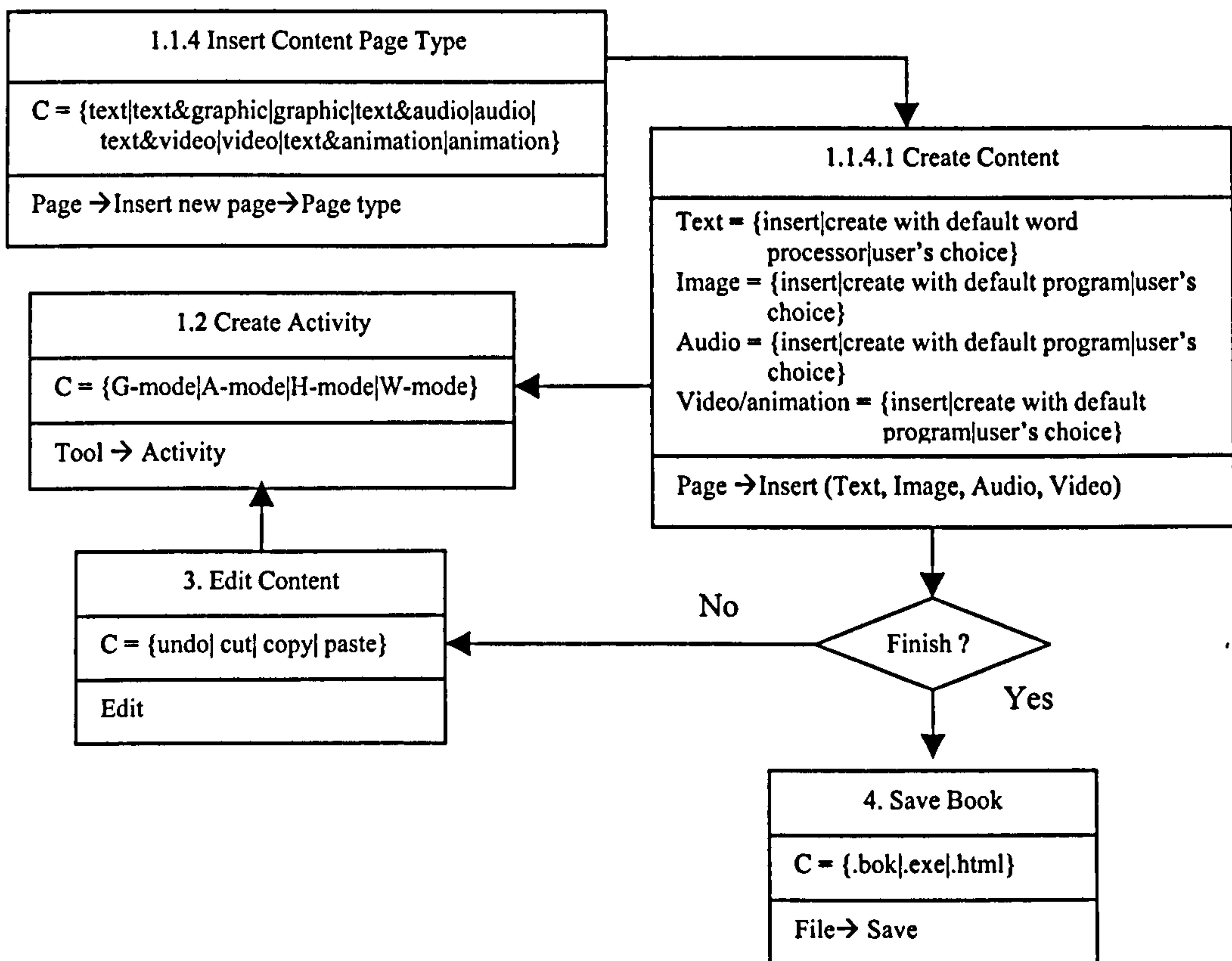


Figure 5.16: Create content

### 5.5.1.7 Level 1.1.5: Create Back Cover

When users select *insert a back cover*, they can choose from at least four different designs. To create content, which can be in multiple media (i.e. text, graphic, audio, video, animation), they can use the default software, or select their own preferred choices or insert existing content from existing files. They then continue to edit the content, insert new pages or save what has been created (see Figure 5.17).

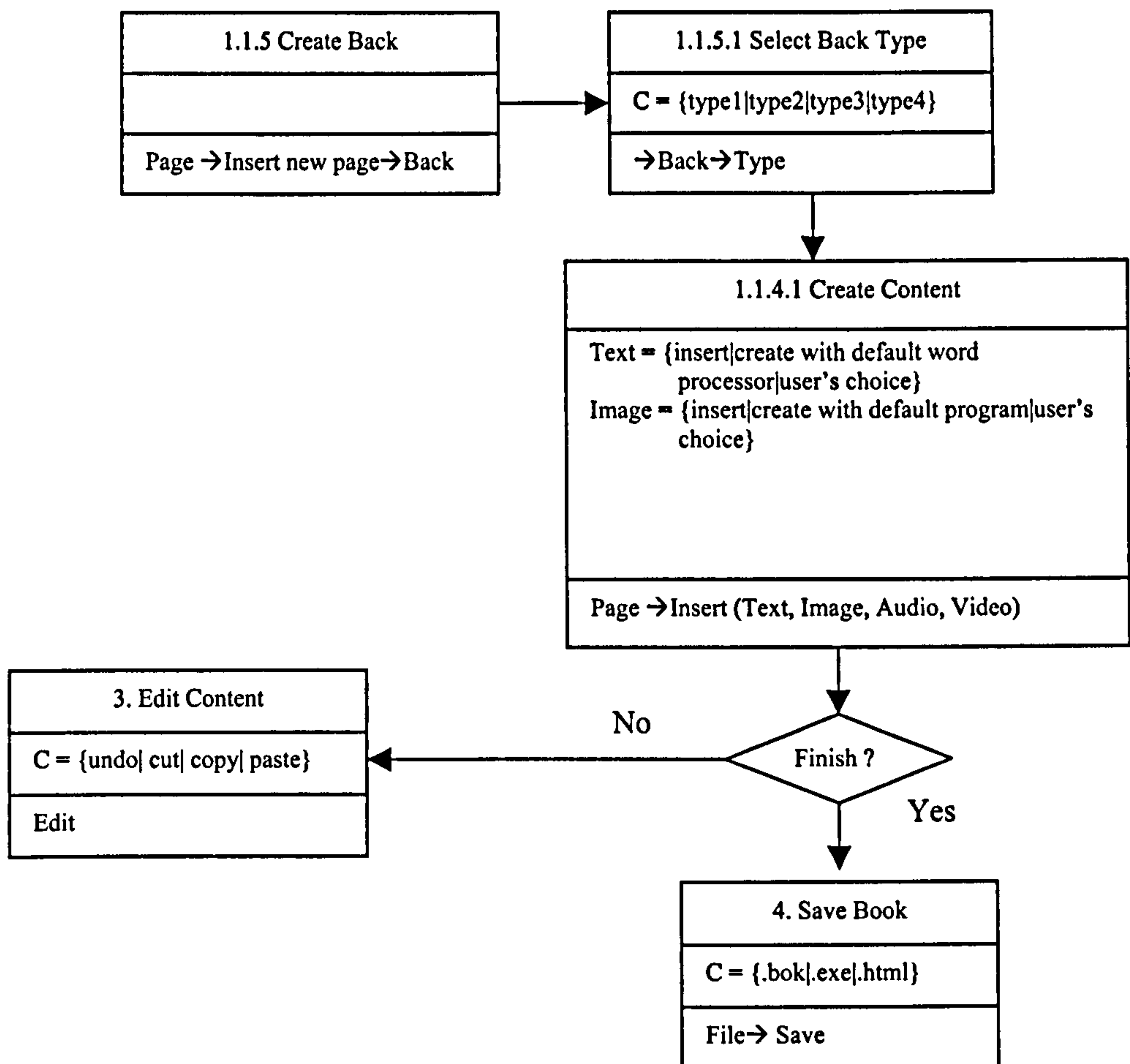


Figure 5.17: *Create back cover*



### 5.5.1.8 Level 1.2: Create Activity

For each content page, users have the option of creating activities to support the content of that page. As mentioned in chapter 4, activities are grouped into 4 modes: graphic, audio, hypermedia and Web. In each mode, users have further choices of various program builders that are used to develop the activities.

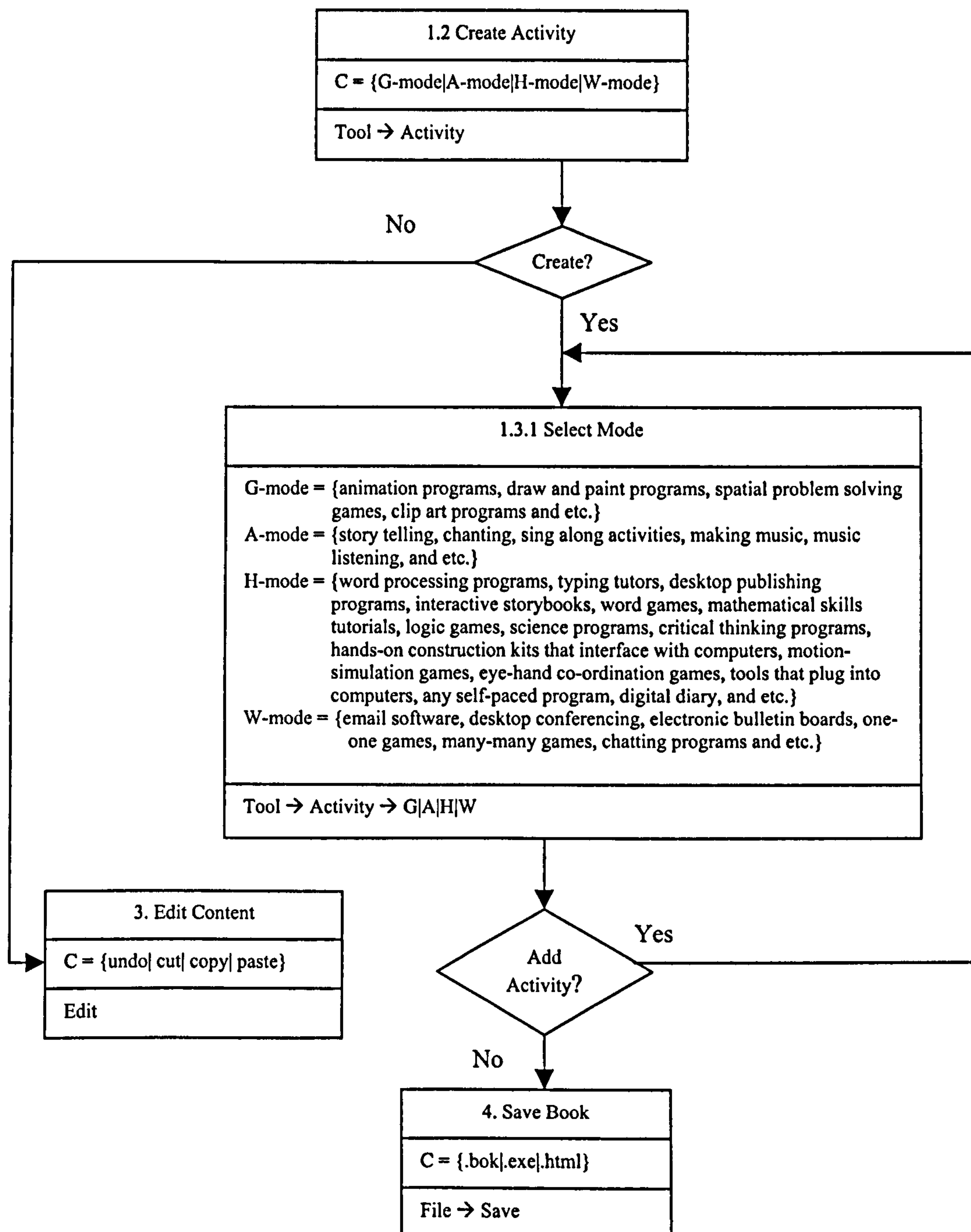


Figure 5.18: Create activity



Activities should be easily and automatically created (i.e. without requiring users to have prior programming knowledge). Users should be able, for example, to create picture puzzles by just stating the number of puzzle pieces and choosing the appropriate image. To create a colouring activity, users will choose a suitable image (i.e. one that matches the content of that particular page), define hot spots and select colours. When children use the book in read mode, the colouring activity should look similar to that depicted in Figure 5.19.

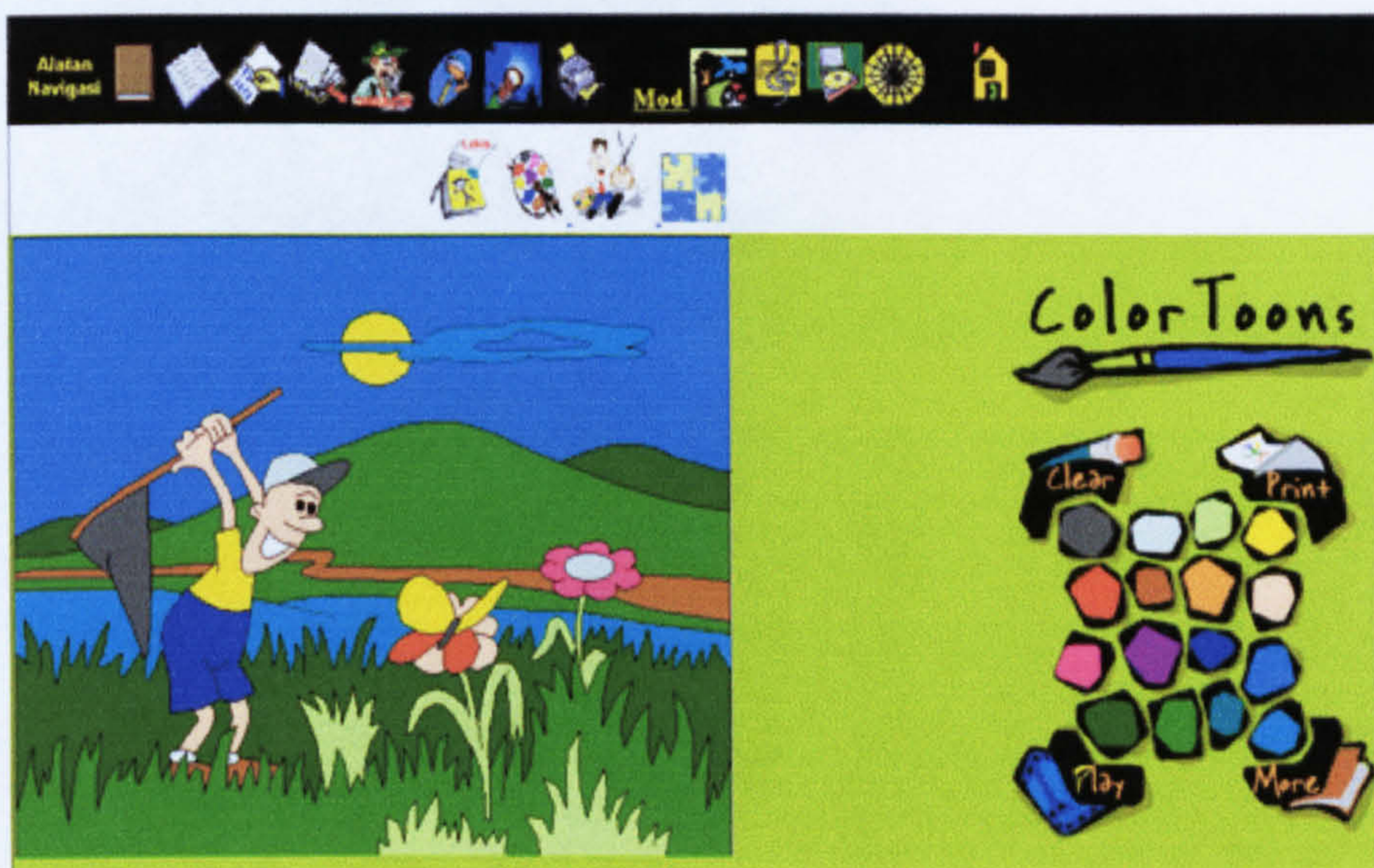
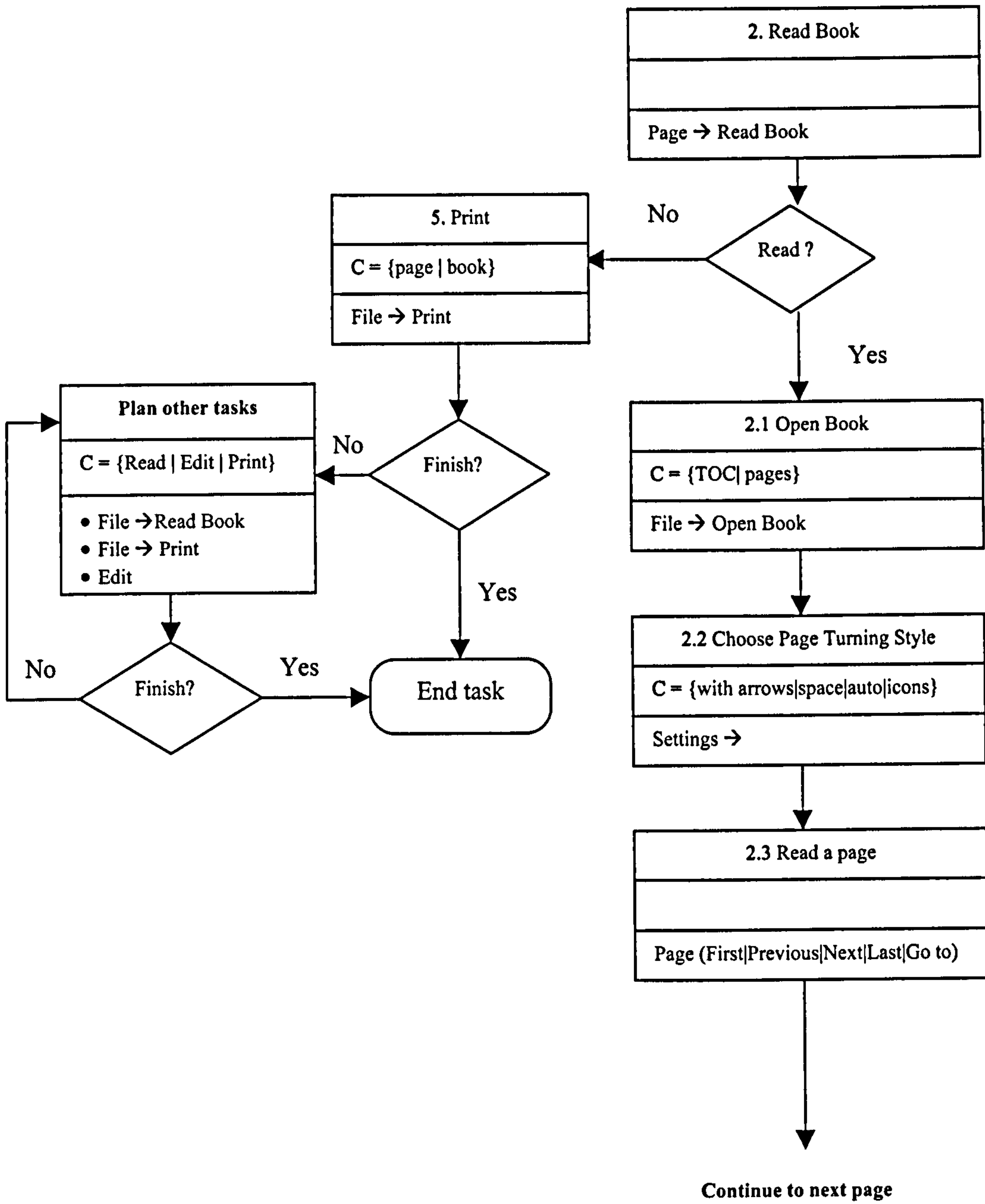


Figure 5.19: Colouring activity

### 5.5.1.9 Level 2: Read Book

To read a book, users select the function Open Book and choose either *accessing pages with TOC* or *go to particular page* (first, previous, next, last, go to) using page-turning style options (i.e. with arrow keys, space key, page-turn automatically after certain duration of time or icons). While reading, users can also perform other actions such as playing audio/video, narrating text, personalising, searching, zooming and playing activities that support that particular content (see the following Figure 5.20).





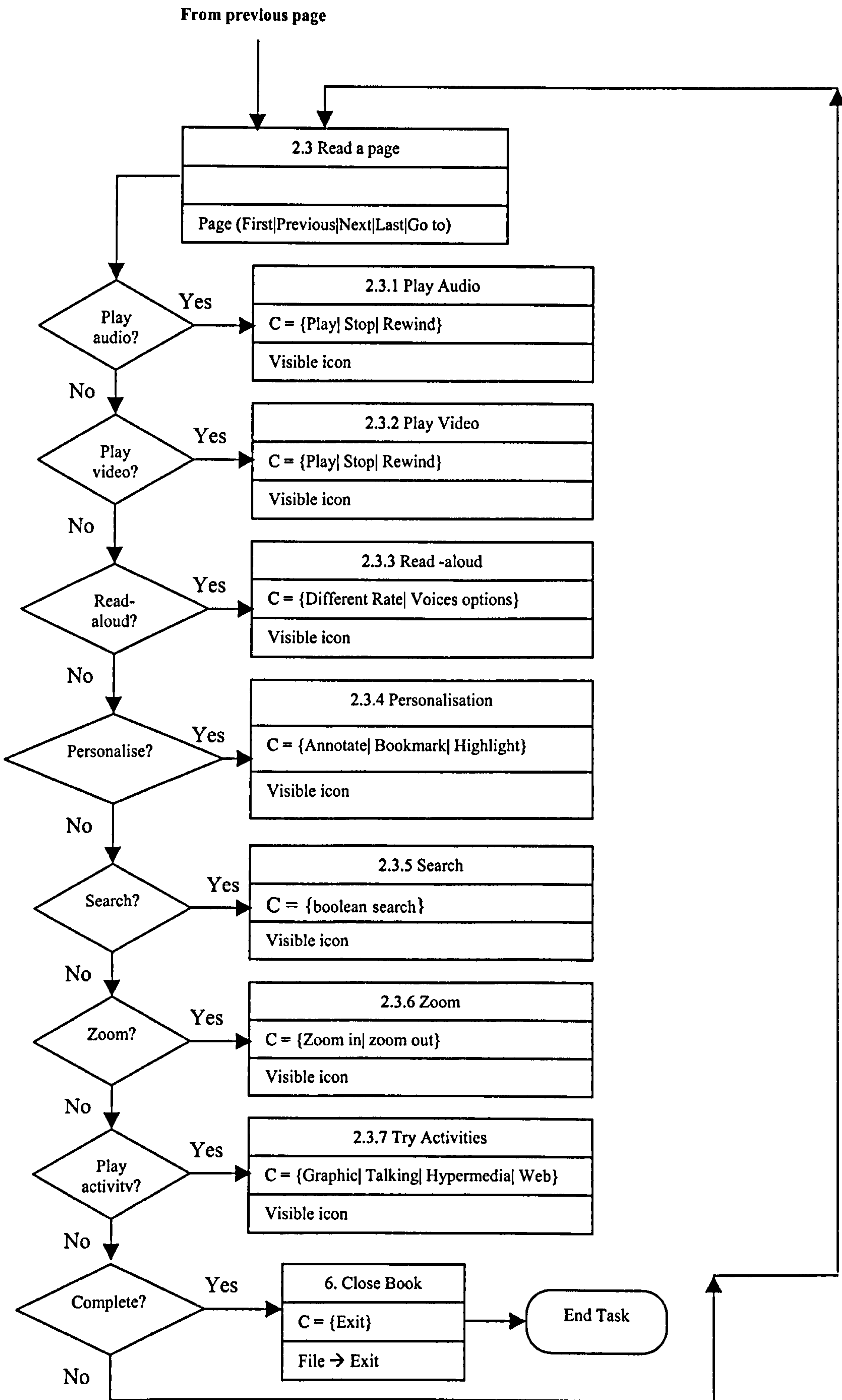


Figure 5.20: Read book



### 5.5.1.10 Level 3: Edit Content

This level shows the functions associated with a book when it is being edited. In order to edit a book a user simply selects Edit Book, and then performs the required actions (see the following Figure 5.21).

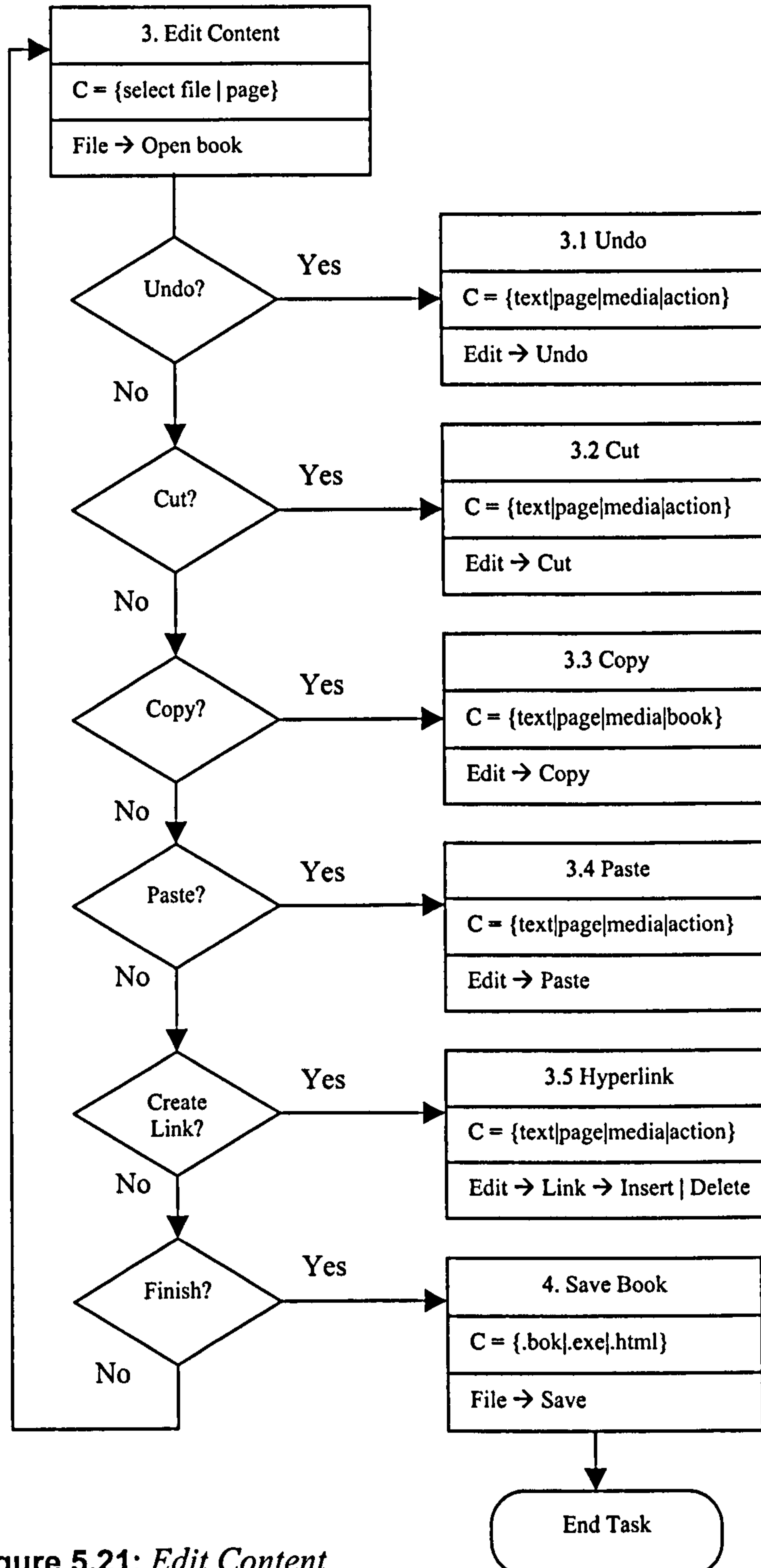


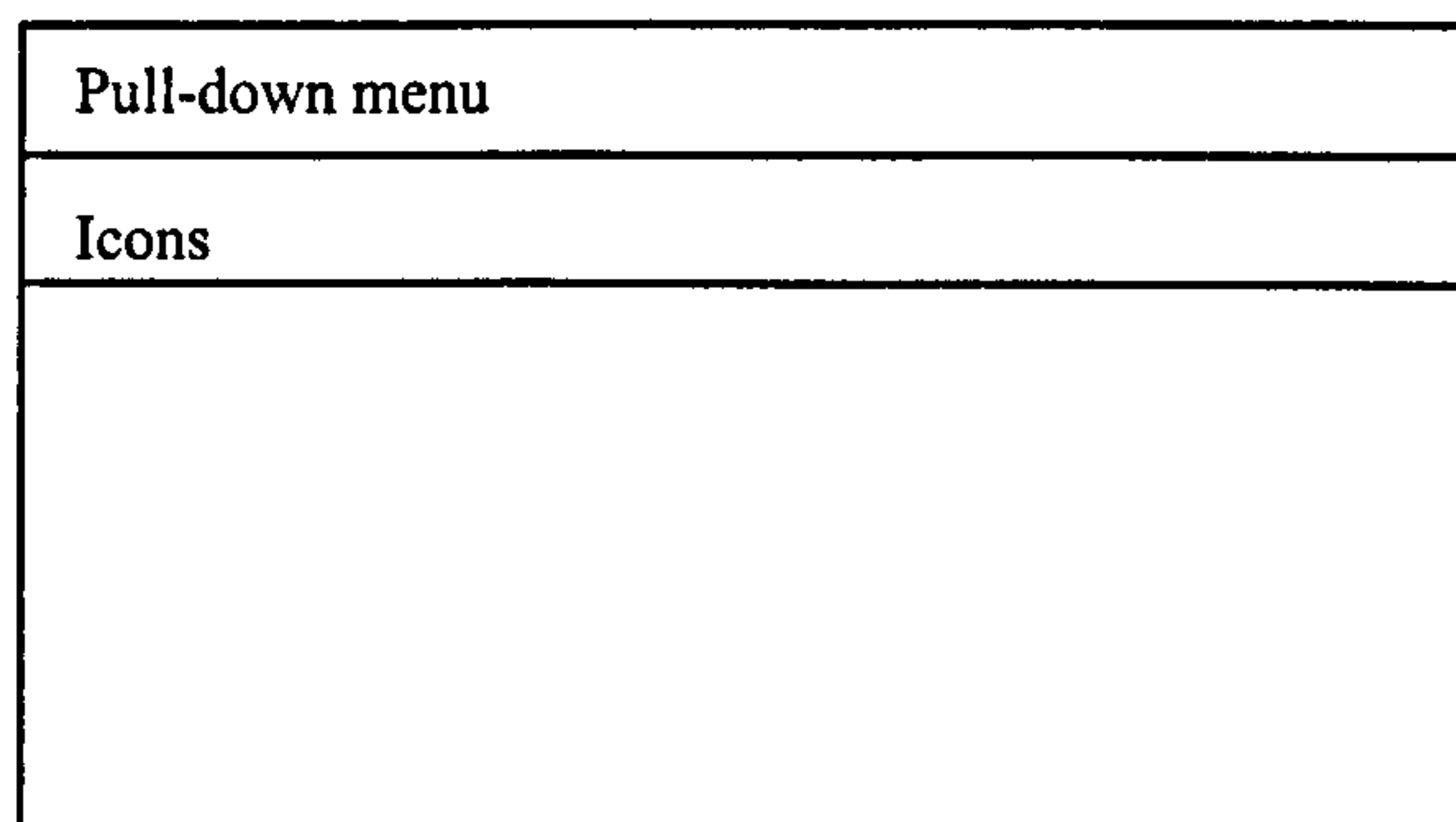
Figure 5.21: *Edit Content*

### 5.5.2 Non-Functional Modelling

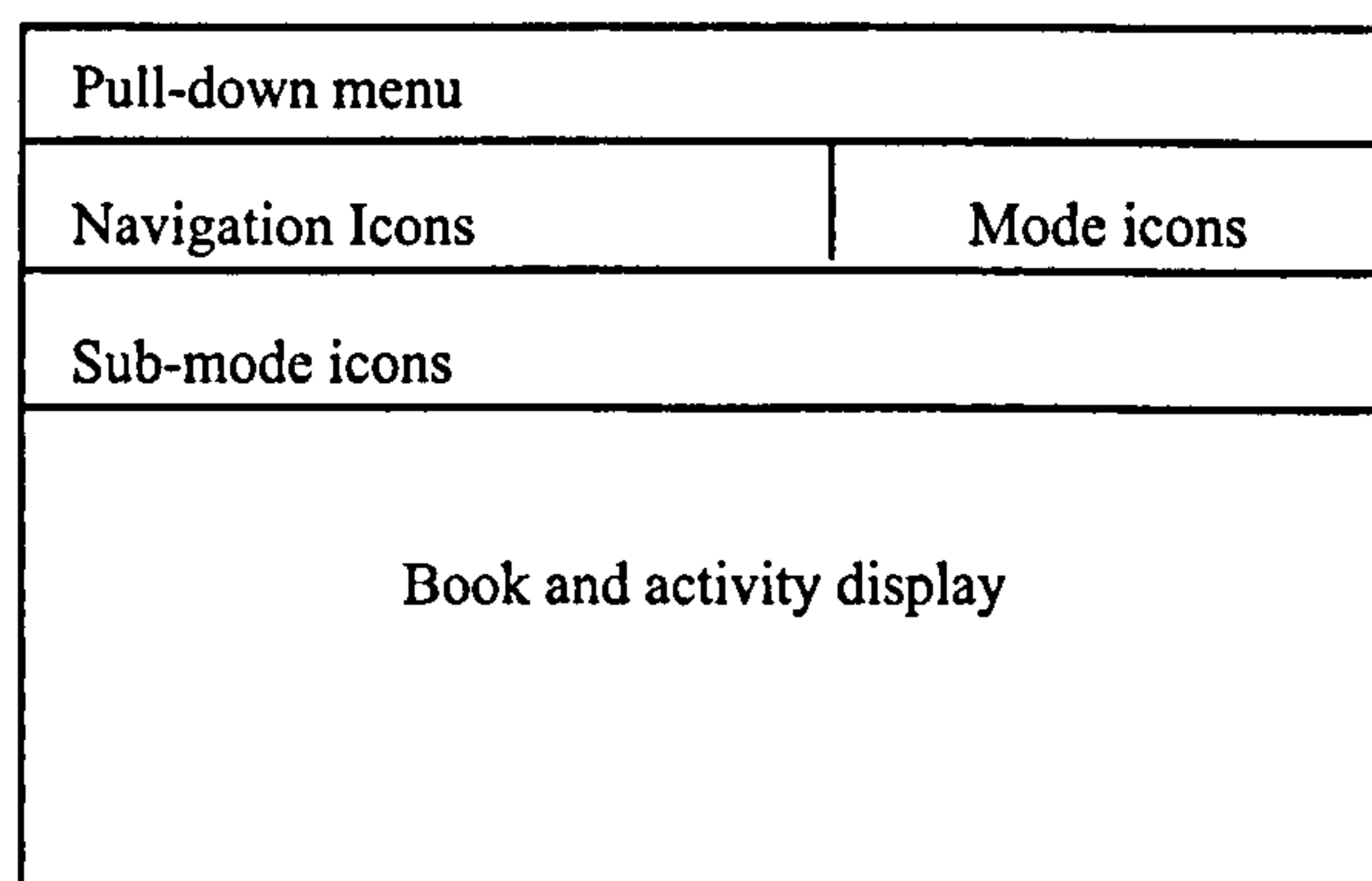
*“The simplest type of end-user interface for an e-book will consist of two basic components, a display screen and some form of on-screen pointing facility.”* (Barker & Giller, 1991).

This section outlines the suggested interface layout for the InterActivity Book Builder for use in the `Create` and `Read` modes. In addition, features that are usually unique to e-book technology are also listed.

The `Create`-mode and `Read`-mode should include icons and pull-down menus in order to be flexible enough to accommodate a range of expertise and ages. Users should be able to choose from using an iconic mode or a pull-down menu, or both. Furthermore, it should be possible to customise icons with lower or larger numbers of pixels (i.e. make icons smaller or larger). Layouts for the interface are shown in Figures 5.22 and 5.23. Examples of suitable icons are shown in Figure 5.24.



**Figure 5.22:** *Create-mode layout*



**Figure 5.23:** *Read-mode layout*





**Figure 5.24:** *Layout with icons in read-mode*

The menu should be customisable as well so that users can turn on or off different buttons and functionalities (i.e. show only what they want). With menu customisation teachers will be able to set different functionalities to different age groups to suit the different levels of expertise.

An e-book wizard that guides users through each step of the way to creating e-books should also be made available.

In order to be more flexible, the e-book builder should support a wide range of file types, for example, BMP, GIF, JPG, MID, WAV, MP3, AVI, MPEG, and so on. In addition, it should run on both PC and Apple Macintosh platforms.

Completed books should be able to be protected (especially if the books are to be commercially published) by using password, registration key or limited access. Limited access can work in the following ways<sup>8</sup>:

<sup>8</sup> See how some companies protect their books at [http://www.firstbusinesswebsite.com/articles/ebook\\_setup.html](http://www.firstbusinesswebsite.com/articles/ebook_setup.html) and <http://www.ebooksprogram.com/page4.html>



- Allow or disallow copy, paste and printing;
- Enable printing only after book is registered;
- Set expiration date for trial pages;
- Limit number of access times (i.e. one book can be accessed only for a pre-defined number, say twenty times, after which a new password or publishers' permissions are required).

Lastly, the usability level of the e-book builder should be high. The e-book builder should be easy to use, easy to learn, and should try to limit errors made by users. Well-structured user manuals, informative error messages, a help facility and a consistent end-user interface are also essential requirements.

## 5.6 Conclusions

this chapter discussed how the second sub-objective was achieved. By reusing the information obtained from the Smart School blueprint, the domain of the proposed e-book builder was elaborated. In addition, the roles of and relationships between, the stakeholders were also specified schematically. The roles of the most important actors (i.e. the teachers and children) led to the analysis of tasks required in order to produce e-books using the proposed e-book builder. In this regard, the necessary functional and non-functional requirements were extracted and identified by means of reviewing the Book Builder program and testing it with a number of children. Some suggestions for the improvement of the Book Builder's functionalities were listed. Furthermore, many icons that were considered suitable for the end-user interface of the proposed e-books were evaluated where the children's reactions were documented.

The final parts of this chapter discussed the formalised models of the proposed e-book builder requirements. The models were specified using the flow-chart notations. Chapter 6 will report on the outcomes of the validation of these requirements.



# Chapter 6

## Hypothesis Testing and Evaluation

### 6.1 Introduction

In chapter 4, a conceptual model of the InterActivity Book was introduced. Its main feature was the inclusion of appropriate interactive activities to support a diversity of learning styles. Chapter 5 then reported on the context in which the InterActivity Book would be most likely to be used – that is, a school environment, more specifically the Malaysian Smart School. In this context, there is a necessity for teachers and children to build their own tailor-made books. For example, teachers might want to develop their own T/L materials based mainly on textbooks supplied by the Ministry of Education. Children might also like to write their own stories when asked to by their teachers. These books and stories could be in conventional or electronic form; the choice is up to



the teachers and children. If they choose to use the conventional authoring technique then the technology is readily available, that is, pencils/pens and paper. If they opt for the electronic version then there should also be a readily available technology. With this in mind, chapter 5 also discussed and suggested the requirements of such technology, which is known as the e-book builder. These requirements were defined based on the elicitation outcomes obtained from potential users. However, before the requirements could be fully accepted, it was essential that they were validated by different groups of users in order to answer questions such as: would teachers of different gender, age and teaching experience groups agree on the requirements? Would the teachers find the proposed functionalities useful? Additionally, it was important to study how users, and especially children, interact with the technology. Would children be able to use it successfully? Would there be any differences (in the ability to use the technology) between children of different gender, age and computer experience? These are some of the questions that required answers if the technology is to be introduced in a school environment.

It is therefore the aim of this chapter to report on the outcomes of the validation and evaluation actions. In doing so, this chapter accomplishes sub-objective 3 and sub-objective 4 as outlined in chapter 1. As mentioned in chapter 3, EBoChi utilised the prototyping technique, with throw-away and ready-made prototypes, to validate the requirements. When using this particular technique, the literature suggests that the usability of the prototype should be measured. The next section therefore focuses on usability issues. The report then continues to discuss the evaluation questions, research instruments, index descriptions, statistical procedures, sampling and the hypotheses testing results. In the last section of this chapter, the findings from observing how children interacted with e-books on portable devices and the prototypes are outlined.



## 6.2 Requirements Validations

### What to measure?

Usability factors are used to measure how well a system supports people in any particular activity. Such factors have two key dimensions: one related to subjective perception and the other related to objective measures of interaction (Keinonen, 1998). Factors for educational software which are based on computer system usability factors, require additional criteria. Reeves (1994) identifies two types of factors for educational software: the user interface and pedagogical factors. The user interface factor is concerned with the aspects of design that ensure that learners can actually engage in interacting with the software. Some of its attributes are as follows:

- ease-of-use;
- navigation;
- cognitive load;
- screen design;
- information presentation;
- media integration.

The pedagogical factor is related to aspects of software that affect learning and has attributes such as:

- goal orientation;
- instructional sequencing;
- accommodation of individual differences;
- learner control;
- user activity;
- co-operative learning.

Barker and King (1993) also focus their study on attributes specifically for evaluating interactive multimedia educational software. The outcome is a basic checklist, which lists engagement, interactivity, tailorability, quality of interaction, quality of end-user interface and learning styles as key attributes for defining quality in educational software.



In addition to the above, another attribute, child-proofing, which is concerned with whether the e-book is designed with a child in mind and follows children's software design guidelines, should also be considered when evaluating children's software (Childrensoftware.com, 1998).

From the above descriptions, it can then be deduced that some of the important usability factors<sup>1</sup> for educational software (such as e-books) are: subjective perception, user interface and pedagogical issues (Norshuhada & Landoni, 2001; 2002).

There are many guidelines on how to evaluate subjective perception and user interface design (e.g. Kirakowski, 1993,1998; Kirakowski & Corbett, 1993; ISO 9241<sup>2</sup>; Lu & Yeung, 1998; Shackel, 1991; Nielsen, 1993; Shneiderman, 1998). However, at this requirements engineering stage, EBoChi first identified the perceived usefulness of the functions and activities and the ease-of-use of the prototypes. Both Nielsen (1993) and Shackel (1991) consider usefulness to be one of the attributes influencing product acceptance. Nielsen defines usefulness as whether the system can be used to achieve a desired goal. In other words, does it have the functionality which would meet the users' need? The perceived usefulness construct is gaining widespread acceptance as a valid and predictive measure of system acceptability (Davis, 1993; Hubona & Blanton, 1996). It is widely suggested that as the functions and interface features of a new system are made, it is an ideal time to measure users' assessments of a proposed system in order to get an early indication of its acceptability (Davis, 1989; Chin et al., 1988; Adams et al., 1992).

Other usability factors were not opted for because they did not fit the purpose of EBoChi. For instance, efficiency is typically measured with the time taken to perform an activity. This dimension has a low priority in the design of an e-book

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<sup>1</sup> Usability factors of educational software ( $U_{es}$ ) = Subjective perception ( $S_{pc}$ )  $\cup$   
 User interface ( $UI_{fc}$ )  $\cup$   
 Pedagogic ( $P_{dg}$ )

In short  $U_{es} = S_{pc} \cup UI_{fc} \cup P_{dg}$



since in a learning environment, learning tools such as e-books are developed on the basis that learning is important rather than the speed with which users perform a task. The intended evaluation also did not attempt to address the effectiveness of the learning experience. This is due to the fact that the prime aim of this evaluation was to measure how users accept the requirements of e-book and e-book builder features. Nonetheless, the evaluation tries to address the potential of e-books to provide a constructive learning experience.

### 6.2.1 Evaluation Questions

The sub-hypotheses arose as a result of some questions which came up when the sub-research question 3 (i.e. how to assess usefulness and ease-of-use) and sub-objective 3 (i.e. how to analyse system functionalities usefulness and ease-of-use) were being constructed. The questions were:

1. What are the teachers' perceptions regarding the usefulness of the activities in addressing children's learning styles?
2. Do teachers think e-books with interactive educational activities are more useful than those without?
3. What are the teachers' perceptions on the usefulness of the proposed e-book builder in assisting their classroom teaching tasks?
4. Is there any difference in the perception of the usefulness of the proposed e-book builder functionalities in relation to teachers' gender, age, teaching experience, computer technology experience and school location?
5. Is there any difference in the perception of teachers and experts about the proposed e-book builder functionalities?
6. Can the teachers and children use the e-book builder easily?
7. Do teachers think the proposed e-book builder concept should be implemented in schools?

From these questions and the main hypotheses (see chapter 1), the following sub-hypotheses were formed and used to verify the research objectives.

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<sup>2</sup> Go to <http://www.iso.ch/iso/en/CatalogueListPage.CatalogueList?ICS1=13&ICS2=180>



- H<sub>1</sub>: A number of specific educational activities (e.g. storytelling, singing, drawing, etc.) are perceived to be useful for catering for children's learning styles.
- H<sub>2</sub>: An e-book is seen as more useful when a number of the specific activities, which can cater for children's learning styles are included.
- H<sub>3</sub>: Due to its potential in assisting classroom teaching tasks, teachers perceive the **InterActivity Book Builder** as useful.
- H<sub>4</sub>: Teachers' gender, age, teaching experience, computer experience and school location do not have any significant effects on the perceived usefulness of the **InterActivity Book Builder** functionalities.
- H<sub>5</sub>: There is no significant difference between teachers' and experts' perceived usefulness of **Book Builder's** existing functionalities.
- H<sub>6</sub>: There is no significant difference between teachers' and experts' perceived usefulness of the additional functionalities suggested for the **Book Builder**.
- H<sub>7</sub>: Teachers' gender, age and computer experience do not have any significant effects on the perceived ease-of-use of **Book Builder**.
- H<sub>8</sub>: Children's gender, age and computer experience do not have any significant effects on the ease-of-use of **Book Builder**.

## 6.2.2 Evaluation Instruments

Since evaluation objectives were more about finding subjective measures, questionnaire items were constructed in the form of nominal and ordinal measures. The ordinal items used a Likert scale rating having bands ranging from 1 through 5 (see Appendices F and G). However, EBoChi treated Likert scale ordinal measurements as intervals and assumed that there is an equal distance between the adjacent bands (i.e. the difference between 1 and 2 is the same as that between 2 and 3). Although the results of a Likert-type scale are actually ordinal, it is conventional to treat and use them as interval-level data (Ritchie, 1999; Wright, 1997; Emory & Cooper, 1991) because the scale can be used to assign ratings to



qualitative responses, thereby quantifying the data. In addition, studies also show that analysing the data as interval levels produces results similar to analyses at the ordinal level (Ritchie, 1999; Wright, 1997).

There were three sets of questionnaires; one was designed for the teachers, one was for the experts and the last one was for the children. The children's questionnaire was actually a form that was utilised by the researcher to capture observation results. Even though teachers and experts were asked to perform the same set of tasks, in the experts' questionnaire fewer questions were asked (there were only four parts as opposed to six parts for the teachers). Part I (Participant's Background), Part II (Tasks), Part III (the perceived usefulness of functionalities of Book Builder Create-mode) and Part IV (the perceived usefulness of functionalities of Book Builder Read-mode) contained similar sets of questions for both teachers and experts. Items for measuring the perceived usefulness of functionalities were developed based on the functions that should be included in the InterActivity Book Builder model.

For teachers, however, two more parts were included: Part V and Part VI. Part V measured the perceived usefulness of activities in catering for children's learning styles, while Part VI adopted an instrument by Davis (1993) for measuring the teachers' overall perceived usefulness in assisting tasks and ease-of-use. Experts were not asked to complete these two parts for the following reasons:

- it was assumed that since they did not possess the classroom teaching expertise with children, they would lack knowledge about the kinds of activities that are most appropriate for children;
- this study was more interested in finding how teachers (not experts) perceived the usefulness and ease-of-use of the Book Builder in assisting their teaching tasks.

The children's observation form was divided into Background and Book Builder Usage sections. Items in the Book Builder Usage section were concerned with how well children learned and then used the program to build a 5-page book (see Appendix H for the instructions). While interaction took place, the following observations were recorded:

- each child's learning time (LEARNT) in minutes;
- the number of questions asked during learning (QLEARN);
- the number of questions asked during book building (QBUILD);
- the building time (BUILDT) in minutes.

When creating books, the children were asked to try their best to perform all tasks, but if they failed on any task, they were allowed to ask questions. Help was given, however if they failed to do the task after the help was provided, they were asked to skip the task and do other tasks. The QBUILD score was incremented by one point for this action and the BUILDT score increased relative to the time taken. In addition, the children's ability to complete tasks successfully, their own perception of the ease-of-use, and finally their interest in using such a program (if given the opportunity) were also recorded.

From the items in the questionnaires, seven indexes were formed:

- i. Perceived Usefulness of activity functionalities (USACTYFN);
- ii. Perceived Usefulness of Book Builder existing functionalities (USBOOKFN);
- iii. Perceived Usefulness of additional functionalities (USADDFN);
- iv. Perceived Usefulness of InterActivity Book Builder functionalities (USEBOOK);
- v. Perceived Usefulness of InterActivity Book Builder concept in assisting teaching tasks (USASSTTK);



- vi. Perceived Ease-of-use of Book Builder for teachers (EASETEAC);
- vii. Ease-of-use of Book Builder for children (EASECHIL).

where

- USACTYFN is used as a measure of the suitability of suggested activities in catering for children's learning styles;
- USBOOKFN is used as a measure of the perceived usefulness of existing functionalities in Book Builder;
- USADDFN is used as a measure of the perceived usefulness of the proposed additional functionalities (which are currently not available in Book Builder);
- USEBOOK is used as a measure of the perceived usefulness of the functionalities of the InterActivity Book Builder;
- USASSTTK is used as a measure of teachers' perceived usefulness of the InterActivity Book Builder concept in assisting their teaching tasks;
- EASETEAC is used as a measure of how teachers perceive the ease-of-use of Book Builder;
- EASECHIL is used as a measure of children's ease-of-use of Book Builder.

### **Index Formation**

Indexes are composite measures of variables (i.e. measurements based on more than one data item) and are constructed through simple accumulation of scores assigned to individual items (Babbie, 1998). Hence, all indexes mentioned above are formed by the addition of the following variables (see Appendices F and G for items associated with each variable):

$$a) \text{USACTYFN} = \sum_{i=1}^5 v_i + \sum_{i=1}^9 m_i + \sum_{i=1}^4 vb_i + \sum_{i=1}^4 ml_i + \sum_{i=1}^5 py_i + \sum_{i=1}^3 ps_i + \sum_{i=1}^4 ip_i$$

where

v = visual activities  
 m = musical activities  
 vb = verbal activities  
 ml = mathematical activities  
 py = physical activities  
 ps = intrapersonal activities  
 ip = interpersonal activities

Note: the upper bound for each summation corresponds to the number of activities included for each style in the prototype.

$$b) \text{USBOOKFN} = \sum_{i=1}^9 cf_i + \sum_{i=1}^4 ce_i + \sum_{i=1}^5 cb_i + \sum_{i=1}^{10} cp_i + \sum_{i=1}^4 ct_i + \sum_{i=1}^2 rf_i \\ + \sum_{i=1}^5 rp_i + \sum_{i=1}^2 rs_i$$

where

cf = create mode, existing file functions  
 ce = create mode, existing edit functions  
 cb = create mode, existing book functions  
 cp = create mode, existing pages functions  
 ct = create mode, existing tools functions  
 rf = read mode, existing file functions  
 rp = read mode, existing pages functions  
 rs = read mode, existing settings functions

Note: the upper bound for each summation corresponds to the number of functions available in Book Builder.

$$c) \text{USADDFN} = cf_{10} + \sum_{i=5}^6 ce_i + \sum_{i=6}^7 cb_i + \sum_{i=11}^{14} cp_i + \sum_{i=5}^7 ct_i + \sum_{i=3}^4 rf_i + \sum_{i=6}^{11} rp_i + rs_3$$

where

cf<sub>10</sub> = create mode, additional file function  
 item number 10  
 ce = create mode, additional edit functions  
 cb = create mode, additional book functions  
 cp = create mode, additional pages functions  
 ct = create mode, additional tools functions  
 rf = read mode, additional file functions  
 rp = read mode, additional pages functions  
 rs<sub>3</sub> = read mode, additional settings function  
 item number 3

Note: the upper bound for each summation corresponds to the number of functions proposed for Book Builder.

$$d) \text{USEBOOK} = \text{USBOOKFN} + \text{USADDFN} + \text{USACTYFN}$$



$$e) \text{USASSTTK} = \sum_{i=1}^6 us_i$$

where

us = items relating to perceived usefulness in assisting tasks

Note: the upper bound for the summation corresponds to the number of items asked.

$$f) \text{EASETEAC} = \sum_{i=1}^7 es_i$$

where

es = items relating to perceived ease-of-use

Note: the upper bound for the summation corresponds to the number of items asked.

$$g) \text{EASECHIL} = \text{LEARNT} + \text{QLEARN} + \text{QBUILD} + \text{BUILDT}$$

For USACTYFN, USBOOKFN, USADDFN, USEBOOK, USASSTTK it was assumed that the higher the mean value, the more useful the items were. For EASETEAC, it was assumed that the higher the mean value, the easier it was perceived. For EASECHIL<sup>3</sup>, it was assumed that the lower the mean value, the easier the program was.

### 6.2.3 Statistical Procedures

Inferential statistics are procedures used to infer characteristics of a population from the observations made on a sample of that population. When making inferences, we are interested in calculating the level of confidence we can have in generalising about the population from the sample (Pilcher, 1990). This requires tests of significance, and is based on the assumption that data have been obtained from a probability sample such that cases are selected randomly. In a probability sample each member of the target population has a chance of being sampled. There are several ways to select samples: random, stratified, cluster (all three are probability sampling techniques), quota, purposive and convenience

(these three are non-probability sampling techniques) (for more information on sampling types, refer to Emory & Cooper (1991) and Wright (1997)). EBoChi drew its samples from performing stratified sampling whereby some schools were sampled in different counties in a state (only one state out of 14 states was used), and then within these schools teachers and children were chosen.

The procedures used to make inferences depend on the type of data collected. For nominal and ordinal data, non-parametric tests are more appropriate. For interval and ratio data, parametric tests are more suitable (Emory & Cooper, 1991). Also, for nominal and ordinal data, descriptive statistics are used to describe and present the results.

In EBoChi, data collected from samples were described using various descriptive procedures such as frequency tables in which there were columns for frequency value, percent, and cumulative percent. Pie charts, bar charts and line plots were also used in some cases. To measure the tendencies and variability of groups, the mean and standard deviation were calculated from the interval data.

The mean is the arithmetic average. It is the sum of observed values divided by the number of observations. A low mean value in EBoChi (such as 1.25 or 2.32) for any Likert scale item indicates that teachers or experts perceived the functionality described by the item as not useful. In contrast, a high mean value indicates a useful functionality. Standard deviation is a measure of the variability of response to an item (Emory & Cooper, 1991). It is a measure of score dispersion about the mean. The larger the standard deviation, the wider the spread of data (Black, 2002).

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<sup>3</sup> In EBoChi any external factors such as the child's personality (e.g. shyness, feeling afraid or uncomfortable, etc.), ability to learn and understand, distraction (e.g. noise, toilet needs, etc.) were assumed not to have any influence on the calculation of the EASECHIL.



In making inferences and because EBoChi assumed the Likert-style data as interval, the following parametric procedures were utilised:

- t-Test: was used to determine the statistical significance difference between a sample mean and a hypothesised mean. In addition, it was also used to compare means of one variable for two different groups (i.e. the teachers and experts);
- ANOVA (One way Analysis of Variance): was applied to compare means of a single variable between two or more groups (e.g. between different age groups, between different computer experience groups);
- $\chi^2$  (Chi-square) goodness-of-fit: was used on data which has a nominal level to test whether data followed a hypothesised distribution (test of chance of occurrence);
- Pearson's Coefficient Correlation (r): was utilised to study relationships between two or more variables.

In addition to the above procedures, research instrument (i.e. the questionnaire) quality (i.e. its validity and reliability) was also measured. Validity refers to the extent to which a test measures what it is supposed to measure (Thorndike & Hagen, 1969; Black, 2002) and is essentially a judgmental analysis. One of the criteria for validity is to guarantee its content validity. Content validity of an instrument is the extent to which it provides adequate coverage of the topic under study (Emory & Cooper, 1991). Since EBoChi was concerned with measuring the perceived usefulness of functionalities, activities which cater for learning styles and perceived ease-of-use of prototypes, questions had been designed carefully to cover all necessary topics.

A reliable instrument should produce consistent results at different times under different conditions (Emory & Cooper, 1991; Kaplan, 1987). Reliability of the EBoChi instrument was measured using Cronbach's Alpha ( $\alpha$ ) Coefficient to test internal consistency among items. The value

of acceptance of alpha was set at 0.8 indicating good inter-item correlation within each formed index (see Table 6.1 and Appendix I. Note that  $\alpha$  was only calculated if it was applicable for each type of participants). For items which were adopted from Davis (1989; 1993) to measure perceived usefulness in assisting tasks and perceived ease-of-use, reliability of the indexes has been demonstrated in previous studies such as Hendrickson et al. (1993), Adam et al. (1992) as well as in this study.

**Table 6.1: Cronbach's Alpha ( $\alpha$ ) Coefficient for each index**

Index	Cronbach's Coefficient Alpha ( $\alpha$ )		
	Teachers	Experts	Children
USADDFN	0.8560	0.8049	-
USACTYFN	0.9192	-	-
USBOOKFN	0.9342	0.9280	-
USEBOOK	0.8522	-	-
USASSTTK	0.8771	-	-
EASETEAC	0.8762	-	-
EASECHIL	-	-	0.8140

Finally, since some selected procedures were parametric tests, EBoChi made the following assumptions:

- the observations were independent (i.e. the selection of any one case did not affect the chances for any other case);
- the observations were drawn from a normally distributed population.

To check the normality of data (i.e. to test the hypothesis that data are from a normal distribution), EBoChi used the normal probability plot. This plot compares the observed values with those expected from a normal distribution. If the data display the characteristics of normality, the points fall within a narrow band along a straight line (Emory & Cooper, 1991) (see example of plots in Figures 6.4 and 6.5). When data are found to be skewed, tests of symmetry were performed. In all relevant cases, hypotheses of symmetry were accepted when skewness statistics were between 2.0 and  $-2.0$ , i.e.  $-2.0 \leq \text{skewness} \leq 2.0$  (SPSS, 1999). Examples of this can be seen in Table 6.4.



Another assumption when performing t-Tests for independent groups and ANOVA is the equality of variances. Levene's test for equality of variances was used to test the homogeneity of variance assumption. When the p-value<sup>4</sup> is 0.05 or less, this indicates that the variances are heterogeneous which violates the assumption. Therefore, one should then say that equal variances are not assumed. Examples of this can be found in Tables 6.21 and 6.23.

#### 6.2.4 Evaluation Subjects

Subjects were samples of real users, who were teachers, school children and parents. However, since this study was restricted to a school environment, it was assumed that parents were not directly involved in class activities. Thus only teachers and children were used as samples.

Teachers were selected randomly by the Kedah State Education Department and the Teacher Training College. Children were randomly selected from the attendance list by the head teachers whose schools were visited and sometimes by the class teacher to represent different gender and ages (7 to 9). Experts participated voluntarily by completing the tasks and answering the on-line questionnaire posted to various mailing lists. Calls for participation were also distributed at international and European level conferences. Fifty-eight teachers attended the two one-day workshops. Twenty-one experts answered the questionnaire and fifteen children were interviewed and observed.

The sample size adequacy should be determined before data collection was conducted. Bouma & Atkinson (1995) suggest that if the population that is to be sampled is fairly homogeneous (i.e. the relevant

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<sup>4</sup> p is the probability value. It refers to how unlikely a value as extreme as the observed value if null hypothesis ( $H_0$ ) was true will be observed. The convention is that when the p-value is less than 5% (0.05) we can reject the null hypothesis.

characteristics are fairly evenly distributed), a smaller sample can be relied on than if the population is highly variable.

In this study, the requirements of the samples were:

For teachers:

- at least a years teaching experience;
- experienced paper books users;
- aware of how the children's textbooks contents are presented (e.g. mainly text and graphics with bright colours to attract attention, inclusion of activities instructions, and so on).

For children:

- have some experience in using paper books;
- be able to read.

Since these requirements were easily met, it was possible to show that sample characteristics such as different gender, races, teaching experience and computer experience were fairly homogeneous in any sample of school teachers and children. Hence, a small number of participants were assumed to be adequate.

When using expert reviews as part of the research method, Shneiderman (1998) suggests three to five expert reviewers as being adequate for producing reliable results. Therefore this study considered twenty-one respondents as adequate and reliable. In addition, their expertise were assumed justified since the requirements for the experts were easily met:

- having experience in using e-books or;
- having experience in using authoring tools or;
- having experience in e-publishing or;
- being knowledgeable in human-computer-interaction.



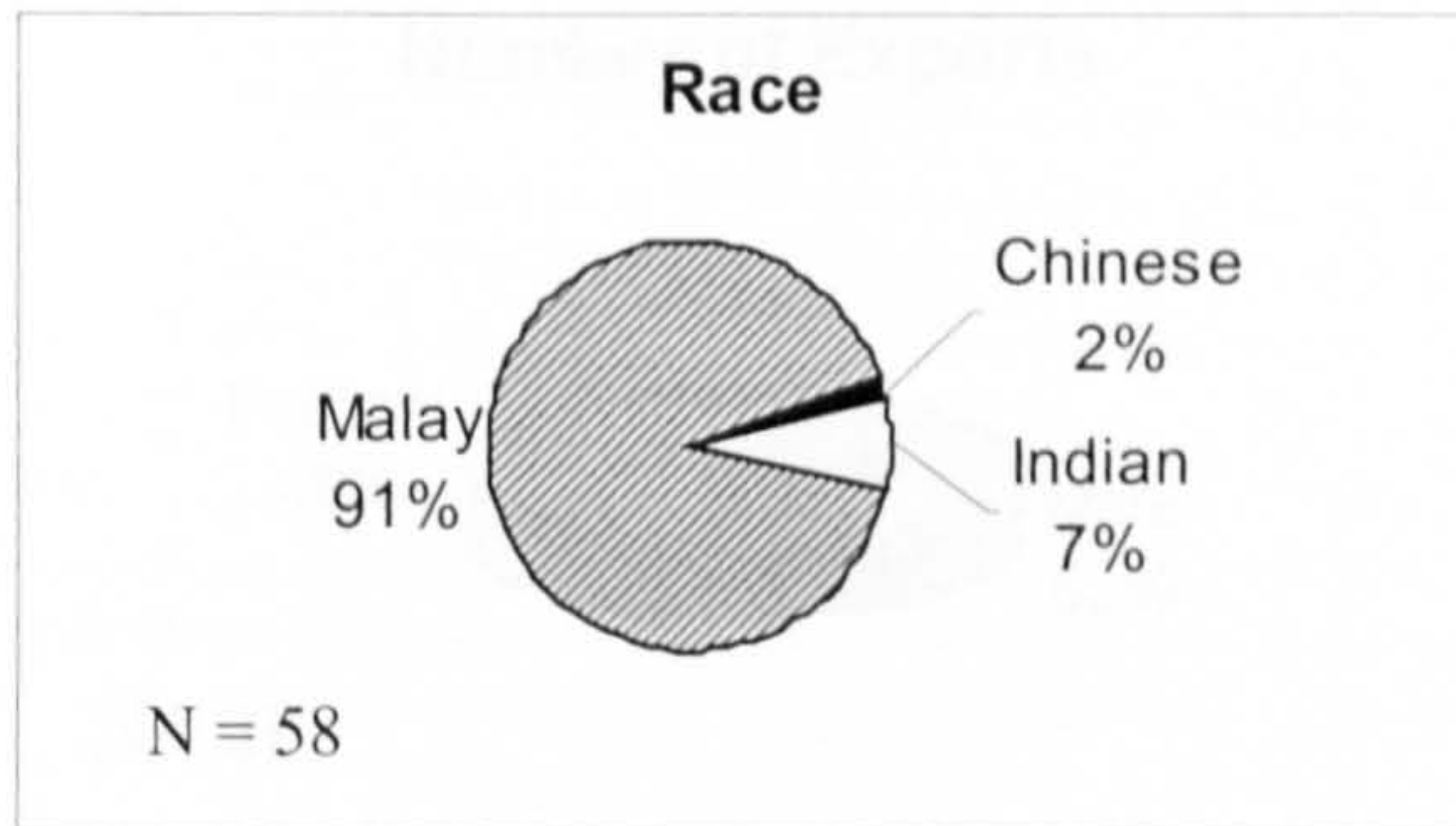
### 6.2.5 Results

This section presents the results of each analysed hypothesis. Analysis started with the coding of data in the coding form (see Appendix J) and was completed by interpreting the results obtained from using SPSS (Statistical Package for Social Science) statistical package. Before presenting the results which test the hypotheses, summaries of the participants' background data are presented in Figures 6.1, 6.2 and 6.3.

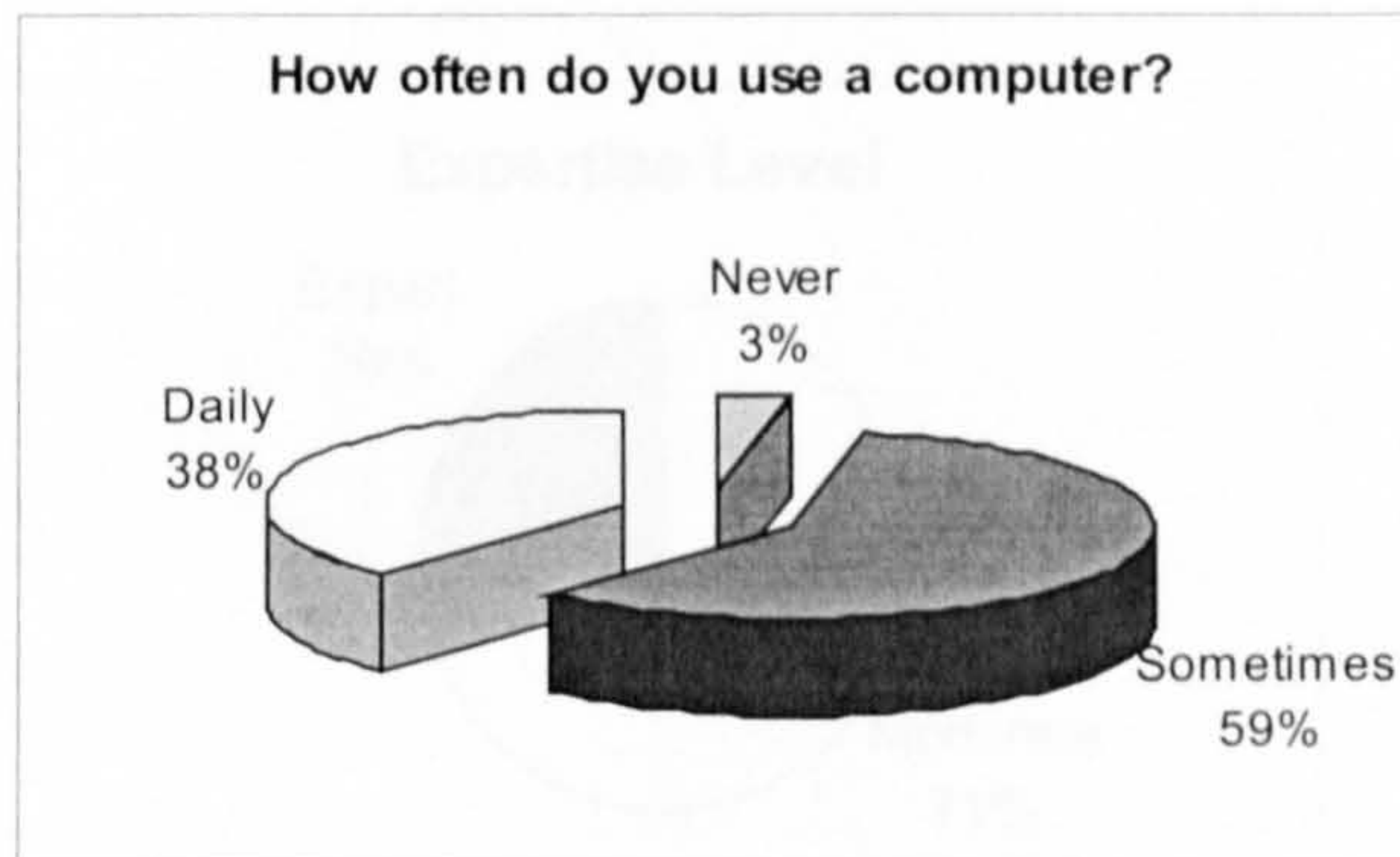
The teachers who participated in this study represented all of the major ethnic groups in Malaysia. The subject areas in which teachers worked were wide-ranging. Thus, the data obtained can be said to represent a range of teaching expertise: Malay, English, Mathematics, Science, Computers, History, Religion, Geography, Art and Music. Most of the teachers had some computer experience and about thirty-eight percent used computers everyday. Only three percent had no experience at all. About ten percent had experience in using authoring programs while the rest had never used authoring programs before. Experts who participated included eleven male and ten female. Most had a Masters degree (sixty-one percent), twenty-nine percent had a Bachelors degree and ten percent had a PhD. The majority (i.e. seventy-one percent) considered themselves as having moderate expertise, while the rest rated themselves as experts. Thirty-eight percent had three years e-book experience (i.e. either using e-books, building e-books or using authoring programs), twenty-nine percent had two years experience, fourteen percent had four years experience, and the rest (fourteen percent) had five years experience.

There were eight male and seven female children. Five were 7 years old, three were 8 years old and seven were 9 years old. Six had no computer experience and nine had some experience, mostly with using CD titles and playing computer games. In short, the samples did represent different gender, age groups and computer experience.

### Teachers' Background



Subject Area	Frequency	Percent	Cumulative Percent
Malay language	19	32.80	32.80
English language	10	17.20	50.00
Mathematics	7	12.10	62.10
Science	4	6.90	69.00
Computers	1	1.70	70.70
History	2	3.40	74.10
Religion	4	6.90	81.00
Others	11	19.00	100.00
Total	58	100.00	



#### Do you have multimedia authoring experience?

	Frequency	Percent	Cumulative Percent
Yes	6	10.30	10.30
No	52	89.70	100.00
Total	58	100.00	

Figure 6.1: Teachers' background data



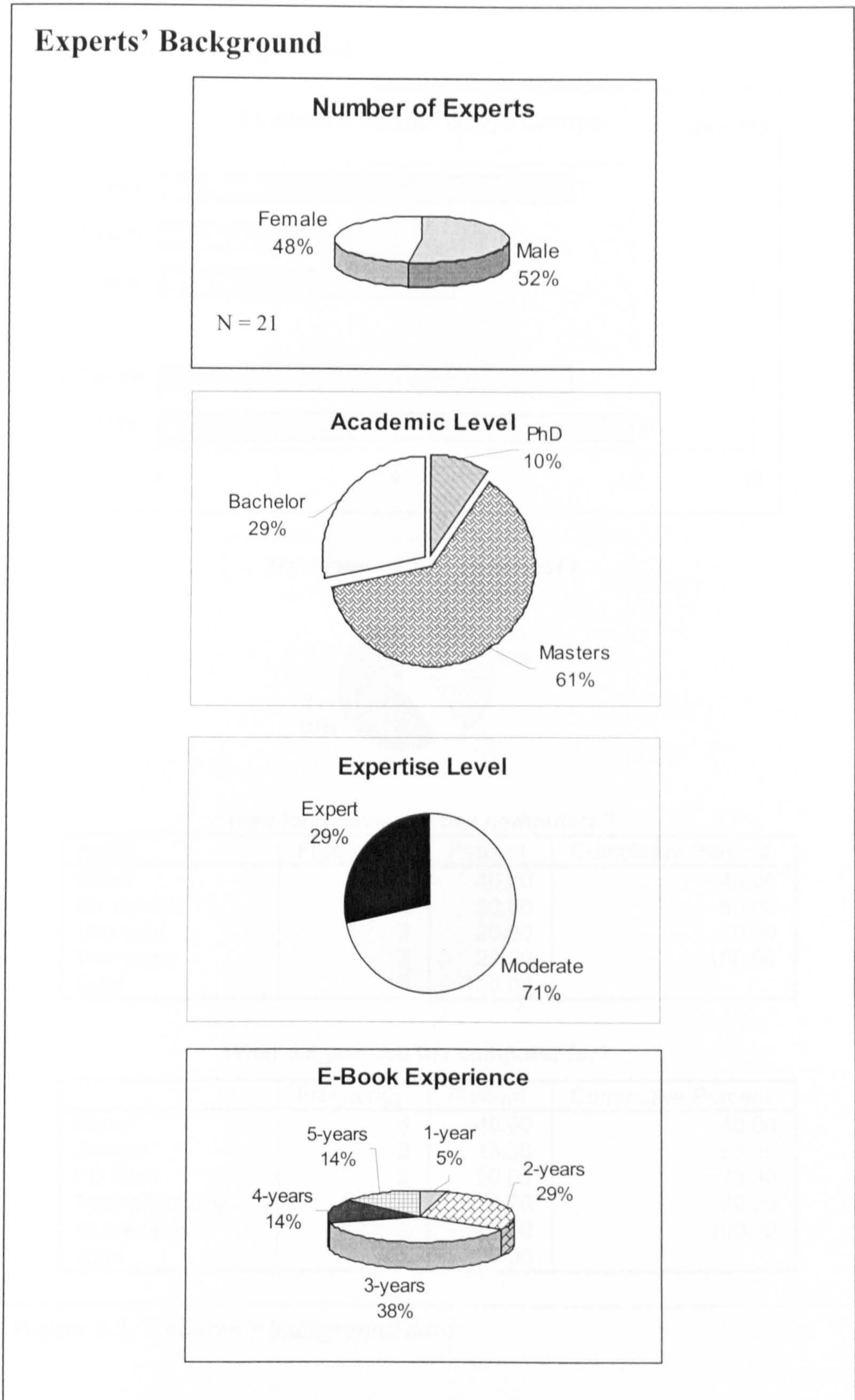
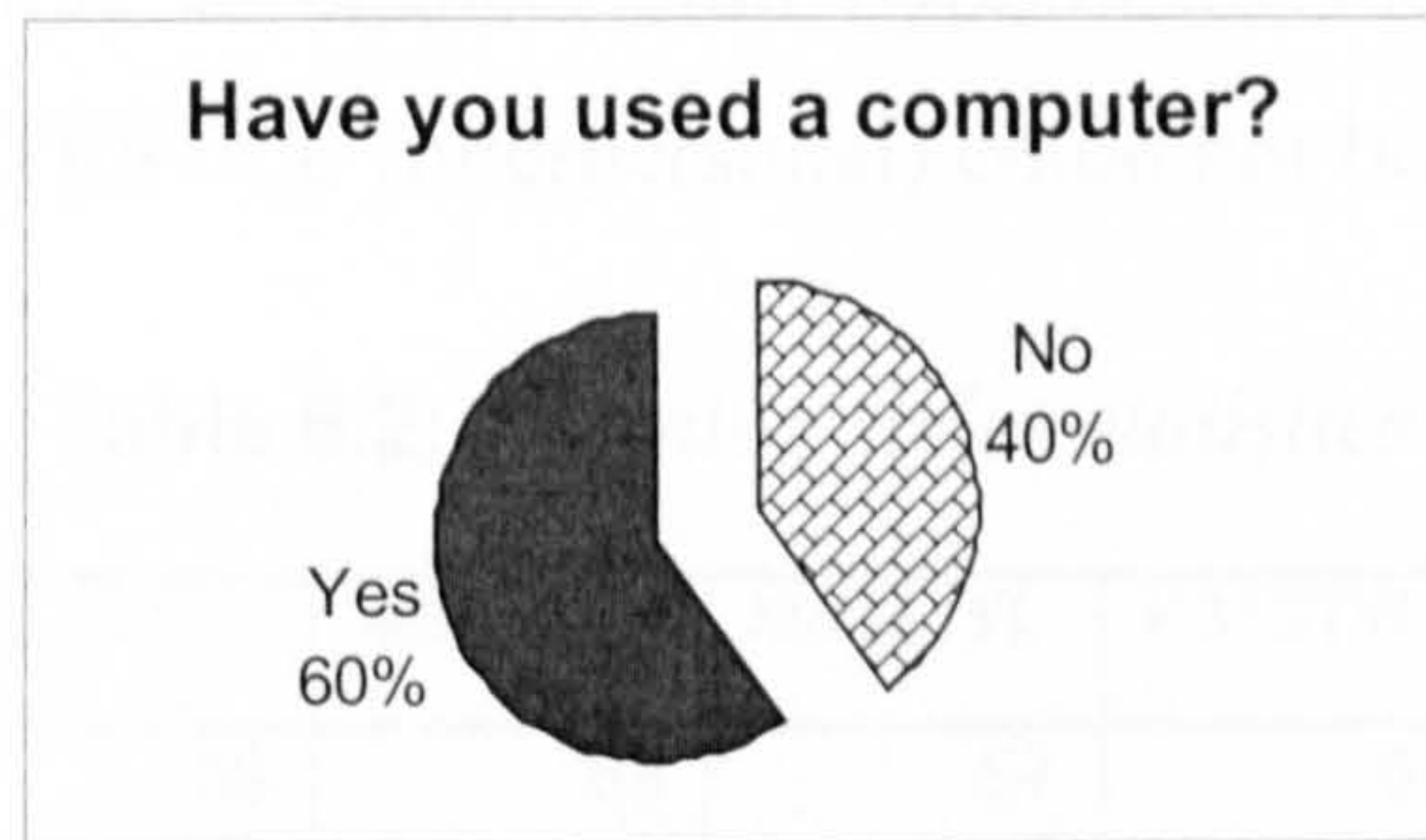
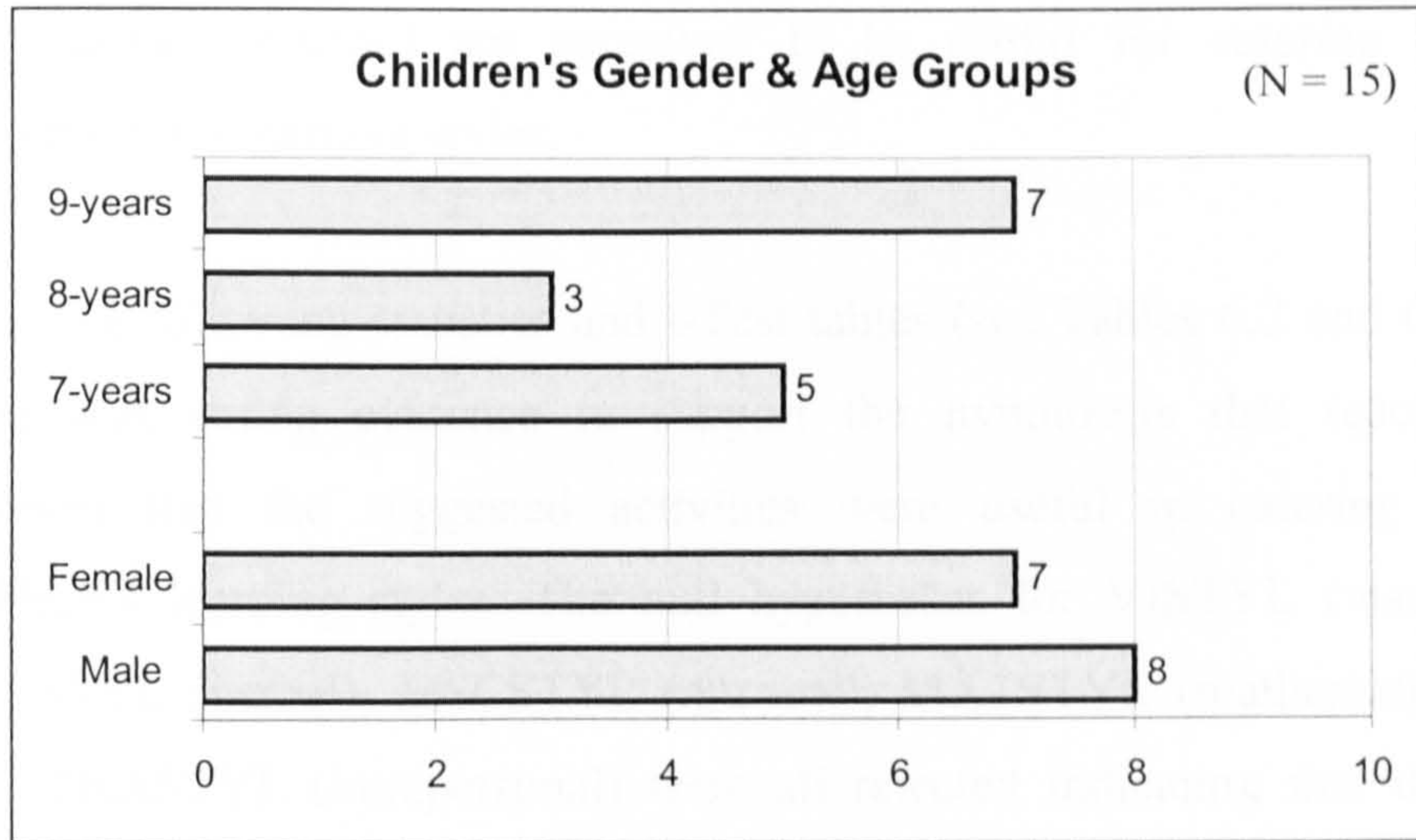


Figure 6.2: Experts' background data



### Children's Background



**How long have you use computers?**

Years	Frequency	Percent	Cumulative Percent
Never	6	40.00	40.00
Six months	3	20.00	60.00
One year	3	20.00	80.00
Two years	3	20.00	100.00
Total	15	100.00	

**What did you use the computer for?**

	Frequency	Percent	Cumulative Percent
Never	6	40.00	40.00
Games	2	13.30	53.30
CD titles	3	20.00	73.30
Typing/Drawing	1	6.70	80.00
All the above	3	20.00	100.00
Total	15	100.00	

**Figure 6.3:** Children's background data



### 6.2.5.1 Testing $H_1$

$H_1$ : A number of specific educational activities (e.g. storytelling, singing, drawing) are perceived to be useful for catering for children's learning styles.

From the following statistics and t-Test tables (see Tables 6.2 and 6.3), there was strong evidence to support the hypothesis that teachers believed that the suggested activities were useful in catering for children's learning styles. The null hypotheses for VISTYL (visual), VBLSTYL (verbal), MSCSTYL (musical), MATSTYL (mathematical) and ITRASTYL (intrapersonal) were all rejected indicating that these results were not due to chance. Null hypotheses for both KSTSTYL (kinesthetic) and ITESTYL (interpersonal) could not be rejected.

**Table 6.2: Learning styles statistics**

	VISTYL	VBLSTYL	MSCSTYL	MATSTYL	KSTSTYL	ITESTYL	ITRASTYL
N Valid	57	58	58	57	58	58	58
Missing	1	0	0	1	0	0	0
Mean	4.38	4.45	4.13	4.39	4.10	4.11	4.22
Std. Dev	0.45	0.47	0.49	0.46	0.59	0.65	0.54
Variance	0.21	0.22	0.24	0.22	0.36	0.43	0.29

**t-Test (test value = 4)**

**Table 6.3: Learning styles t-Test results  
One-Sample Test**

	Test Value = 4			
	t	df	Sig.(1-tailed)	Conclusion
VISTYL	6.27	56	0.00	Reject $H_0$ ( $p < 0.01$ )
VBLSTYL	7.42	57	0.00	Reject $H_0$ ( $p < 0.01$ )
MSCSTYL	1.98	57	0.03	Reject $H_0$ ( $p < 0.05$ )
MATSTYL	6.49	56	0.00	Reject $H_0$ ( $p < 0.01$ )
KSTSTYL	0.88	57	0.19	Fail to reject $H_0$
ITESTYL	1.26	57	0.11	Fail to reject $H_0$
ITRASTYL	3.09	57	0.00	Reject $H_0$ ( $p < 0.01$ )

A hypothesised mean value of 4 (i.e. band for Agree) was used as this study predicted that teachers would at least agree to this statement. So,  $H_0: \mu = 4$  and  $H_1: \mu > 4$ .

### Normality and test of symmetry

Data was found to be skewed, so the test of symmetry was performed, and all skewness statistics showed values between  $-2.0$  and  $2.0$ , which is considered acceptable. Thus the hypothesis of normality was not rejected (see the following Table 6.4).

**Table 6.4:** *Learning styles normality testing*

	N		Skewness	Std. error
	Valid	Missing		
VISTYL	57	1	0.20	0.32
VBLSTYL	58	0	0.02	0.31
MSCSTYL	58	0	0.10	0.31
MATSTYL	57	1	-0.44	0.32
KSTSTYL	58	0	-0.53	0.31
ITESTYL	58	0	-0.67	0.31
ITRASTYL	58	0	-0.68	0.31

### 6.2.5.2 Testing $H_2$

$H_2$ : An e-book is seen as more useful when a number of the specific activities, which can cater for children's learning styles are included.

The laboratory sessions started with a presentation of some e-book examples. The examples included e-books with and without activities to show the difference between including and excluding activities. At the end of the laboratory sessions, participants were asked to comment on whether e-books with activities were more useful than those without them.

Seventy percent of the teachers said yes and thirty percent said not sure. Since the data was in nominal form, the Chi-square goodness-of-fit test (test for chance of occurrence) was used to find a p-value. The p-value was found to be highly significant ( $p = 0.02$ ) (see Tables 6.5 and 6.6). Hence, it was possible to conclude that the result was not due to chance and that  $H_2$  has been substantiated.



### Chi-Square Test

**Table 6.5:** *Observed, expected and residual values for  $H_2$*

Ebook usefulness			
	Observed N	Expected N	Residual
Yes	48	39.9	8.1
Not sure	9	17.1	-8.1
Total	57		

**Table 6.6:** *Chi-square results for  $H_2$*

Test Statistics	
E-Book Usefulness	
Chi-Square	5.48
df	1
Sig.	0.02

#### 6.2.5.3 Testing $H_3$

$H_3$ : Due to its potential in assisting classroom teaching tasks, teachers perceive the InterActivity Book Builder as useful.

The p-value was found to be highly significant ( $r = 0.57$ ,  $p < 0.01$ ) (see Tables 6.7 and 6.8). Therefore there was strong evidence to reject the null hypothesis. USEBOOK was positively correlated with USASSTTK ( $r = 0.57$ ). Teachers perceived the InterActivity Book Builder as being useful because it had the potential to assist them in their teaching tasks.

#### Correlations between USEBOOK and USASSTTK

**Table 6.7:** *Descriptive statistics for USEBOOK and USASSTTK*

Descriptive Statistics			
	Mean	Std. Dev	N
USEBOOK	4.23	0.33	58
USASSTTK	4.28	0.52	58

**Table 6.8: Correlation between USEBOOK and USASSTK**

Correlations Statistics		USEBOOK	USASSTK
USEBOOK	Pearson Correlation	1.00	0.57**
	Sig. (2-tailed)	.	0.00
	N	58	58
USASSTK	Pearson Correlation	0.57**	1.00
	Sig. (2-tailed)	0.00	.
	N	58	58

\*\* . Correlation is significant at the 0.01 level (2-tailed)

Note:

Null hypothesis ( $H_0$ ):  $\rho = 0$  (i.e. there is no association between USEBOOK and USASSTK).  $r$  = correlation value,  $p$  = probability value.  $r$  can range from  $-1$  to  $+1$ . A  $+1$  correlation means that there is a perfect linear positive relationship. A  $0$  correlation means there is no linear relationship; this does not necessarily mean that there is no relationship, only that a straight line does not describe it. When the  $p$ -value is small, the finding is statistically significant. That is, the data provide enough evidence to allow us to reject  $H_0$ . Usually, when  $p < 0.05$ , we reject  $H_0$ . If  $p > 0.05$ , we fail to reject  $H_0$ .

#### 6.2.5.4 Testing $H_4$

$H_4$ : Teachers' gender, age, teaching experience, computer experience and school location do not have any significant effects on the perceived usefulness of the InterActivity Book Builder functionalities.

#### Comparing Means of the Usefulness of book functionalities

##### (a) USEBOOK by Gender

The  $p$ -value was rather large ( $p = 0.15$ ) indicating that there was not enough evidence to reject  $H_0$  ( $p > 0.05$ ) (see Tables 6.9 and 6.10). Thus male and female teachers could be in agreement on the usefulness of the InterActivity Book Builder functionalities.

In addition data was also tested for normality. Normality plots showed a near straight line scatters (see Figure 6.4).



**Table 6.9:** *Descriptive statistics for USEBOOK and teachers' gender*

**Descriptive Statistics**

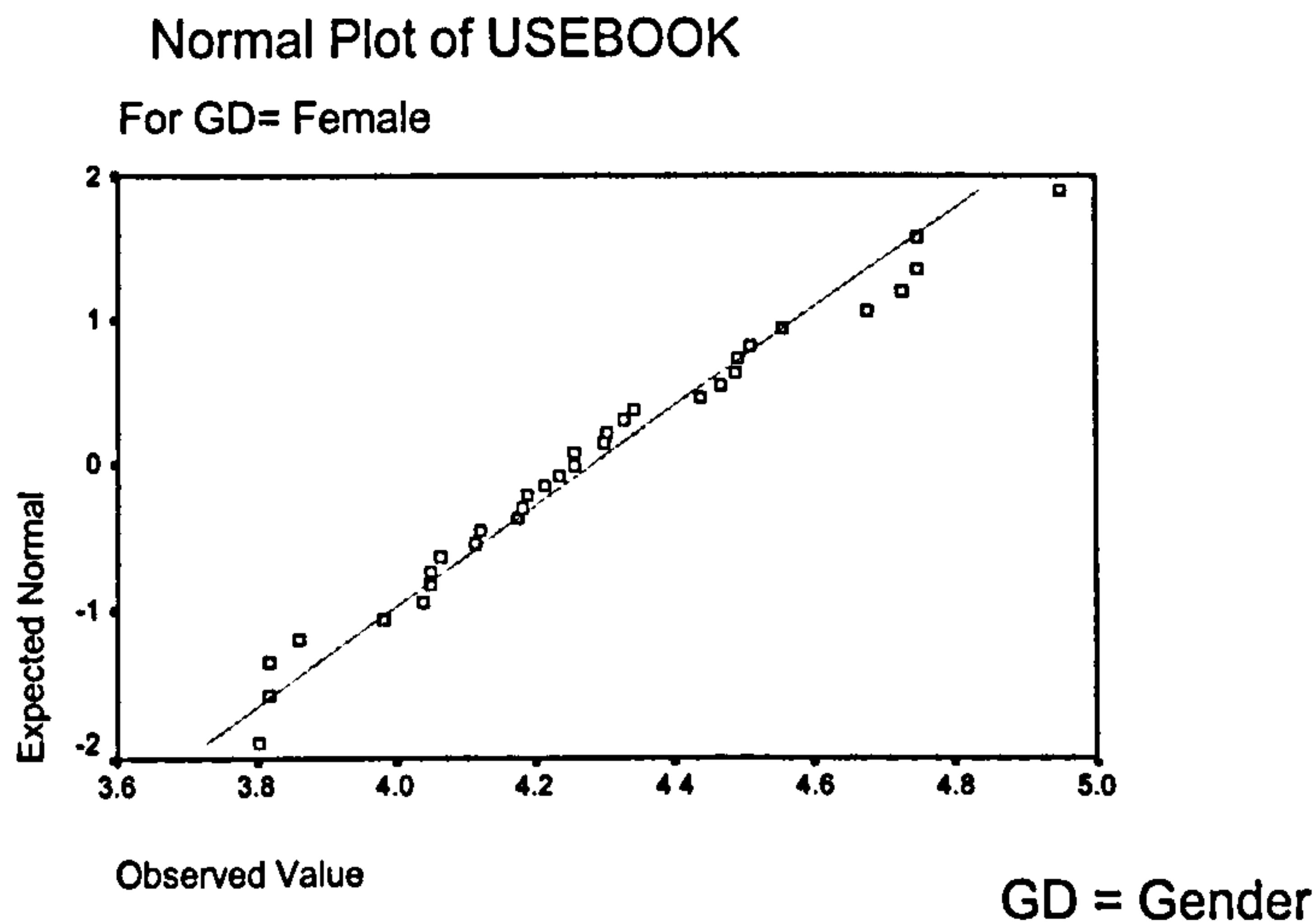
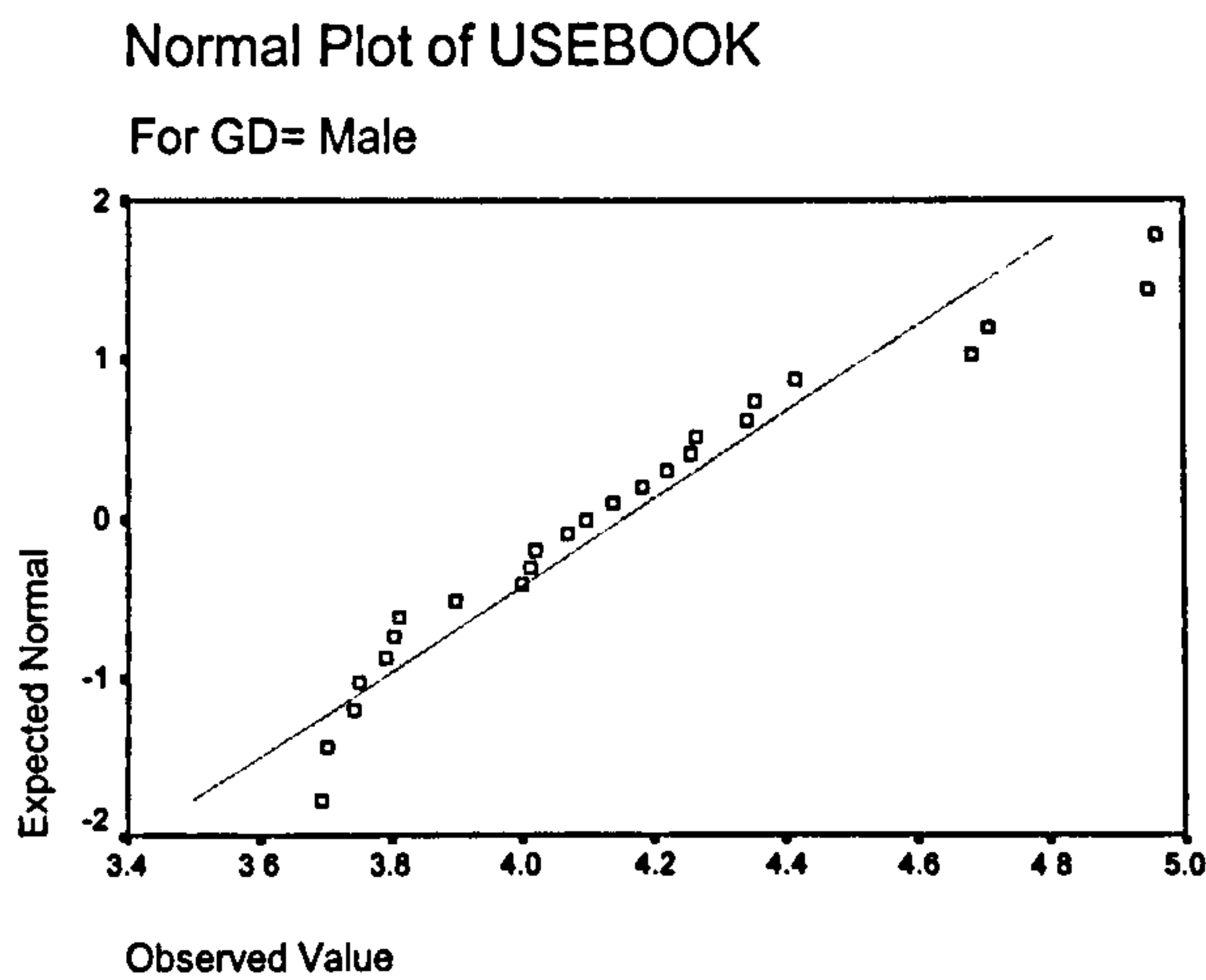
**USEBOOK**

Gender	Mean	Std. Dev	N
Male	4.15	0.37	25
Female	4.28	0.29	33

**Table 6.10:** *ANOVA results for USEBOOK and teachers' gender*

ANOVA Table	Sum of squares	df	Mean Square	F	Sig.
USEBOOK * Gender	0.23	1	0.23	2.09	0.15
Between Groups (Combined)					
Within Groups	6.04	56	0.11		

**USEBOOK**  
**Normal Plots**



**Figure 6.4:** *Normal plots for USEBOOK and teachers' gender*

**(b) USEBOOK by Age Group**

The p-value was 0.77 indicating that there was not enough evidence to reject the null hypothesis ( $p > 0.05$ ) (see Tables 6.11 and 6.12). Hence, there was no significant difference between teachers' age groups. Teachers of all ages agreed on the usefulness of the InterActivity Book Builder functionalities.

**Table 6.11: Descriptive statistics for USEBOOK and teachers' age**

Descriptive Statistics			
USEBOOK			
Age group	Mean	Std. Dev	N
Missing value	4.49	.	1
19	4.29	0.19	3
20-29	4.20	0.30	16
30-39	4.19	0.30	29
40 above	4.32	0.51	9

**Table 6.12: ANOVA results for USEBOOK and teachers' age**

ANOVA Table		Sum of squares	df	Mean Square	F	Sig.
USEBOOK * Age	Between Groups (Combined)	0.21	4	0.05	0.45	0.77
	Within Groups	6.11	53	0.11		

**(c) USEBOOK by Teaching Experience Group**

The p-value was 0.10 indicating that there was not enough evidence to reject the null hypothesis ( $p > 0.05$ ) (see Tables 6.13 and 6.14). Hence, teaching experience had no significant effects on USEBOOK.

**Table 6.13: Descriptive statistics for USEBOOK and teaching experience**

Descriptive Statistics			
USEBOOK			
Teaching Exp. (years)	Mean	Std. Dev	N
Missing value	4.51	0.31	5
1 to 5	4.18	0.29	11
6 to 10	4.24	0.31	24
11 to 15	4.13	0.36	10
16 to 20	4.01	0.33	5
21 to 25	4.49	0.39	3



**Table 6.14: ANOVA results for USEBOOK and teaching experience**

ANOVA Table	Sum of squares	df	Mean Square	F	Sig.
USEBOOK * Teach. Experience	0.98	5	0.19	1.90	0.10
Between Groups (Combined)					
Within Groups	5.29	52	0.10		

**(d) USEBOOK by Computer Experience Group**

The p-value was large ( $p = 0.69$ ) indicating that there was not enough evidence to reject the null hypothesis ( $p > 0.05$ ) (see Tables 6.15 and 6.16). Thus, whatever teachers' computer experience, they agreed that the functionalities suggested for the system were useful.

**Table 6.15: Descriptive statistics for USEBOOK and teachers' computer experience**

**Descriptive Statistics**

**USEBOOK**

Computer Exp. (years)	Mean	Std. Dev	N
Missing value	4.14	0.17	2
0 to 4	4.18	0.36	24
5 to 9	4.24	0.28	25
10 to 14	4.34	0.46	7

**Table 6.16: ANOVA results for USEBOOK and teachers' computer experience**

ANOVA Table	Sum of squares	df	Mean Square	F	Sig.
USEBOOK * Comp. Experience	0.16	3	0.05	0.45	0.69
Between Groups (Combined)					
Within Groups	6.11	54	0.11		

**(e) USEBOOK by School Location**

The p-value was greater than 0.05 ( $p = 0.06$ ) indicating that there was not enough evidence to reject the null hypothesis ( $p > 0.05$ ) (see Tables 6.17 and 6.18). Hence, there was no significant difference between teachers' school locations. Both rural and urban school teachers were in agreement on the usefulness of the InterActivity Book Builder functionalities.

**Table 6.17: Descriptive statistics for USEBOOK and school locations**

Descriptive Statistics			
USEBOOK			
School Location	Mean	Std. Dev	N
Rural	4.10	0.32	17
Urban	4.28	0.33	41

**Table 6.18: ANOVA results for USEBOOK and school locations**

ANOVA Table		Sum of squares	df	Mean Square	F	Sig.
USEBOOK * Sch. Location	Between Groups (Combined)	0.38	1	0.38	3.45	0.06
	Within Groups	5.89	56	0.11		

**6.2.5.5 Testing  $H_5$** 

$H_5$ : There is no significant difference between teachers' and experts' perceived usefulness of Book Builder's existing functionalities.

The p-value was very large ( $p = 0.52$ , see Tables 6.19 and 6.20) indicating that there was not enough evidence to reject the null hypothesis ( $p > 0.05$ ). Hence, there was no significant difference between teachers' and experts' perceived usefulness of Book Builder's existing functionalities. Teachers and experts agreed on the usefulness of the functionalities.



**t-TEST: USBOOKFN****Table 6.19:** *Descriptive statistics for USBOOKFN (teachers vs. experts)*

	Mean	Std. Dev	N
Teachers	4.30	0.32	58
Experts	4.35	0.28	21

**Table 6.20:** *t-Test results for USBOOKFN (teachers vs. experts)*

USBOOKFN	Levene's Test for Equality of Variance		t-Test for Equality of Means		
	F	Sig.	t	df	Sig.(2-tailed)
Equal variances assumed	1.31	0.26	-0.65	77	0.52
Equal variances not assumed			-0.70	40.90	0.49

Note that since the p-value for Levene's test is large ( $p = 0.26$ ), the equal variances assumption is not violated.

**6.2.5.6 Testing  $H_6$** 

$H_6$ : There is no significant difference between teachers' and experts' perceived usefulness of the additional functionalities suggested for the Book Builder.

The p-value was 0.013 indicating two different interpretations (see Tables 6.21 and 6.22). If the significance level is set at 0.05, the null hypothesis would have been rejected as  $p < 0.05$ . However, when tested at a 0.01 significance level,  $H_0$  could not be rejected ( $p > 0.01$ ). Hence, there was no significant difference between teachers' and experts' perceived usefulness of Book Builder's additional functionalities at a 0.01 significance level.

**t-TEST: USADDFN****Table 6.21: Descriptive statistics for USADDFN (teachers vs. experts)**

Descriptive Statistics			
USADDFN			
	Mean	Std. Dev	N
Teachers	4.15	0.43	57
Experts	4.37	0.29	21

**Table 6.22: t-Test results for USADDFN (teachers vs. experts)**

Independent Samples Test					
USADDFN	Levene's Test for Equality of Variance		t-Test for Equality of Means		
	F	Sig.	t	df	Sig.(2-tailed)
Equal variances assumed	4.25	0.04	-2.16	76	0.034
Equal variances not assumed			-2.57	53.25	0.013

Note that since the p-value for Levene's test is less than 0.05, the equal variances assumption is violated. Thus, one should select p-value (0.013) for "equal variances not assumed". Note also that for testing  $H_6$ , three decimal places for p-value was used to detect a more meaningful reading.

**6.2.5.7 Testing  $H_7$** 

$H_7$ : Teachers' gender, age and computer experience do not have any significant effects on the perceived ease-of-use of Book Builder.

**Comparing Means for the Perceived Ease-of-use****(a) EASETEAC by Gender**

The p-value was rather large ( $p = 0.24$ ) indicating that there was not enough evidence to reject the null hypothesis ( $p > 0.05$ ) (see Tables 6.23 and 6.24). Thus male and female teachers were in agreement on the perceived ease-of-use of Book Builder.

In addition the data was also tested for normality. Normality plots show a near straight-line scatters (see Figure 6.5).



**Table 6.23:** *Descriptive statistics for perceived ease-of-use and teachers' gender*

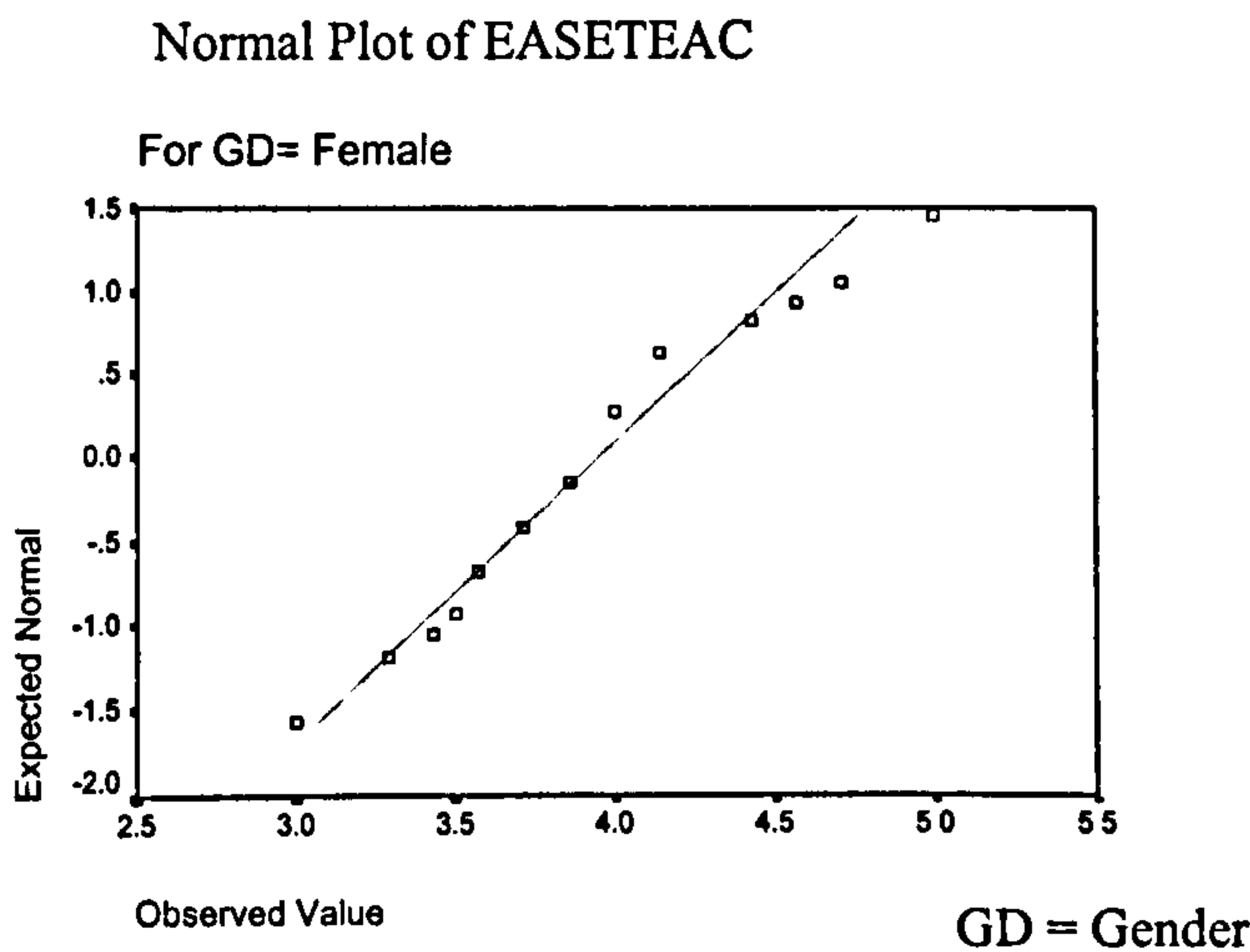
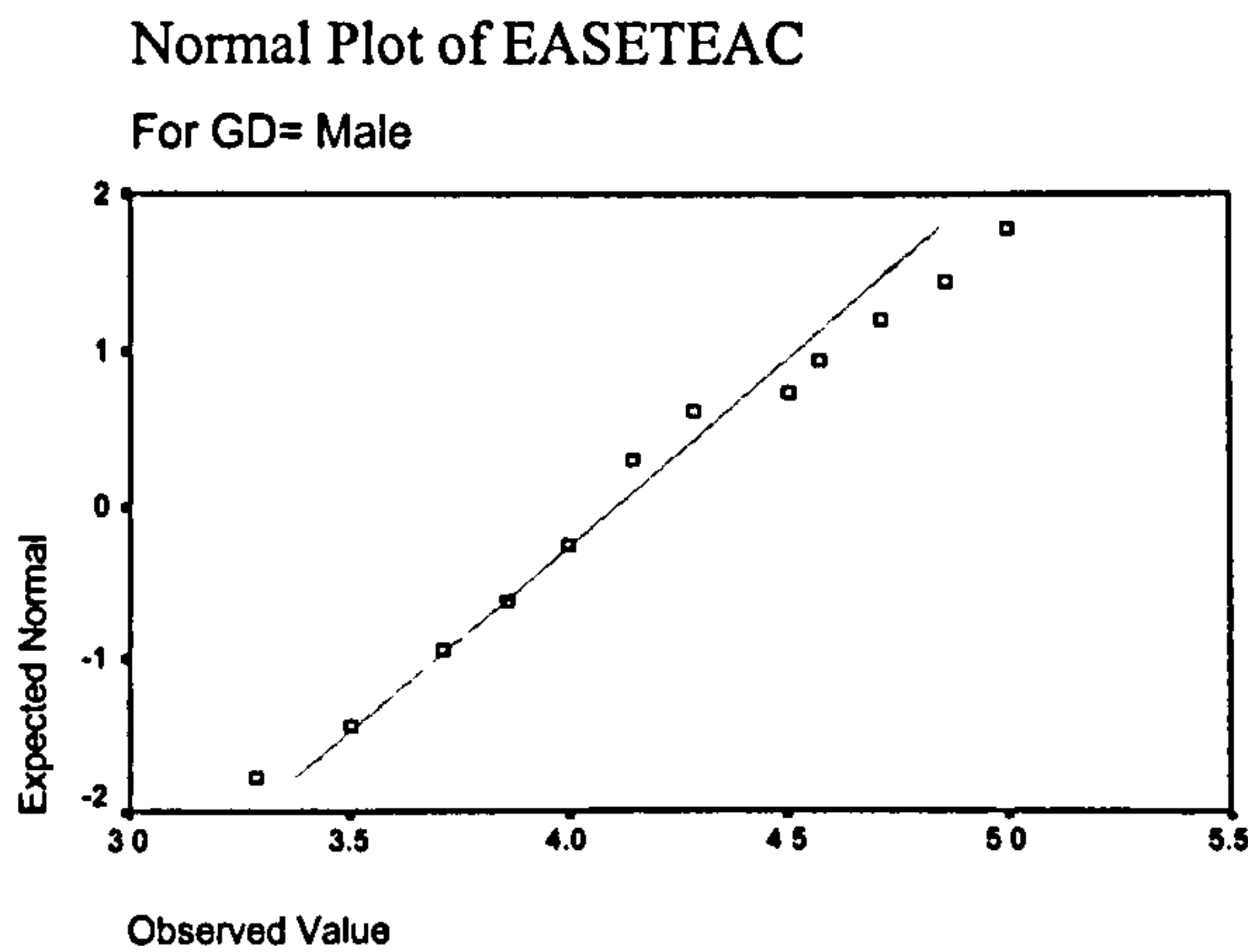
**Descriptive Statistics**  
**EASETEAC**

Gender	Mean	Std. Dev	N
Male	4.11	0.42	25
Female	3.95	0.56	33

**Table 6.24:** *ANOVA results perceived ease-of-use and teachers' gender*

ANOVA Table		Sum of squares	df	Mean Square	F	Sig.
EASETEAC * Gender	Between Groups (Combined)	0.36	1	0.36	1.44	0.24
	Within Groups	14.23	56	0.25		

**EASETEAC**  
**Normal Plots**



**Figure 6.5:** *Normal plots for perceived ease-of-use and teachers' gender*

**(b) EASETEAC by Age Group**

The p-value was 0.29 indicating that there was not enough evidence to reject the null hypothesis ( $p > 0.05$ ). Hence, age did not have any significant effects on perceived ease-of-use.

**Table 6.25:** *Descriptive statistics for perceived ease-of-use and teachers' age*

Descriptive Statistics			
EASETEAC			
Age	Mean	Std. Dev	N
Missing value	5.00	.	1
19	4.05	8.24E-02	3
20-29	3.91	0.42	16
30-39	4.01	0.56	29
40-above	4.13	0.49	9

**Table 6.26:** *ANOVA results for perceived ease-of-use and teachers' age*

ANOVA Table		Sum of squares	df	Mean Square	F	Sig.
EASETEAC * Age	Between Groups (Combined)	1.28	4	0.32	1.28	0.29
	Within Groups	13.31	53	0.25		

**(c) EASETEAC by Computer Experience Group**

The p-value was 0.11 indicating that there was not enough evidence to reject the null hypothesis ( $p > 0.05$ ) (see Tables 6.27 and 6.28). Hence, whatever computer experience teachers had, they were in agreement on the perceived ease-of-use of Book Builder.

**Table 6.27:** *Descriptive statistics for perceived ease-of-use and teachers' computer experience*

Descriptive Statistics			
EASETEAC			
Computer Exp.	Mean	Std. Dev	N
.	4.36	0.30	2
0 to 4	3.83	0.51	24
5 to 9	4.12	0.46	25
10 to 14	4.18	0.57	7



**Table 6.28: ANOVA results for perceived ease-of-use and teachers' computer experience**

ANOVA Table		Sum of squares	df	Mean Square	F	Sig.
EASETEAC * Comp. Exp.	Between Groups (Combined)	1.52	3	0.51	2.13	0.11
	Within Groups	13.07	54	0.24		

### 6.2.5.8 Testing H<sub>8</sub>

H<sub>8</sub>: Children's gender, age and computer experience do not have any significant effects on the ease-of-use of Book Builder.

Learning times (LEARNT) ranged from 15 to 60 minutes, with an average of about 37 minutes. During the learning process the number of questions asked (QLEARN) ranged from 0 to 28, giving an average of about 9 questions. When asked to build a book independently (BUILDT), the time taken ranged from 10 to 40 minutes (see Table 6.29). On average, about 12 questions were asked (QBUILD) during the book building process.

**Table 6.29: Descriptive statistics for LEARNT, QLEARN, BUILDT and QBUILD**

	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

The ease-of-use index (EASECHIL), as stated earlier, is the summation of learning time, questions asked during learning, questions asked during building and building time. It was assumed that the lower the value of EASECHIL (i.e. shorter times and fewer questions asked), the easier the program was to use. EASECHIL

ranged from 9.25 to 33.25, with an average of about 21 (see Table 6.30).

**Table 6.30:** *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 for the Ease-of-use

#### (a) EASECHIL by Gender

The p-value was rather large ( $p = 0.46$ ) indicating that there was not enough evidence to reject the null hypothesis ( $p > 0.05$ ) (see Tables 6.31 and 6.32). Thus male and female children found it easy to use Book Builder.

#### Ease-of-use (children) by Gender

**Table 6.31:** *Descriptive statistics for ease-of-use and children's gender*

**Descriptive Statistics**

**EASECHIL**

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

**Table 6.32:** *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 by Age Group**

The p-value was 0.12 indicating that there was not enough evidence to reject the null hypothesis ( $p > 0.05$ ) (see Tables 6.33 and 6.34). Hence, there was no significant difference between children's age groups. Children of all ages (7 to 9) found Book Builder easy to use.

**Ease-of-use (children) by Age****Table 6.33: Descriptive statistics for ease-of-use and children's age**

Descriptive Statistics			
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

**Table 6.34: 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 by Computer Experienced Group**

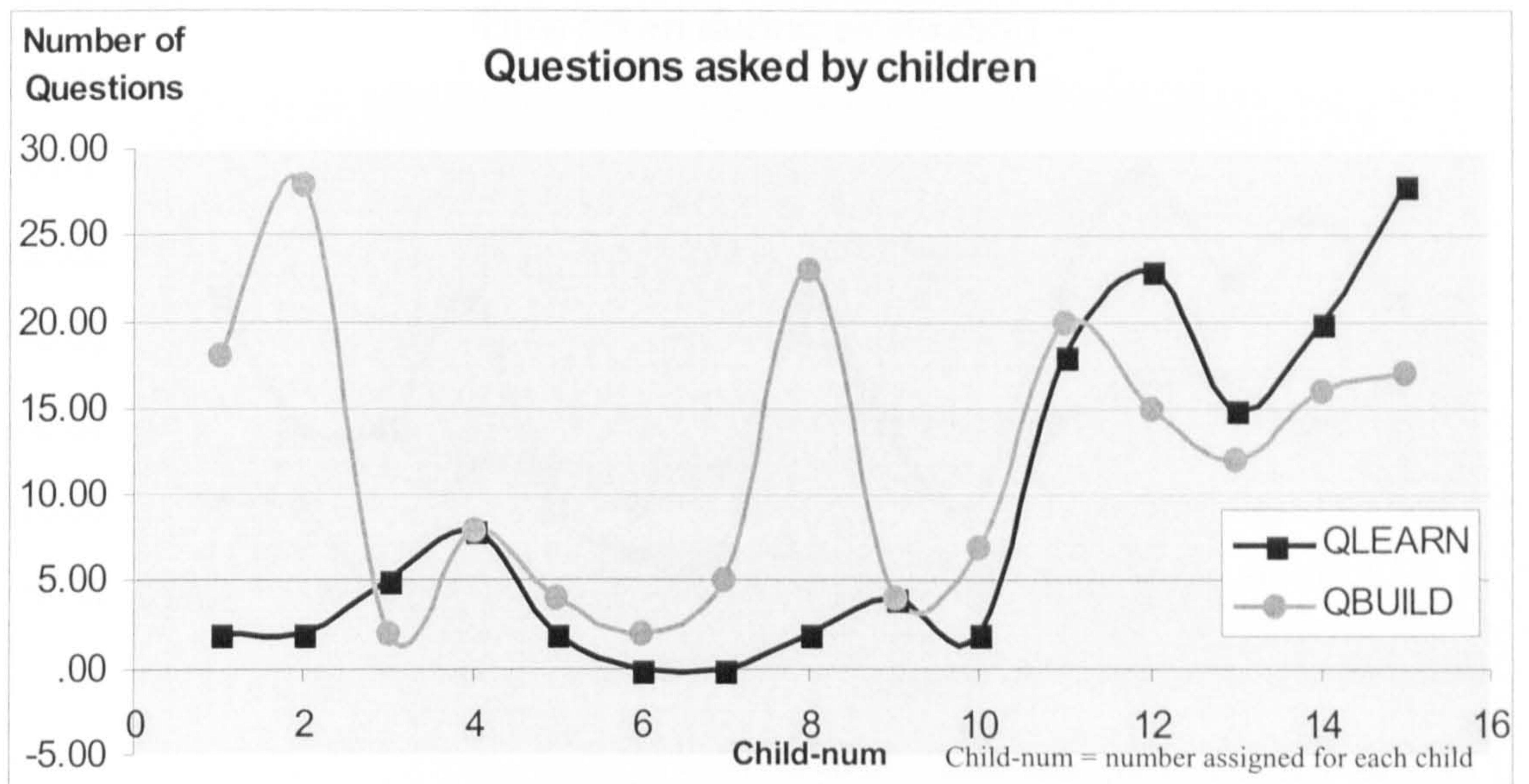
The p-value was  $< 0.01$  indicating that there was enough evidence to reject the null hypothesis (see Tables 6.35 and 6.36). Hence, there was significant difference among means. Those who had no computer experience did not find Book Builder easy to use.

**Ease-of-use (children) by Computer experience****Table 6.35: Descriptive statistics for ease-of-use and children's computer experience**

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

**Table 6.36:** ANOVA results for ease-of-use and children's computer experience

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

**(d) Further Analysis of QLEARN and QBUILD****Figure 6.6:** Plot of questions asked by children

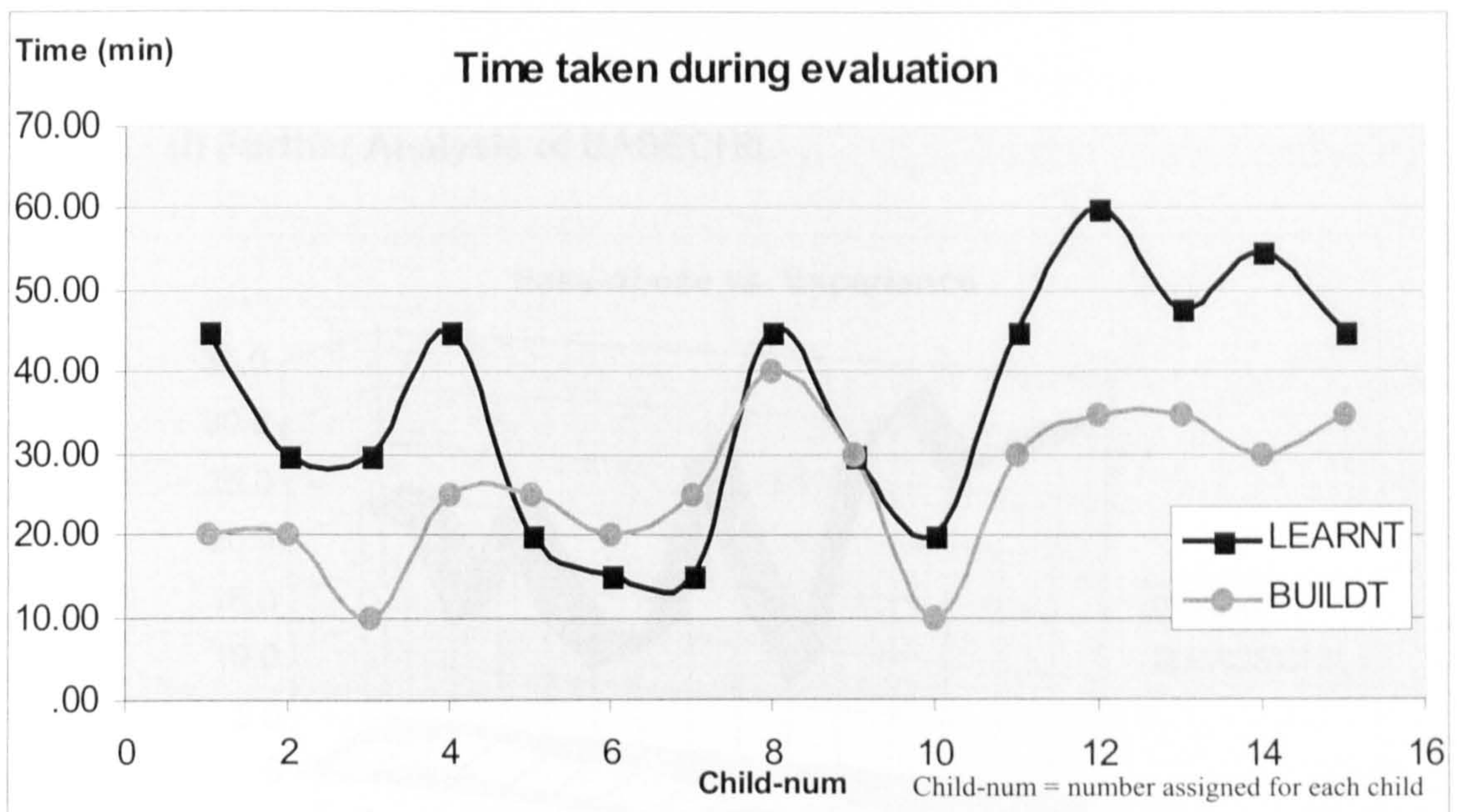
From the plot shown in Figure 6.6, it can be seen that for eight children, more questions were asked during the e-book building time (QBUILD) than the training time (QLEARN). Possible reasons for this could be:

- children need hands-on experience in order to learn. Therefore, while building the actual e-books, they progressively gained the understanding of using the e-book builder functionalities;
- by the time they were building their own e-books, they felt more at ease with the evaluator, and were thus able to speak up and ask for help.



Further analysis showed that, the three highest numbers of questions asked during building time were from children aged 7 years old. This could be interpreted as since they were the youngest, their ability to learn and understand was not as good as the older children. Therefore, the training session was not as successful to them.

### (e) Further Analysis of LEARNT and BUILDT



**Figure 6.7:** Plot of time taken during children's evaluation

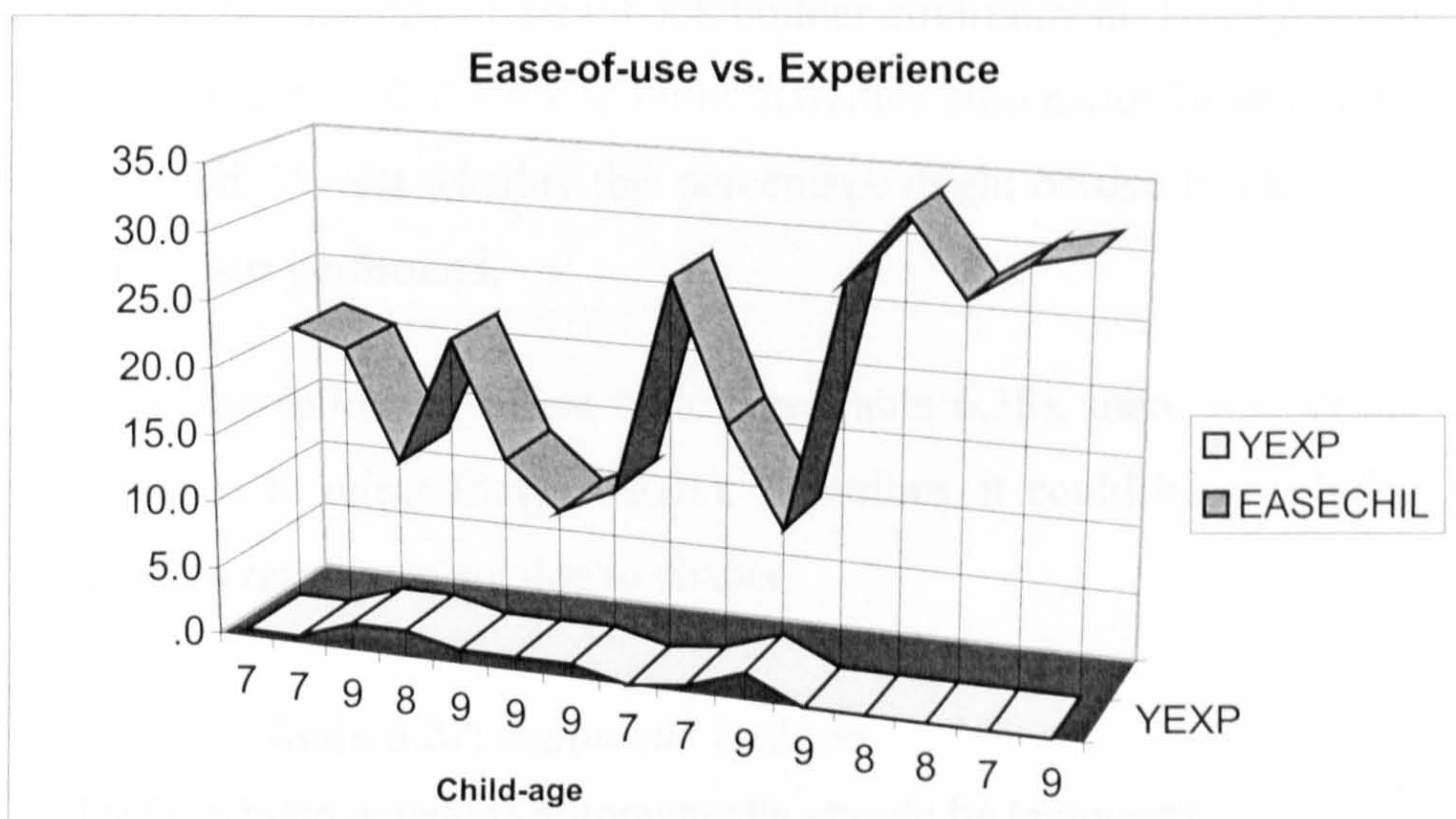
The graphs depicted in Figure 6.7 show that for most of the children, the time taken to build their books was less than the training time. This could be interpreted as a positive indication that the children easily understood how to use the program. After just one training session, that lasted less than 60 minutes, children were able to build books with minimal requirements (i.e. cover, content that was made of text and graphics and back page) within 40 minutes.

There were three children whose training time (LEARNNT) was less than the building time (BUILDT). Further analysis showed that



these children were 9 years old and had at least 1 year of computer experience. Because they were capable, they used more time when building their e-books to include a variety of information type (i.e. they added graphics, audio and video). They were also the children who asked the least questions during training and building times. The children whose building time was 20 minutes or less failed to complete all tasks, and only managed to produce e-books with minimal requirements.

#### (f) Further Analysis of EASECHIL



**Figure 6.8:** Plot of children's ease-of-use vs. experience

From the plot shown in Figure 6.8, the three lowest values for the ease-of-use index (i.e. less than ten) were for children with at least one year of computer experience. This indicates that experienced children 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 was up to four times harder to use.



### 6.2.5.9 Testing Additional Hypothesis $H_9$

$H_9$ : Most teachers agree that tools, which let users build activities automatically, should be included in the proposed InterActivity Book Builder.

This hypothesis was developed following the emergence of a pattern in the data. Its purpose was to test whether this result was due to chance. From the frequency table (see Table 6.37), none of the teachers had responded that they strongly disagreed or disagreed, and only three percent said neither, when asked whether they agree that tools to build the educational interactive activities automatically should be included in the e-book builder environment. Ninety-seven percent agreed that tools to build activities automatically should be included. To test whether this percentage might be due to chance, a t-Test was performed.

From the following t-Test table (see Table 6.38), there was strong evidence to reject  $H_0$  ( $p < 0.01$ ). Therefore, it could be concluded that this result was not due to chance.

**Table 6.37:** *Automatic builders*

**Tools to build activities automatically should be included?**

Neither	3%
Agree	43%
Strongly agree	54%

**Table 6.38:** *t-Test results for  $H_9$*

**t-Test (test value = 4)**

**One-Sample Test**

	Test Value = 4			
	t	df	Sig.(1-tailed)	Conclusion
Build activities automatically	6.68	57	.00	Reject $H_0$ ( $p < 0.01$ )



### 6.2.5.10 Further Findings

In addition to testing the hypotheses, further analysis was conducted which revealed more findings. The findings are presented using cross-tabulations, pie charts and bar charts.

#### (a) Cross-tabulation: TEACHERS

**Table 6.39:** *Cross-tabulation for program rating vs. teachers' computer experience*

Program Rating \* Comp Exp3: Do you have multimedia authoring experience?  
Crosstabulation

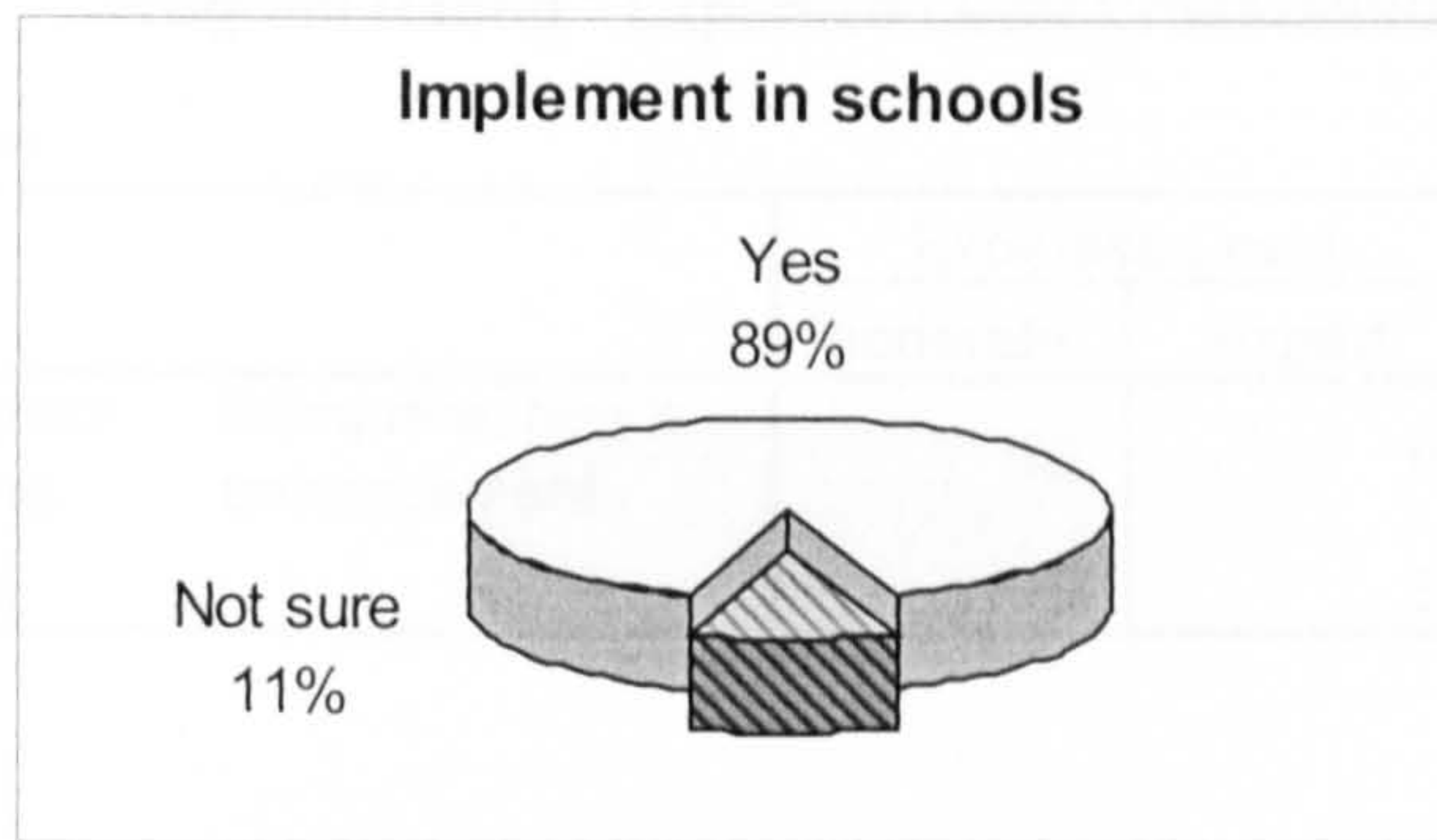
			Comp Exp3: Do you have multimedia authoring experience?		Total
			Yes	No	
Program Rating	Inadequate (poor)	Count	1	5	6
		% of Total	1.9%	9.6%	11.5%
	Adequate, needs enhancement	Count	4	30	34
		% of Total	7.7%	57.7%	65.4%
	Excellent	Count	1	11	12
		% of Total	1.9%	21.2%	23.1%
Total		Count	6	46	52
		% of Total	11.5%	88.5%	100.0%

Five out of six teachers who had authoring experience, rated Book Builder as either poor or required enhancement (see Table 6.39). This indicates that experienced teachers felt that Book Builder functionalities should be enhanced so as to meet their requirements. It was also found that 35 out of 46 teachers who had no authoring experience chose to say that Book Builder did not meet their requirements.

It is not surprising to see that 11 out of 12 teachers who rated Book Builder as excellent had no previous authoring experience. This fact has two interpretations; first, it could indicate that they might not have any experience to compare with, hence the reason for selecting Book Builder as excellent. Second, the product is probably good enough as it is (i.e. adequate functionalities) for novice users.



## (b) Teachers' opinion

**Figure 6.9:** Pie chart for teachers' opinion

When asked whether they would like an e-book builder to be implemented in schools, eighty-nine percent of the teachers said yes and eleven percent were not sure. Nobody said no (see Figure 6.9).

## (c) Cross-tabulation: TEACHERS

**Table 6.40:** Cross-tabulation for program rating vs. implementation**Program Rating \* Implement in schools Crosstabulation**

			Implement in schools		Total
			Not sure	Yes	
Program Rating	Inadequate (poor)	Count		6	6
		% of Total		11.5%	11.5%
	Adequate, needs enhancement	Count	6	28	34
		% of Total	11.5%	53.8%	65.4%
	Excellent	Count		12	12
		% of Total		23.1%	23.1%
Total		Count	6	46	52
		% of Total	11.5%	88.5%	100.0%

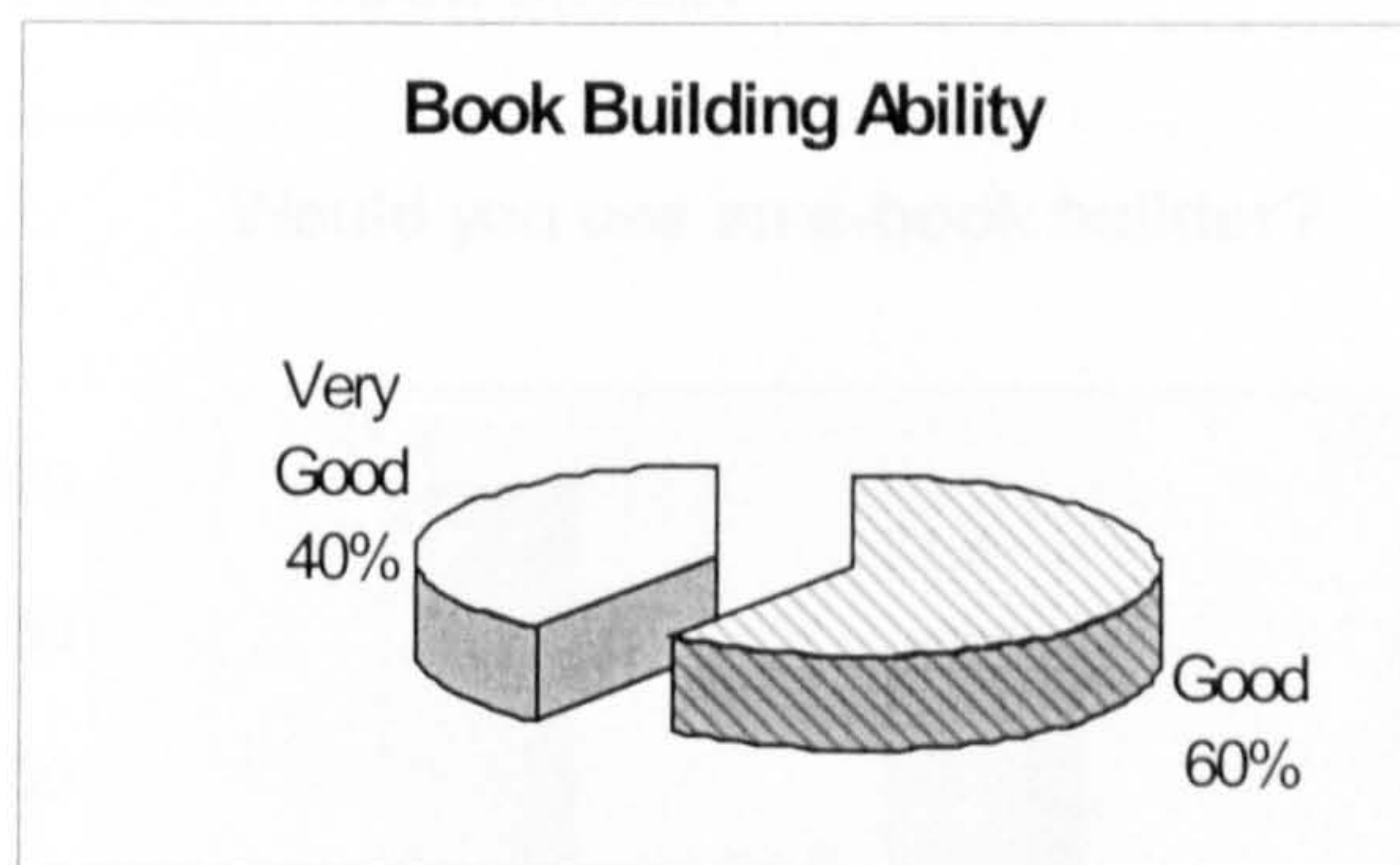
As can be seen in Table 6.40, fifty-three-point-eight percent of the teachers agreed that Book Builder required enhancement, but they would still like it to be implemented in schools. Eleven-point-five percent who judged Book Builder as poor, also wanted it to be implemented in schools.



(d) **Cross-tabulation: EXPERTS****Table 6.41:** *Cross-tabulation for Program Rating vs. Expertise***Program Rating \* Expertise Level Crosstabulation**

Count		Expertise Level		Total
		moderate	expert	
Program Rating	Adequate, needs enhancement	15	6	21
Total		15	6	21

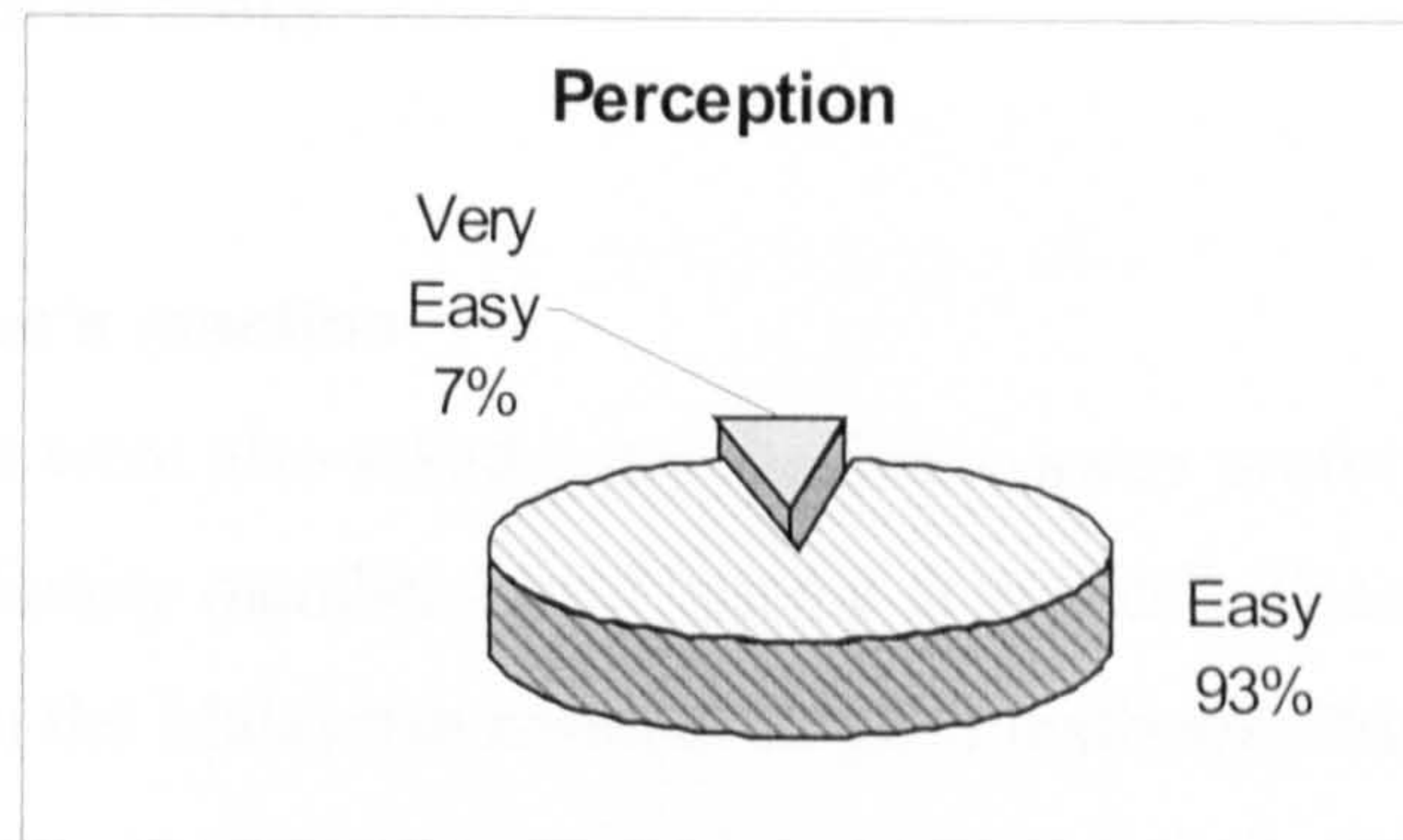
All the experts agreed that Book Builder required enhancement (see Table 6.41). Fifteen rated themselves as having moderate expertise and six rated themselves as expert.

(e) **Children's Ability****Figure 6.10:** *Pie chart for children's ability*

All children managed to build a 5-page book. Sixty percent produced a good book (i.e. it contained 5 pages, with at least 2 different information types and used at least 1 tool such as the drawing package, and designed cover and back pages). Forty percent produced a very good book (i.e. it contained 5 pages, with at least 3 different information type, used at least 1 tool such as the drawing package, formatted text to different sizes and colours, designed cover and back pages, and used functionalities such as bookmark and read-aloud) (see Figure 6.10).



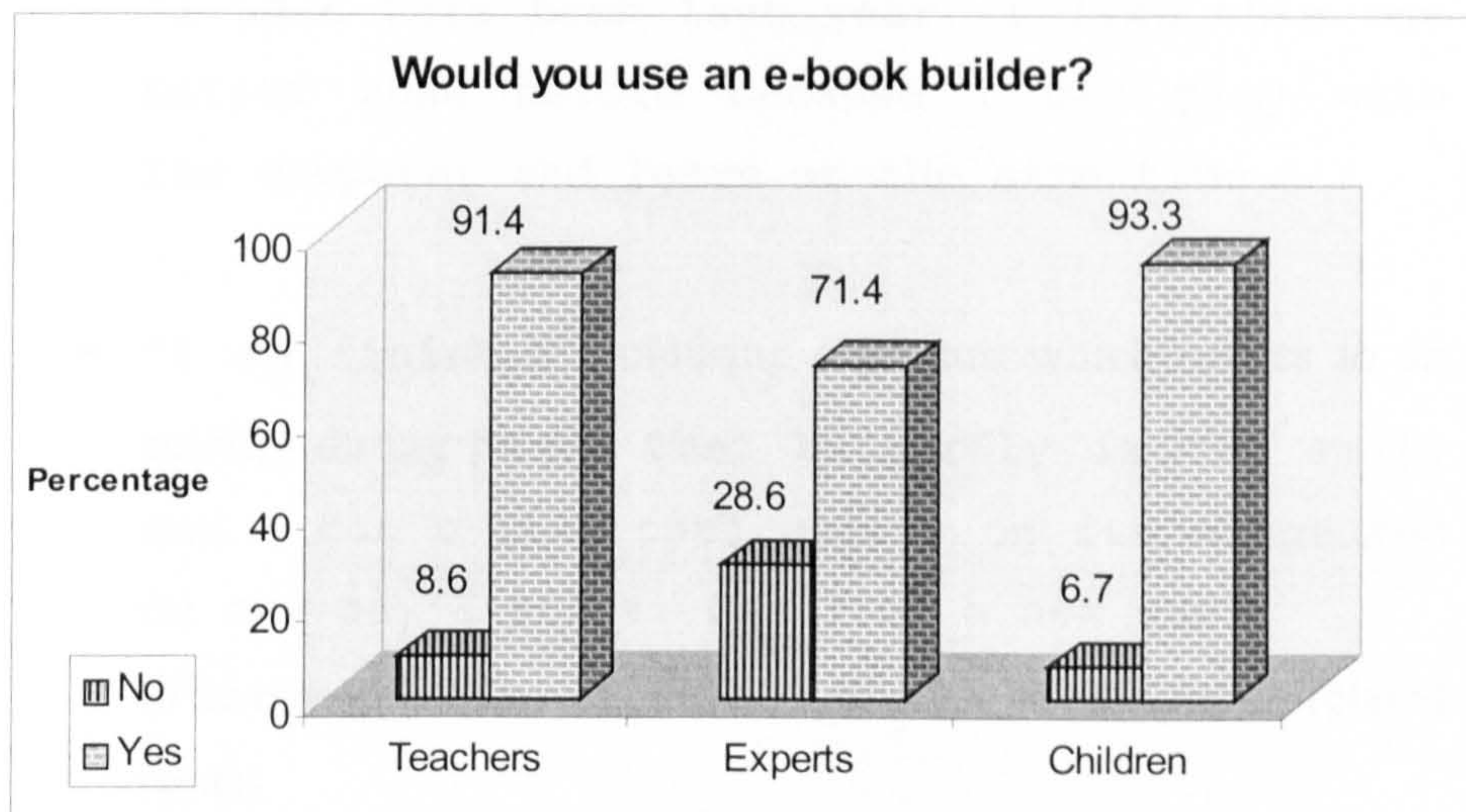
## (f) Children's perception



**Figure 6.11:** Pie chart for children's perception

When asked whether they found Book Builder to be easy, very easy or difficult to use, ninety-three percent of the children said it was easy to use (see Figure 6.11).

## (g) Interest in an e-book builder



**Figure 6.12:** Bar chart for levels of interest in e-book builder

When asked whether they would like to use an e-book builder, ninety-one-point-four percent of teachers said yes indicating that they were interested in such software. When the experts were asked specifically whether they wanted to use Book Builder, seventy-one-point-four percent said yes. This indicated that although all of them would want Book Builder to be enhanced, most were still interested in using it in its current form. For the children, ninety-three-point-



three percent said they were interested in using such software to write stories or books.

**(h) Children's reaction**

Children were also asked to try the throw-away prototype to learn about "family members" and "picnic activities". These topics are taught in the Malaysian national English textbook, Primary 1. For each theme, appropriate activities were included which required the children to solve problems (e.g. solve puzzles, answer mathematical questions) and follow instructions (e.g. sing along, write a short story, play interactive games and draw/colour pictures). Generally, they were able to read the pages, accomplish tasks without too many difficulties and give positive responses as follows:

- "I used this book last year. I like this one better than before because I can play with the computer and learn at the same time."
  
- "I am finished (colouring a picture which relates to an activity during picnic). That butterfly is too small and I don't like that colour on its wings...and on the boy's shirt. Can I do a new one?"

(The researcher showed her how to erase the colour on related spots)

"Ehh...I can't do this if I use paper. I would have to do a completely new one. I like this...I don't have to colour every part, just the ones I don't like."

- "I've learnt about picnic with Mrs.H. We discussed fruits, food, cakes, where the picnic was and what we liked to do. This is better...I can colour the fruits. I learn how



to spell the fruit names with the word puzzle. We didn't do this previously.

(The researcher then asked her to go to audio mode and choose the sing-along activity. She sang not realising that while she was singing, her voice was being recorded. When her singing voice was played back, she commented while laughing...)

"We didn't sing when I was learning about food and picnic. This is fun. I'm going to tell my friend. I know my friend can sing very well... not like me. Can I sing again?"

(The researcher asked her would she like to create her own music on fruits using a musical keyboard. She nodded and the researcher showed her the program. She played with every key and humming a tune at the same time. At the end of her session, she said:)

"This book has everything. Amazing. How do you put everything in it? I like having a book like this."

### **6.2.6 Conclusions**

The evaluation process with teachers was easily handled as teachers were interested and committed. However, some problems were encountered during interactions with the children. In addition to the training and building time, time was also allocated for "get to know" sessions. The children had to become "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. They were also easily distracted by even a faint sound from outside the evaluation room. Language was another barrier as most of the menu or pop-up instructions had to be translated to the Malay language. 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 character

positions were areas which needed most practice. Using right and left mouse buttons to activate certain functions such as read-aloud and options of voices added difficulty to the evaluation process because children got easily confused over which buttons to click.

Experts were very hard to get. Calls for participation had to be performed twice because of the low response rate. Some experts who responded had to be ignored because instead of answering and completing the on-line questionnaire, they suggested e-book compilers which they considered the best in the market. In other words, they wanted the researcher to use what they suggested rather than the Book Builder program from SPAsoft.

Despite these problems, all hypotheses (from  $H_1$  to  $H_9$ ) were analysed with the data collected from the samples selected for the study. Thus, the evaluation questions described in section 6.2.1 were verified except for one statement. This verification contributed significantly to supporting the main hypotheses and objectives of EBoChi.

The next section presents the outcomes of observing children while they were interacting with e-books on portable devices and serves to validate sub-objective 4.

## **6.3 E-Books on Portable Devices**

### **6.3.1 The Children's Laptop**

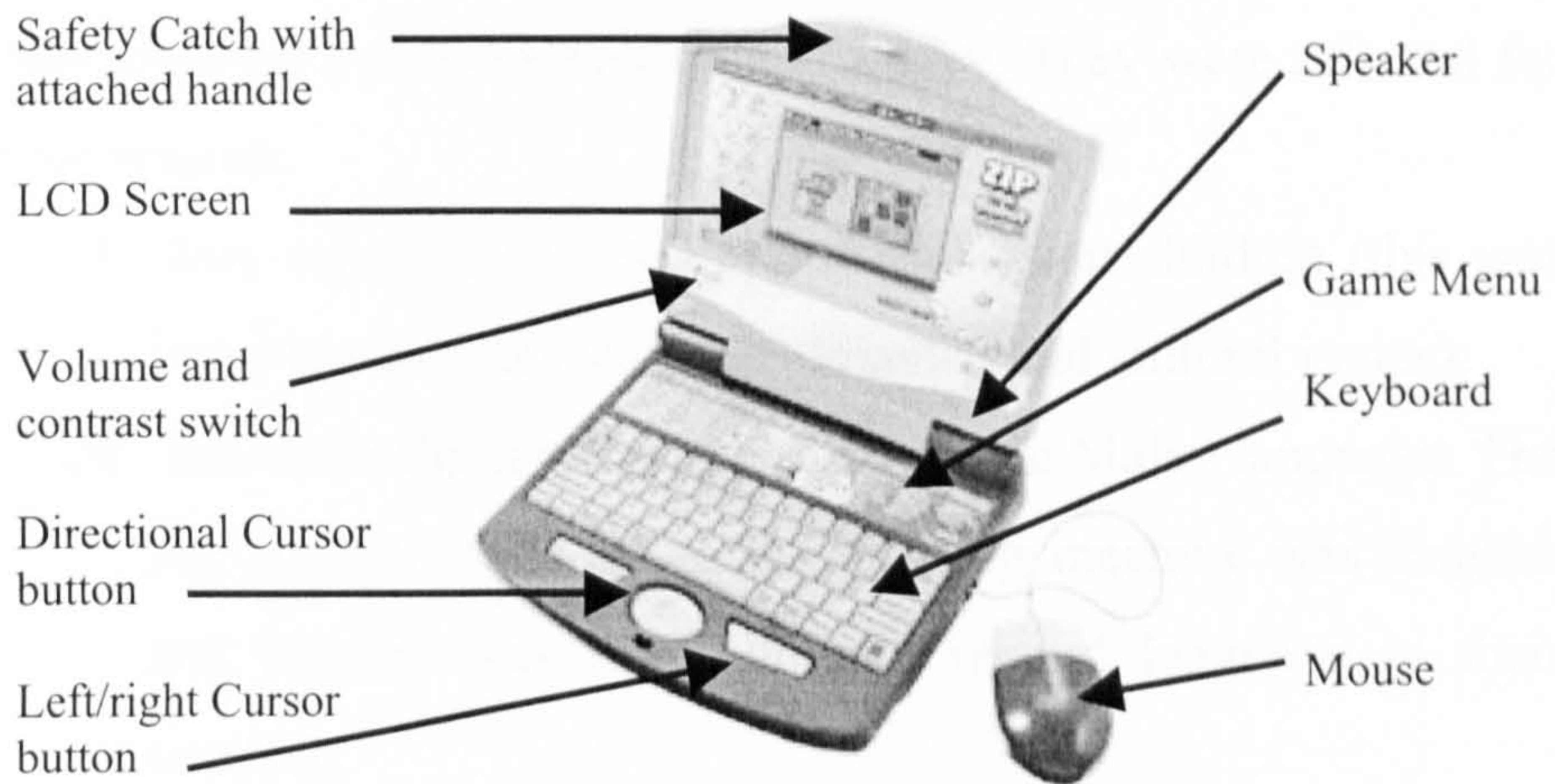
An electronic learning machine was used to observe children's technology preferences (see Figure 6.13). It was a laptop look-alike machine (with keyboard and mouse) that displayed learning activities on a built-in screen: a PC-based e-book for young children. The machine, Zip the Robot Learning PC from Oregon Scientific<sup>5</sup>, is designed for 4-7 year-olds and has fifty game activities covering

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<sup>5</sup> Go to this Web site <http://www.oregonscientific.co.uk> for more information on their latest products.



vocabulary, spelling, grammar, maths, music and games. It could be expanded with add-in smart cards. Like a real laptop it had a QWERTY keyboard and a mouse in order to introduce essential computer skills. The machine is powered either by 4AA size batteries or a 9V AC adapter.



**Figure 6.13:** *Physical design of the Zip Robot laptop*

### 6.3.1.1 The Machine Features

Ten game activities (such as word puzzles, spelling drill and practice and sing along) and questions were included in each level (there were six levels of difficulty). Users were given three attempts to answer each question. Points were awarded according to the number of attempts taken to answer each question correctly. Each attempt to answer a question was timed one minute for level 1-5 and thirty seconds for level 6. If users were unable to answer in time, it was counted as an incorrect attempt. Users were praised for each correct answer and prompted for action if the given time was exceeded.

The score was displayed at the end of each activity and a score of eighty-five points or higher after a group of ten questions would take a user to the next level of difficulty. A score of sixty points or below would take them back a level.



### 6.3.1.2 Observed Results

In the evaluation study that was conducted, six children were given the opportunity to play with the learning machine. Five of the children, whose parents were studying at the University of Strathclyde, came from Malaysia and one from Indonesia. All of them attended a primary school in Glasgow. They were selected for three reasons:

- (1) they represented a sample of Malaysian children (this was important in order to eliminate social and cultural issues);
- (2) they have the same mother-tongue: the Malay language. The pre-installed software in the learning machine was English and English was the children's second language in their country;
- (3) all participants were considered as "moderate technology users" for their age as all have had experience playing with CD titles, video games and personal computers. Moderate technology experience was essential as this study assumed that the children were used to handling input devices.

While using the machine, the children were observed for their reactions and at the end of the playing time, each child was asked to answer orally some questions regarding selected parameters.

This study attempted to observe the childrens' preferences towards the learning device. A study of display preferences by Wearden (1998a) was therefore partially adopted. He measured display preferences in six categories:

- navigability;
- information utility;
- design;
- physical format;
- time;



- overall preference.

Navigability, physical format and overall preference were selected and used as observation parameters. In addition, the researcher measured the overall time each child took to play with the machine. 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 the readability concept, this parameter was also observed in this study.

In order to study how the children read and felt towards the learning device, the parameters were further broken down into the following questions:

- Navigability:
  - (i) how easy is it to make game choices?
  - (ii) are the input devices easy to use and handle?
- Physical format:
  - (i) how heavy is the machine?
  - (ii) do you like the design of the casing, screen and keyboard?
- Readability:
  - (i) are the texts clearly displayed?
  - (ii) are the texts and graphics smoothly outlined or are they too jagged?
  - (iii) do you like the black and grey display?
  - (iv) is the audio clear?
- Overall preference:
  - (i) do you prefer learning with CD-ROM, paper or the electronic learning machine?



Table 6.42 outlines the positive (✓) and negative (☒) feedback given by the children.

**Table 6.42:** *Feedback from children*

Parameter	Observation Feedback
Navigability	<ul style="list-style-type: none"> <li>✓ It was easy to select the choices of activities.</li> <li>✓ The right, left and directional buttons were easy to use.</li> <li>☒ The mouse movement was not smooth enough.</li> </ul>
Physical format	<ul style="list-style-type: none"> <li>✓ It was light.</li> <li>✓ The design shape was good with built-in handle.</li> <li>✓ Keyboard worked well.</li> <li>☒ The display screen was too small. Difficult to see the text display.</li> </ul>
Readability	<ul style="list-style-type: none"> <li>☒ Texts and graphics looked too jagged.</li> <li>☒ Displays were not colourful (only black and grey).</li> <li>☒ Grey display panel was too dull.</li> <li>☒ Certain characters were often mistaken for another character (for example, letters g and s).</li> <li>☒ Audio sounds were too robotic.</li> <li>✓ Numbers were easy to read as compared to letters.</li> </ul>
Overall preference	Preferred CD titles displayed on computer monitor or video games displayed on television monitor.

When measuring each child's playing time, the timing started when they had familiarised themselves with switching on the machine and selecting a particular activity. Table 6.43 shows the playing time for each child measured to the nearest minute. The average playing time was calculated to be 19.16 minutes.

**Table 6.43:** *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) states that an important parameter of an e-book is its necessary weight limitation. It can not be heavier than we normally expect a book to be. The laptop provides fifty activities, and say, if each activity were equivalent to ten pages, the bound conventional paper book would have to have about five hundred pages. These five hundred pages are indeed heavier than the weight of the machine. When asked about the weight of the device, the children agreed that the laptop was not too heavy and they preferred collections of books in electronic form compared to paper books.

Jagged edges (jaggies)<sup>6</sup> in LCD were found to be liked least in a study by Gujar et al. (1998). The six children in this study also complained about the too jagged texts and graphics in the laptop. Examples of jagged characters in the Zip the Robot machine are illustrated in Figure 6.14.



Letter **g** was sometimes mistaken for **s**. One child even read the **g** as **9**.



These graphics do not seem to represent the intended objects. Many of the children failed to recognise half of the animals.

Figure 6.14: *Examples of jagged characters*

<sup>6</sup> Stairlike lines that appear where there should be smooth straight lines or curves. Jaggies can occur for a variety of reasons, the most common being that the output device (display monitor or printer) does not have enough resolution to portray a smooth line.

According to the children involved in this study, the readability of the laptop was low (Norshuhada & Landoni, 2000; 2003). The reasons for this included low-resolution black and grey displays, small display screens, dull grey display panels, and too many jagged texts and graphics. Not surprisingly, Nielsen (1998) also states in his design guidelines that low resolution monitors have poor readability.

There was however, one interesting finding. These children preferred richer colourful multimedia displays. This contrasts with the findings of Wearden (1998b) who did a survey of two-hundred-seventy-six university students and found that the least important potential features of e-books were animated graphics, audio and video. It is possible to conclude that the age factor has some affects on this parameter, and that further studies should be performed to validate it.

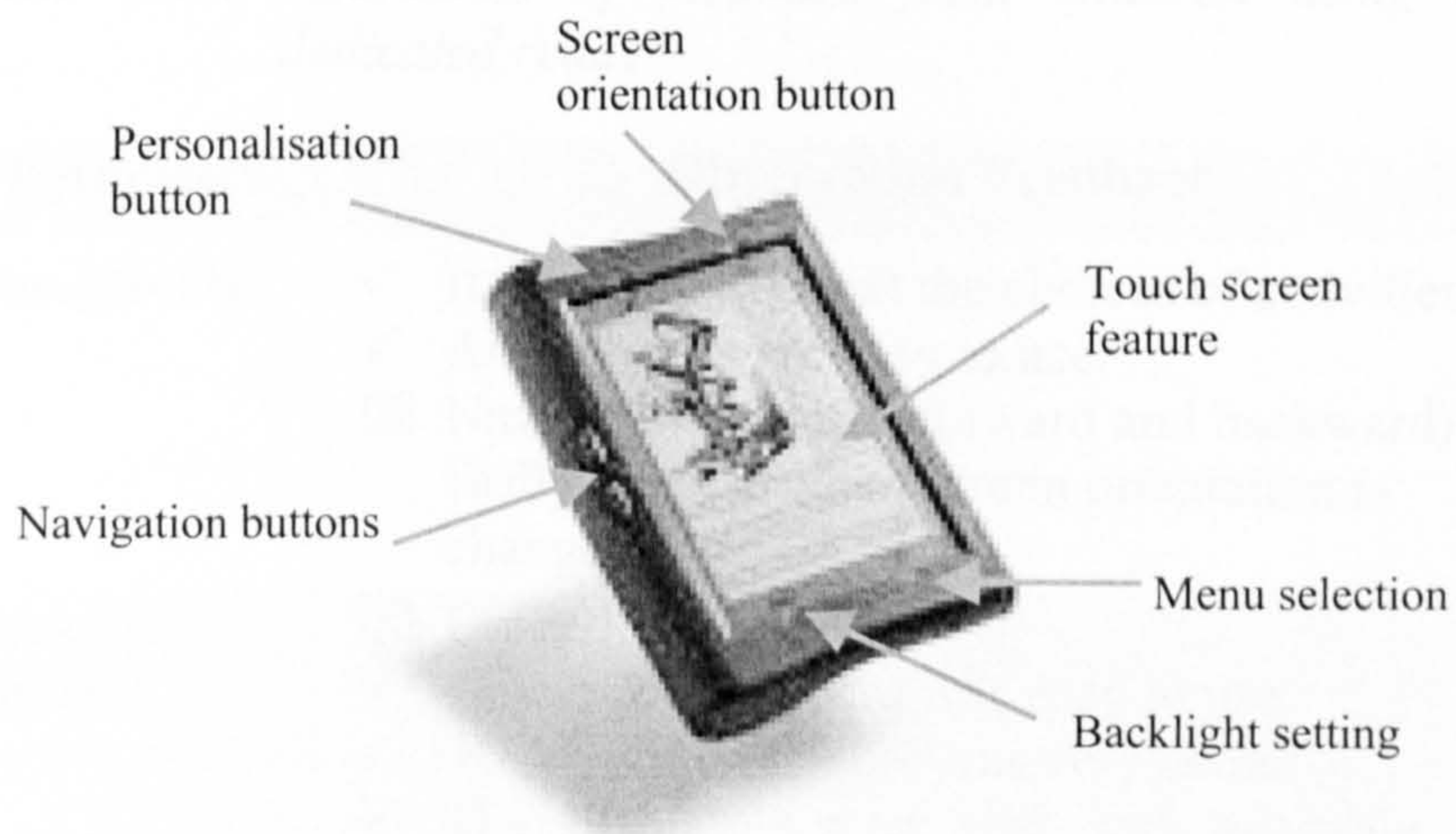
One other issue that needs to be discussed is the average time each of the children took to play with the machine. Liu (1996) found that multimedia technology with its use of video, audio and graphics could engage children for a longer period of interaction time. However, this was not the case in this study. All six children seemed to manage to get excited and interested for no more than thirty minutes. This suggests that there is not enough fun for the children in the contents, displays and activities when using the e-books.

### **6.3.2 Using a Dedicated E-Book Reader**

A dedicated reader<sup>7</sup> was tested with four out of six children from the same group who participated in the evaluation of the laptop machine. The now obsolete NuvoMedia Rocket eBook (see Figure 6.15) had the following features:



- price: USD 269 (retail price);
- size and 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;
- e-book Reading Software: Closed, proprietary system developed by NuvoMedia;
- connectivity: Connects to PC or Apple Macintosh via cradle and serial cable;
- interactivity: Touch screen and buttons;
- tools: Library, personalisation, adjustable text size and screen orientation and backlight setting.



**Figure 6.15:** *NuvoMedia Rocket eBook*

All four children<sup>8</sup> 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 the functionalities easily (with very little

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<sup>7</sup> The device was provided by another project (E-Books On-Screen Interface: **EBONI**) conducted by researchers at Department of Information Science, Strathclyde University. For more details see <http://eboni.cdjr.strath.ac.uk/>



help) and were very comfortable with the touch screen feature (Norshuhada & Landoni, 2003). They were able to annotate without much difficulty and used the free-hand feature more than the keyboard facility. Texts were easily recognised (as they were not too jagged) and read. Graphics were identified correctly. As predicted, they opted for the larger text size before reading a page.

Only a few negative factors were noted: grey scale display (i.e. no colour), the thickness of the device (quite thick to hold), lack of audio and lack of activities (or in the children's words: "games"). When asked to choose between the laptop and the dedicated reader, none of the children were able to decide but it seemed that they would like to play activities (that are installed on the laptop) on the dedicated reader. Table 6.44 summarises the positive (✓) and negative (☒) feedback.

**Table 6.44:** *Summaries of feedback from children using the dedicated reader*

Parameter	Observation Feedback
Navigability	<ul style="list-style-type: none"> <li>✓ It was easy to select the choices of activities.</li> <li>✓ All buttons were easy to use.</li> <li>☒ Navigation buttons (forward and backward) easily confuse when screen orientation is changed.</li> </ul>
Physical format	<ul style="list-style-type: none"> <li>☒ Quite thick to hold.</li> <li>✓ On-screen keyboard was easy to use.</li> <li>✓ Touch screen feature was very useful.</li> <li>✓ The display screen size was adequate for reading.</li> </ul>
Readability	<ul style="list-style-type: none"> <li>✓ Texts were easily read.</li> <li>✓ Displays were easily recognised.</li> <li>☒ Displays were not colourful. Only black and grey.</li> <li>☒ Grey display panel too dull.</li> </ul>
Overall preference	Like it very much and would like to read books on it.

<sup>8</sup> Only 4 out of the 6 could participate in this evaluation as the other 2 had gone back to Malaysia.



In this study, children's playing time was not recorded. The reason for this was that each child was asked to read a few pages of a book. The reading time for each child reflects his/her own reading skill. Taking reading times was therefore not appropriate for the purpose of this study.

### **6.3.3 Conclusions**

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

Children 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 (Carlson & White, 1998). Before the devices currently under investigation can become hundred percent successful, they should be able to display the pre-installed contents, and also be capable of displaying pages of many different types, - from documents to journals, letters, newspapers, magazines and Web pages (Fidler, 1998). They should also be able to support analytic reading and other electronic activities. These types of pages are obviously very essential for school children who are constantly learning. The devices should also have the ability to personalise (highlight, add notes, underline items or bookmark) the contents as this ability is often required by students even as young as 7 years old (Fidler, 1998). In addition, the machines should be an affordable technology able to motivate and at the same time affect the currency and accuracy of 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 cost of buying fifty activity books with each book priced at £1 (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 most parents to buy for their children. Even if parents could afford it, there are still lacks of materials 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 (see chapter 2 for examples of such publishers). Additionally, prices of dedicated readers are getting lower by the year and studies seem to indicate that hybrid hand-held devices are gaining popularity in school environments (e.g. [Electronic-School.com](http://Electronic-School.com), [EducatorsPalm.org](http://EducatorsPalm.org), [K12handhelds.com](http://K12handhelds.com), British Educational Communications and Technology Agency (Becta)). These devices are becoming smaller, cheaper, better in performance and more connected (i.e. able to browse Internet and transfer data).

Although a printed book is a familiar companion and is very portable, it offers readers only text that is forever immutable (Chartier, 1998), and for children this is not as attractive as a multimedia presentation in an electronic environment. Furthermore, printed books fall apart over time especially when young children use them (Rothman, 1996). In this sense, the dedicated reader does have some advantages over printed books. However, the demand for dedicated e-book readers is still low even in the adult consumer market (Molina, 1998). This may be due to



the cost and comfort factors that are said to play a significant role in making paper-based reading a preferable activity (Munyan, 1998).

In conclusion, the learning machine is just another aspect of the newest evolution of learning devices. It is an addition to the learning devices list which include paper-based materials, 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.

## 6.4 Overall Conclusions

Most of the requirements proposed in chapter 5 were validated in this chapter. Hypotheses that were set up for this study were also tested. Moreover, children's interactions with e-books, e-book builder and e-book devices were discussed. In particular, teachers perceived the suggested activities as useful in catering for children's different learning styles. E-books were also seen as more useful when the activities were included than without them. In addition, teachers also voiced that they would like to develop their own teaching materials (e.g. textbooks) using tools such as the e-book builder because they believed that the e-book builder has potential in assisting their teaching tasks and therefore should be implemented in schools. All teachers regardless of their gender, age, teaching experience, computer experience and school locations shared these views.

In validating the functional requirements for an e-book builder as proposed in chapter 5, the Book Builder program was empirically tested with two groups of participant: teachers and experts. Both the groups were in agreement on the usefulness of the existing functionalities of the program. However, almost all of them (i.e. about seventy-seven percent of the teachers and hundred percent of

the experts) said the program required enhancement. Therefore, a number of new functionalities were proposed and then validated by the teachers and experts. Most teachers believed that the “automatic interactive activity builders” should be included in an e-book builder environment. The activity builders should assist them in building their own tailor-made educational activities easily.

A software should be easy to use and easy to learn by different groups of user, for instance, experienced and novice users, male and female users, and so on. Book Builder was perceived by different groups of teacher as easy to use. Most children also found Book Builder easy to use especially children with computer experience. However, those without computer experience found the program not as easy to use. Even though this was the case, all the children managed to build a 5-page book successfully after just one training session that lasted on an average less than an hour. The most frequently used functionalities by the children were the drawing program, recording program and read-aloud the texts.

Two experiments were also conducted with the children in order to study their interactions with the latest e-book reading devices. A laptop machine designed specifically for children and a dedicated e-book reader were utilised by the children to complete some pre-specified tasks. It was found that children showed no resistance to the devices and were able to use them comfortably and easily. Although they enjoyed using the devices, all of them complained about the grey, as opposed to colourful, displays. Additionally, they also indicated that they would like to play (activities installed on the laptop) on the touch-screen-dedicated reader. Touch-screen facility grabbed the children’s attention and is a positive design feature.

The outcomes explained and outlined in this chapter provided inputs to the next chapter, which is the final chapter in this thesis: **Conclusions and Recommendations.**



# Chapter 7

## Conclusions and Recommendations

### 7.1 Introduction

The research rationales were introduced in chapter 1. In particular, this study focused on teaching and learning materials which would be utilised in school environment. One notable material was selected (i.e. the textbook) and investigated in order to produce its electronic counterpart. To achieve the expectations of this study, three main objectives were formed:

1. To propose features for children's electronic textbooks, which contain existing printed textbook features, as well as features that are perceived to be useful in catering for the diversity of children's learning styles in the Malaysian Smart School environment.

2. To propose features for a children's e-book builder which are easy to use for both teachers and children, and useful for schools.
3. To test hypotheses related to the usefulness and ease-of-use of the functionalities provided in children's e-books and e-book builder.

Any assumptions and related hypotheses were also listed. The research objectives and the review of literature (chapter 2) led to a structured method of this research (chapter 3) which involved investigation, elicitation, deduction, analysis, construction, collaboration, modelling and evaluation processes. A formal model for the proposed e-book (chapter 4) and the requirements specification of the environment for building the e-books (chapter 5) were defined. Two types of prototype were utilised to investigate the e-book concept and its builder in terms of the perceived usefulness and ease-of-use with different groups of users. In addition, two portable e-book reading devices were tested with a group of children who were between 7 and 9 years old. The results of these evaluations (chapter 6) including the testing of hypotheses have contributed to the conclusions and suggestions for future studies outlined in this final chapter. The contents of this final chapter can be classified into:

- overall conclusions from the hypotheses testing;
- e-book features;
- e-book builder features;
- limitations and suggestions.

The next section presents the overall conclusions obtained mostly from validating requirements and testing the hypotheses.

## **7.2 Overall Hypotheses Testing Conclusions**

The main and sub-objectives of this study have been achieved. Features for children's electronic textbooks, which provide activities that are perceived to be useful in catering for the diversity of children's learning styles, have been proposed through the formation of a conceptual model. The requirements for the



e-book builder, which will allow users to build e-books with interactive activities, have been specified in graphical models. In order to validate these requirements, the perceived usefulness of the functionalities, the ease-of-use of the system, and the suitability of e-book reading devices have been successfully analysed. In addition, the main hypotheses have been proven through demonstrating the sub-hypotheses. In particular, the following conclusions can be drawn from the outcomes of this study.

### **7.2.1 For Teachers**

- i. The suggested activities (see chapter 4) are indeed perceived by the teachers as useful in catering for the diversity of children's learning styles;
- ii. When the suggested activities are included, electronic textbooks are seen to be more useful than those without the activities;
- iii. The proposed electronic textbook model and its builder have the potential to assist classroom teaching tasks;
- iv. Teachers of different gender, age, teaching experience, computer experience and school locations perceived the functionalities of the proposed e-book builder as useful;
- v. Teachers of different gender, age and computer experience perceived the existing functionalities of the e-book builder prototype as useful. However, further analysis showed that the mean value of one of the functionalities (i.e. Background music (add/remove)) was considerably lower than the others. This can be interpreted as teachers regarding this function the least useful so that it could probably be omitted from future designs;
- vi. Teachers agreed that tools which let users build activities automatically (i.e. without having to have programming knowledge) and easily should be included in e-book builder;
- vii. Teachers felt that the existing e-book builder prototype functionalities, although adequate, required enhancement. However, there was a small number of novice teachers who thought the prototype was excellent;

- viii. Teachers would like e-books and an e-book builder to be implemented in schools;
- ix. Teachers were interested in using an e-book builder;

### **7.2.2 For Children**

- i. Children of different gender and age used the e-book builder prototype easily;
- ii. Children without computer experience did not find the e-book builder easy to use;
- iii. Children had good book building ability and were interested in using e-books and an e-book builder;
- iv. Children were able to interact with the suggested activities successfully. They had fun and managed to solve the problems proposed by each activity without much effort;
- v. Children were able to use e-books on portable devices easily. Features offered by the devices were handled without much effort.

### **7.2.3 For Experts**

- i. Experts agreed that the e-book builder prototype, although adequate, required enhancement;
- ii. Both experts and teachers were in agreement on the perceived usefulness of the proposed e-book builder functionalities.

When asked to give further comments, teachers suggested that there was an urgent need to implement e-book technology in school. They believed it brings more advantages than disadvantages. However, some were concerned about the accessibility of such technology especially to rural schools and low-income parents. If used only during school time equality of access among school children was also one of the concerns. Having such portable technology, but to confine it to school environment due to limited number of devices would probably reduce the positive impacts.



Generally, there were positive indications to conclude that:

1. E-books containing interactive educational activities are useful to school children and teachers;
2. An e-book builder with special functions to build educational activities is also useful for teachers and children;
3. It is possible to suggest that due to the perceived usefulness of the activities in addressing children's learning styles, it could then be postulated that desirable features for e-books and e-book builders are to incorporate the functionalities proposed in this study.

Having discussed the general conclusions, the following sections outline the conclusions regarding the features of e-books and the e-book builder.

### **7.3 E-Book Features**

When designing e-books, structural and content presentation components should be considered. Ideally, maintaining the book metaphor by including at least the cover page, verso, abstract, acknowledgement, table of contents, chapters, footnotes, references, appendices and back cover would guarantee the e-book's usability. Specifically for children's textbooks, it is however acceptable to include only the following structural components:

- cover page;
- verso;
- table of contents;
- chapters;
- sections;
- paragraphs (with text and images);
- back page.

In each page, the number of paragraphs including images should be less than five, with an average of three. Font size should be larger than 14 point, sans serif type. Each page should contain contents plus a combination of appropriate multimedia elements: graphic, audio, video and animation. The contents will consist of the header and paragraphs, which usually composed from text. The

contents should be supported and reinforced by different activity modes. Perhaps graphic, audio, hypermedia and Web modes as proposed in chapter 4 could be adopted. In each mode a collection of appropriate activities that match different children's intelligences (as suggested by the Multiple Intelligences theory) should be included to ensure children's different learning styles are being catered for.

## **7.4 E-Book Builder Features**

The features for the e-book builder can be divided into three categories:

- domain of e-books and e-book builder;
- functional requirements;
- non-functional requirements.

The domain refers to the possible environment in which the e-books and the e-book builder could be implemented. The functional and non-functional describe the functionalities and end-user interface of both the e-books and the e-book builder.

### **7.4.1 Domain of E-Books and E-Book Builder**

A modern school space should comprise of spaces (see chapter 5), which are connected with networking or wireless technology. The teachers' room should be further divided to include a studio/server room (where if required, on-line lectures can be delivered) and a courseware development room (where teaching and learning materials can be developed). As books, especially textbooks, are the most common learning materials it is therefore proposed that among the tools provided in this room, should be an e-book builder. In order to view or read the books which have been created internally or bought from bookstores, each classroom and the school library should be equipped with appropriate e-book reading devices that could be multimedia personal computers, dedicated readers, laptop look-like machines or hybrid hand-held devices. A minimal requirement for these devices is the capability to display coloured multimedia content.



If e-books are to be built and published the main roles and actors involved in this activity are authors (e.g. teachers, children), internal editors (e.g. head teachers, other teachers, designers), external editors (independent companies), publishers and distributors (e.g. district education departments, the state education department and the Ministry of Education) and end-users (i.e. children, teachers).

When a teacher builds books to be utilised in a classroom situation, the head teacher or other teachers can act as content editors. If he/she wishes to publish and sell the books outside the school circulation, then the district or state education departments or the ministry of education could be the publishers as well as distributors. He/she also has the alternatives to publish with independent companies such as Webs4Kids.com, OZONeBOOKS.COM, Atlantic Bridge Publishing, BOOKS ONSCREEN™, Ebook Express, EBook Mall and Hypertech Media Inc, who are actively seeking e-book submissions to be considered for publication.

On-line publishers, digital libraries and on-line bookstores have been the main distributors of e-books, which are read using special hardware or software readers. In contrast, traditional libraries and bookstores mainly distribute e-books on CD-ROMs. Successful children's distributors include Ebooksnbytes.com, Antelope-ebooks.com, Vangoachbooks.com, Bookmice.com, Ebooksonthe.net and Hiyah.com. Existing popular digital libraries such as The Internet Public Library Online Texts Collection, Net Library and Bartleby Library however store only a limited number of children's e-books. Digital libraries specifically for children, for instance Story Place<sup>1</sup> is an excellent site to visit. It divides the library into two main sections: pre-school library and elementary library. The latest development

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<sup>1</sup> Visit their Web site for more information at <http://www.storyplace.org/storyplace.asp>

is The International Children's Digital Library<sup>2</sup>, a project of The Internet Archive and The University of Maryland's Human-Computer Interaction Lab. It was proposed in March 2001 and is now seeking additional funding, expertise and collaboration. Its main aim is to focus on the inherent promise of the Internet to provide direct and global access to information, anytime. The Children's Library plans to digitise one hundred thousand books and make them available throughout the world.

If children build books, the teachers can act as editors, hence ensuring the suitability and accuracy of the contents. Children too have the opportunity to share and publish their books on Web sites or digital libraries dedicated to children's development.

## 7.4.2 Functional Requirements

An e-book builder normally has two modes, that is the Create-mode and Read-mode. Each mode has its own sets of functionalities and menu structures. Possible functions could be structured as follows:

### Create-Mode

- File → New book, Open book, Save book, Save book as (.bok, .exe, .html), Close book, Export as HTML, Print, Printer Setting, Exit.
- Edit → Undo, Cut, Copy, Paste.
- Book → Show page numbers, Read book, Lock book (password, registration key, limited access), Insert book.
- Pages → Insert new page (cover, verso, TOCs, just text, text and image, just image, just audio, audio and text, just video, text and video), Delete page (left/right/undo), First page, Previous page, Next page, Last page, Go to page, Bookmark, Read aloud.

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<sup>2</sup> This project is headed by Prof. Druin. See this Web site for more detail information (<http://mail.archive.org/icdl/index.html>).



- Insert → Choose sound, Choose video, Hyperlink, Background
- Tools → Picture tool, Text tool, Sound tool, Video tool, Animation tool (2D, 3D), Spell tool, Activity tool (Graphic, Audio, Hypermedia, Web).
- Settings → Layout options, Menu customisable.

### Read Mode

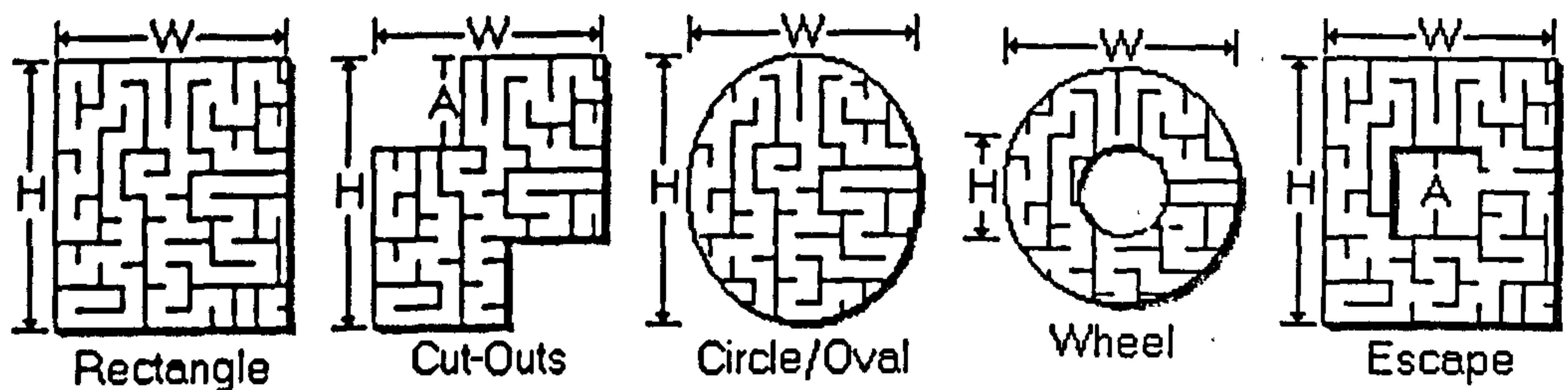
- File → Edit book, Exit Book Builder, Read in HTML, Search, Print.
- Page → First page, Previous page, Next page, Last page, Go to page, TOC, Read-aloud, Zoom.
- Insert → Annotation, Bookmark, Highlight.
- Settings → Turn page (with arrows/space/automatic turning), Menu customisable.

Activity tools in the Create mode should allow users to create activities automatically and easily without programming knowledge. To demonstrate, perhaps the following simple steps<sup>3</sup> to creating puzzle-related activities could be adopted:

**Step 1:** Choose puzzle type (Maze, Word search, Criss-cross, Hidden messages, Letter tiles, Picture);

**Step 2:** If select Maze:

**Sub-step 1:** select maze shape;



**Sub-step 2:** enter size of maze → width \_\_\_ height \_\_\_;

<sup>3</sup> These steps and ideas of puzzle builder were taken from discovery.com and <http://clear.msu.edu/dennic/matie>

**Sub-step 3:** select path style → random, mostly horizontal, mostly vertical, checker board;

**Step 2:** If select **Word search** (type in a list of words and book builder will hide them in a grid of letters):

**Sub-step 1:** enter puzzle size → number of letters across \_\_\_\_, number of letters down \_\_\_\_;

**Sub-step 2:** select options → use each letter only once, share letters occasionally, share letters as much as possible;

**Step 2:** If select **Criss-cross** (type in a list of words and book builder will link, number and format them):

**Sub-step 1:** enter size of puzzle → width \_\_\_\_, height \_\_\_\_;

**Sub-step 2:** enter size of each square, \_\_\_\_;

**Sub-step 3:** enter list of words → \_\_\_\_, \_\_\_\_, \_\_\_\_, \_\_\_\_, etc.

**Step 2:** If select **Picture**:

**Sub-step 1:** enter number of puzzle pieces, \_\_\_\_;

**Sub-step 2:** select type → equal size, non-equal size;

**Sub-step 3:** insert image

Apart from the features described above, by making users build pages through selection of different types of page template (i.e. just text, text and image, just image, just audio, audio and text, just video, text and video) the issue of inclusion of different types of book as suggested by Catenazzi (1993) could be addressed. Text books, static picture books, moving picture books, talking books and multimedia books are the categories (as introduced by Barker (1999)) of books that can easily be created with this function. When designing talking books, a function which allows readers to vary the speed at which texts are narrated should be considered. In addition, there should also be a text-to-speech function.



### **7.4.3 Non-Functional Requirements**

In order to be more accommodating to a range of children expertise and ages, the interface should be iconic as well as using pull-down menus.

Icons should be:

- enabled to be customised with lower or larger pixel;
- presented in at least 2 states: display and mouse-over (this could ensure easier understanding of the meaning of the icons).

Layouts of icons and menus should be limited to at most two sides of the screen display (i.e. a combination of any two of top, bottom, left or right alignments). Both icons and menus should also be customisable, allowing different functionalities to be set according to the different age groups or expertise levels involved.

In addition, an e-book wizard should be made available in order to guide users with respect to creating e-books. Completed e-books, if required, could be protected using different techniques such as inclusion of a password, registration key or limited accessibility.

The limitations of this study will be discussed in the next section. These are mostly due to the limited research time and budget constraints. Taking into account these limitations, the next section will also suggest future research topics which could be considered by experts or new researchers from different areas.

## **7.5 Limitations and Recommendations**

The limitations can be divided into at least five categories:

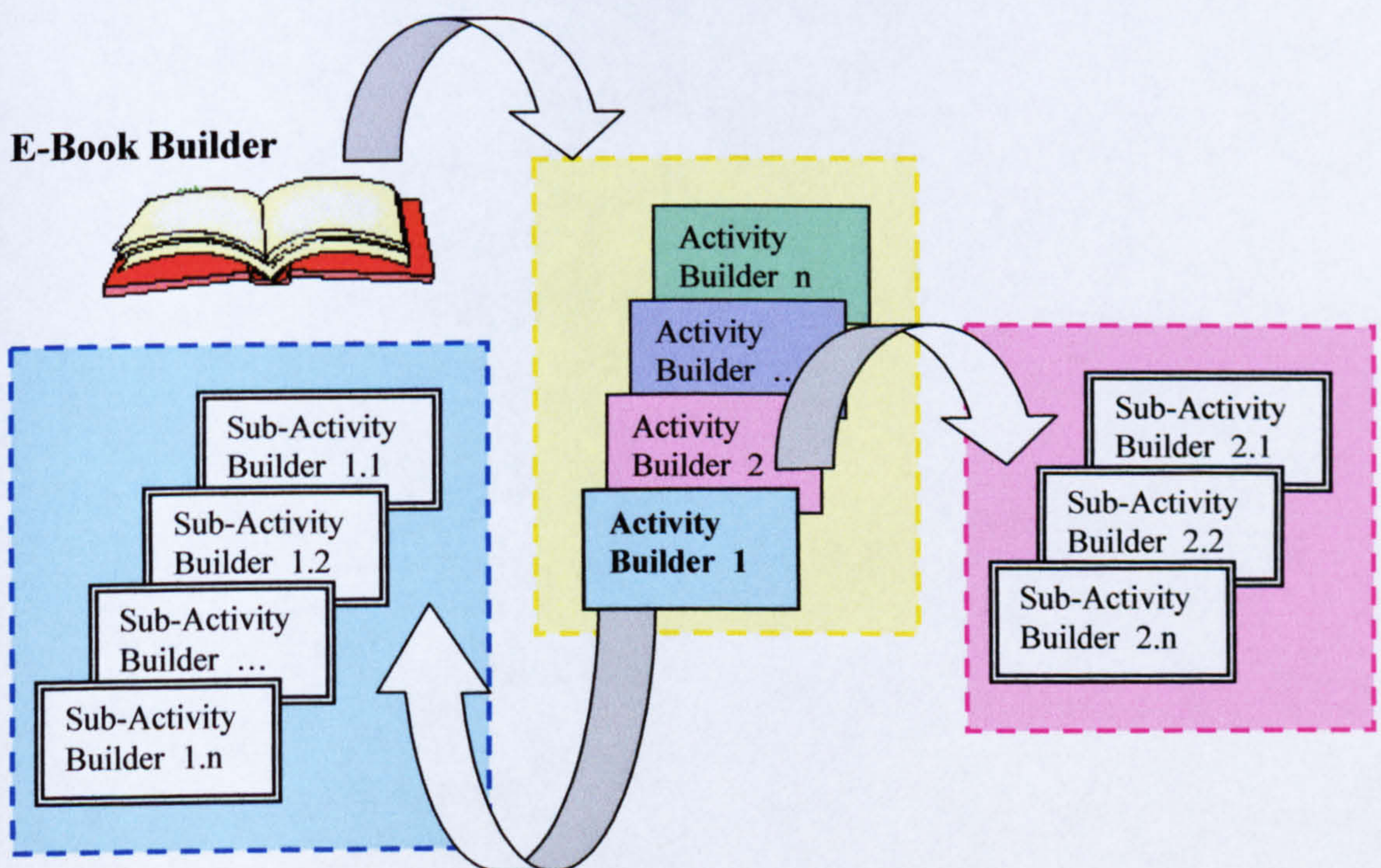
- e-book builder;
- e-books;
- portable reading devices;
- perceptions;
- research subjects and culture.



### 7.5.1 E-Book Builder

In chapter 1, the concept of educational activities was introduced and interpreted as the art of educating children with a variety of motivating and entertaining activities which focus on helping children learn through utilising all of their senses. The introduction of the educational activities concept has led to the specification of e-books with activities and its builder. Given the lack of time, budget, manpower and personal expertise, an e-book builder which was able to produce this variety of educational activities could not be developed at this stage. An existing program that met most of the initial specifications of this study had to be used instead. A future development therefore should be focussed on developing a program that will take into consideration the requirements and features proposed in this study.

If potential software engineers and information scientists appreciate and acknowledge the proposed features, then their e-book builders should consist of activity builders. Therefore, within the e-book builder environment, sub-builders should be incorporated (see Figure 7.1).



**Figure 7.1:** Builders within a builder



Theoretically, this “builders within a builder” concept is complicated and likely to be difficult to realise in practice. Furthermore, the builders should require little technical expertise on the part of their users. Achieving this would probably require adding complex program codes and technicalities to the e-book builder. Obviously, more studies on this matter should be carried out.

In the course of conducting the literature review, it was evident that there was a lack of an e-book builder which could be used by both children and teachers. Had there been more choices to study and compare, perhaps better functionality and non-functionality requirements could have been specified.

One of the EBoChi hypotheses was rejected, that is, that the children’s computer experience did not have any effect on the e-book builder’s ease-of-use. It was found that children without computer experience (i.e. novice young users) could not use the builder as easily as those with experience. This indicates a need for further usability studies. A different evaluation technique could provide more accurate data (such as data logging software which could record the actual sequence of actions and time taken to perform each action). This may produce more powerful and reliable findings.

Writing stories has been one of the dominant classroom activities within school environments. Traditionally, children write and author stories with pencil and paper, thus constantly practising and improving their handwriting. If we now encourage young children to use an e-book builder to write stories in order to take advantage of the benefits of e-books (e.g. multimedia appeal, interactivity, connectivity), it is important to consider what effects this action will have on their handwriting skills using pencils and pens. Although input devices such as the stylus could mimic the

action of pencil/pen, but the results of the writing on computer screen are often not as legible as on paper. In addition, there is also the issue of negative effects on children's health (e.g. eye, wrist and muscles strain) if more time is spent with a stylus or keyboard and looking at computer screens.

It is hoped that encouraging children to use an e-book builder would outdo the benefits of traditional methods of teaching style. Improvements in writing and reading skills, creativity, motivation, expression of stories and ideas, comprehension and computer technology handling are examples of such benefits. It is necessary to study which methods (i.e. either the traditional methods or the e-book builder) hold more benefits in order to limit the risk effects of implementing a new technology. It is therefore suggested that a comparative study on the e-book builder versus traditional methods should bring some insights into this topic. Additionally, extending this comparative study to evaluate the impacts of both traditional methods and the e-book builder on teachers' book authoring skills would be beneficial. It could be interesting to examine:

- how teachers choose to realise the potential of both the proposed e-book and e-book builder;
- whether the activity builders proposed in this study enable teachers to vary or improve their teaching techniques;
- whether creating teaching materials with the proposed e-book builder to support educational activities put extra working burden when compared to existing traditional techniques.

Experts in the areas of cognitive science or education probably would provide better answers to all the above questions.

### **7.5.2 E-Books**

Page-turner books, scrolling books and page-turner plus scrolling books are the categories of e-books discussed in chapter 2. While guidelines suggest using vertical scrolling as little as possible and if possible, to



avoid horizontal scrolling when displaying electronic contents (e.g. Powell, 2000; Nielsen, 2000), most portable e-books reading device displays are of the page-turner plus scrolling type. This is mainly due to their limited screen sizes. It is therefore important to study the effects of these categories of e-book on users' interaction times in order to find whether any one type has more hindering effects than the others. A well-designed comparative study would probably provide the answers.

As noted in chapter 6, child-proofing is one of the usability factors that should be considered while designing educational technology. However, although it is highly essential, no further emphasis was directed at this issue in EBoChi. This was primarily because it was believed that the inclusion of this topic might be too time consuming as it was (and still is) very hard to find literature on this matter. The absence of research into attributes of the child-proofing concept thus requires urgent attention.

Importantly, developing e-books for learning purposes requires the validation of their effectiveness on students' comprehension and learning gains. In addition, it is acknowledged that special effects (such as animation and audio in e-books) have the potential to distract children. This may result in the text being mainly ignored. EBoChi did not explore these highly relevant matters. Maynard (2001) points out that there is a scarcity of research into the effectiveness of e-books on comprehension and the impacts of special effects. She thus focuses her research on this absence and concludes that:

- there is no evidence to support that the added effects offered by e-books reduce children's comprehension of the text;
- e-books might actually aid the children's comprehension rather than hinder it.

Maynard however limited her investigation to storybook comprehension. The scarcity of studies on children's interaction with e-books, and more crucially electronic textbooks and e-book builders, consequently calls for

more investigations. Implementing this technology in a school environment without conclusive and extensive studies could be risky in terms of expenditure, resources and the actual learning gains.

The security issues and digital-rights management of e-books have not been thoroughly explored in this study. The author felt that inclusion of this area would open up another research topic that requires too much attention, which could not be handled in this limited time. Interested researchers could read Bailey (2001), Stork (2001), van Buren and Cogswell (2001), Henke (2001) and Digital Rights Management for Ebooks (Association of American Publishers, 2000) for more information.

### **7.5.3 Portable Reading Devices**

The situation with e-book reading devices is currently highly dynamic. A particular technology can become obsolete within two years of its manufacturing date. This imposes some “updating” problems on the children, teachers, schools, and education departments. On the one hand, features of reading devices are constantly upgraded thus forcing readers to learn new functions if the newer devices are purchased. On the other hand, considering the schools’ and education departments’ limited budgets, upgrading devices regularly is usually not practised. Besides this, books that have been created for later technologies might not be readable on old devices. More studies should be steered towards the practicality of implementing this technology given the limited budgets available for supporting widespread children’s access.

Designing e-books which can be used on different platforms and devices should be among the future considerations since according to van Buren and Cogswell (2001) “the ultimate dream is to be able to read e-books on any viewer of the user’s choice”. Ideally, e-books created from the proposed e-book builder should be capable of being used on multimedia personal computers, dedicated readers, laptop look-like machines or



hybrid handheld devices such as PDAs. Even a children's Game Boy is now capable of reading e-books. All these devices have different screen sizes. Therefore, researching into how to develop a universal interface to fit different screen sizes is indeed necessary. Alternatively, investigation can also be carried out to address the issue of whether small-size display devices such as the Game Boy are indeed appropriate for children to read books.

Another issue regarding e-book devices is their usefulness during in-class activities. Findings by Peters et al. (2001) can not be ignored. They found that e-book devices (Gemstar REB 1100 and Franklin eBookMan) functioned better during out-of-class utilisation. The in-class experience of using e-books was severely constrained by the poor scanning, ruffling and jumping functionalities of the hardware and software. It was difficult to find a location within an electronic text, akin to pagination in a printed text. The general problem is the need for individuals and groups to quickly and easily jump to the same point in a text. Locating specific passages in printed books is far easier than in e-books. In addition, a linked table of contents was found to be inadequate, especially when class members were using different font sizes and screen orientations. Therefore, a further investigation using children in school environments as samples should be carried out. The findings could then be compared with those of Peters et al. (2001) which involved using adults in higher education environments.

#### **7.5.4 Perceptions**

One of the generalisations made in this study is that teachers perceived the suggested activities as useful in catering for the diversity of children's learning styles. EBoChi only attempted to determine teachers' perceptions without measuring the true usefulness effects. With regard to this, investigations into how to actually measure activity usefulness and what attributes should be measured ought to be conducted. This would probably

require a long-term evaluation and comparative studies carried out by educationists and psychologists.

### **7.5.5 Research Subjects and Culture**

The findings of this study are limited to one environment, that is Malaysian school children and teachers. Of course, there is bound to be some cultural differences with other nations. For instance, the icon designs proposed in this study might not suit children in western countries. Then there is the issue of suitable language to use in the e-book and e-book builder. Even though the guidelines suggest using the “language of the intended users” in all products (in this case the Malay language should be used), EBoChi failed to follow this guideline and used the English language instead. Although the findings seemed to indicate that all the participants in EBoChi could use the e-book and e-book builder without much problems (probably because English is the Malaysian second language), utilising the Malay language might produce different (or better) results. Therefore, extending the method of this study to other populations is worthy of further investigation in order to address the issues described above.

Inclusion of the home environment, which was excluded in this study, as the research domain (e.g. what do parents think? can parents afford the technology?) is another noteworthy issue to be considered. Additionally, future research could use larger sample sizes, therefore increasing the power of generalising the results.

Since the features proposed and the theory used in this study are applicable to older children and teenagers, extending this study to include them (e.g. secondary school pupils) is another investigation that requires attention.



## 7.6 General Conclusions

By maintaining the advantages of paper books, eradicating their disadvantages and integrating the benefits of technology, while at the same acknowledging the technology disadvantages could pave the way towards successful e-books. From the findings obtained in this study, there were indications that:

- electronic textbooks with appropriate educational activities that support the content of a particular page; and,
- an e-book builder with special functions to build such educational activities could be useful and satisfying.

In addition, children showed no resistance to the e-book technology. They could interact with e-books comfortably and they also had good e-book building abilities (Norshuhada & Landoni, 2003). Furthermore, teachers perceived the technology as able to assist their teaching tasks and the educational activities have potential in catering for children's different learning styles.

E-book will become an important part of our future. It is an emerging technology, highly dynamic and has a great potential when it comes to delivering up-to-date information. However, e-book is not about replacing the printed book, rather it is about replacing the absence of printed book and is particularly useful in the educational environments.

*“Printed textbooks will shift into electronic versions... The conclusion therefore is that there will be a significant shift away from books in academia... However, books will survive and are likely to remain as an entertainment medium, novels for couch, beach and bus”. (Noam, 1999)*

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# Appendices

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## APPENDIX A

## Descriptions of owners of existing activity initiatives

Description of activity	Program origin	Program owner
Drawing program for children	<a href="http://www.cs.ruu.nl/~markov/kids/draw/">www.cs.ruu.nl/~markov/kids/draw/</a>	A free program by Mark Overmans
Colouring program	<a href="http://www.coloring.com/working/begin.cd?img=summer">www.coloring.com/working/begin.cd?img=summer</a>	A US based site dedicated for children.
Clip art program	<a href="http://www.awesomeclipartforkids.com/">www.awesomeclipartforkids.com/</a>	Awesome clipart is part of EduHound.com dedicated for children, teachers and families.
Jigsaw puzzle	<a href="http://www.kidscarnival.com/Jig01.html">www.kidscarnival.com/Jig01.html</a>	A site for children managed by Cyberville City Inc.
Guitar playing	<a href="http://www.4kids.org/funstuff/music/instruments/guitar/">www.4kids.org/funstuff/music/instruments/guitar/</a>	A web site containing resources for children.
Keyboard music making	<a href="http://www.kidsdomain.com/brain/music/games/keyboard.html">www.kidsdomain.com/brain/music/games/keyboard.html</a>	A dedicated children's site managed and created by Kaboose Inc.
Sing along and recording program	<a href="http://www.niehs.nih.gov/kids/musicchild.htm">www.niehs.nih.gov/kids/musicchild.htm</a>	A site managed by National Institute of Environmental Health Science, part of US Federal government. It is a non-profit educational Web site designed to assist children in learning to read.
Music listening activity	<a href="http://www.wubbiesworld.com/playwubbiesound.html">www.wubbiesworld.com/playwubbiesound.html</a>	A site for children registered trademarks of Wubbies World International Inc.
Learn to read music notes	<a href="http://www.familygames.com/free/notecard.html">www.familygames.com/free/notecard.html</a>	Note card is a freeware music reading utility for Windows managed by Familygame.com, a Web centre for non-violent freeware and shareware for children and families.
Music games	<a href="http://www.playmusic.org/percussion/index.html">www.playmusic.org/percussion/index.html</a>	A site owned by The American Symphony Orchestra League.
Dancing tunes activity	<a href="http://www.isy.vcu.edu/~paiken/creativity/dogs/wftmsong/indexwftmsong.htm#Anchor-I've-23094">www.isy.vcu.edu/~paiken/creativity/dogs/wftmsong/indexwftmsong.htm#Anchor-I've-23094</a> <a href="http://judyanddavid.com/cma.html">judyanddavid.com/cma.html</a>	A site by Peter Aiken.
Write with word processor	<a href="http://www.spasoft.co.uk/writeon.html">www.spasoft.co.uk/writeon.html</a>	SPAssoft produces educational programs for school teachers and children.
Read interactive storybook	<a href="http://www.antelope-ebooks.com/CHILDPIX/pickle1.html">www.antelope-ebooks.com/CHILDPIX/pickle1.html</a>	Antelope Publishing is a publisher of browser readable e-books.
Word puzzle	<a href="http://kidsdomain.funschool.com/current/games/xw1_ds1,1">kidsdomain.funschool.com/current/games/xw1_ds1,1</a> <a href="http://www.kidsdomain.com/holiday/fall/games/word2.html">www.kidsdomain.com/holiday/fall/games/word2.html</a>	A dedicated children's site managed and created by Kaboose Inc.
Maths solving or	<a href="http://kidsdomain.funschool.com/current/g">kidsdomain.funschool.com/current/g</a>	A dedicated children's site



Appendix A: Descriptions of owners of existing activity initiatives

maths games	ames/ag1_ds1,1	managed and created by Kaboose Inc.
Strategy games	www.familygames.com/free/ptt.html	A site by Jake Donham.
Mysteries games	www.w3c2.com.au/onthejob/game/ www.thecase.com/kids/aol	World wide Website Creation and Consulting is a division of Moore Technology Ltd. Based in Australia.
Interactive arcade games	www.funschool.com/current/games/arcade_sk2_skigame,k	A dedicated children's site managed and created by Kaboose Inc.
Physical activity	<ul style="list-style-type: none"> <li>▪ www.sikids.com/games/breakaway/breakaway.html</li> <li>▪ www.sikids.com/games/index.html</li> </ul>	Sikids.com is the on-line counterpart to Sports Illustrated for Kids Magazine, based in New York city.
Drill and practice program	<ul style="list-style-type: none"> <li>▪ kidsdomain.funschool.com/current/games/fgk_1bgd,mg</li> <li>▪ kidsdomain.funschool.com/current/games/plk_ds1,k</li> </ul>	A dedicated children's site managed and created by Kaboose Inc.
Digital diary	www.ajebe.com	A site created by Adrie Berg and it is a free program.
Concentration games	kidsdomain.funschool.com/current/games/cnk_ds4,1	A dedicated children's site managed and created by Kaboose Inc.
Email for children	www.headbone.com/friends/mail	Headbone.com is a registered trademark of Bonus.com, Inc. It is a Web site focussed on building technology for children ages 8-14.
Voice chat for children	www.talkme.com	Talkme is a free plug-in to enable verbal chat.
Multiplayer games	play.yahoo.com/games/yahooligans.html	Yahooligans is a trademark of Yahoo! Inc. and is a Web guide for children.



APPENDIX B

This letter is to thank Mr/Mrs/Miss

for attending a one-day workshop entitled *Developing Electronic Books for Children*

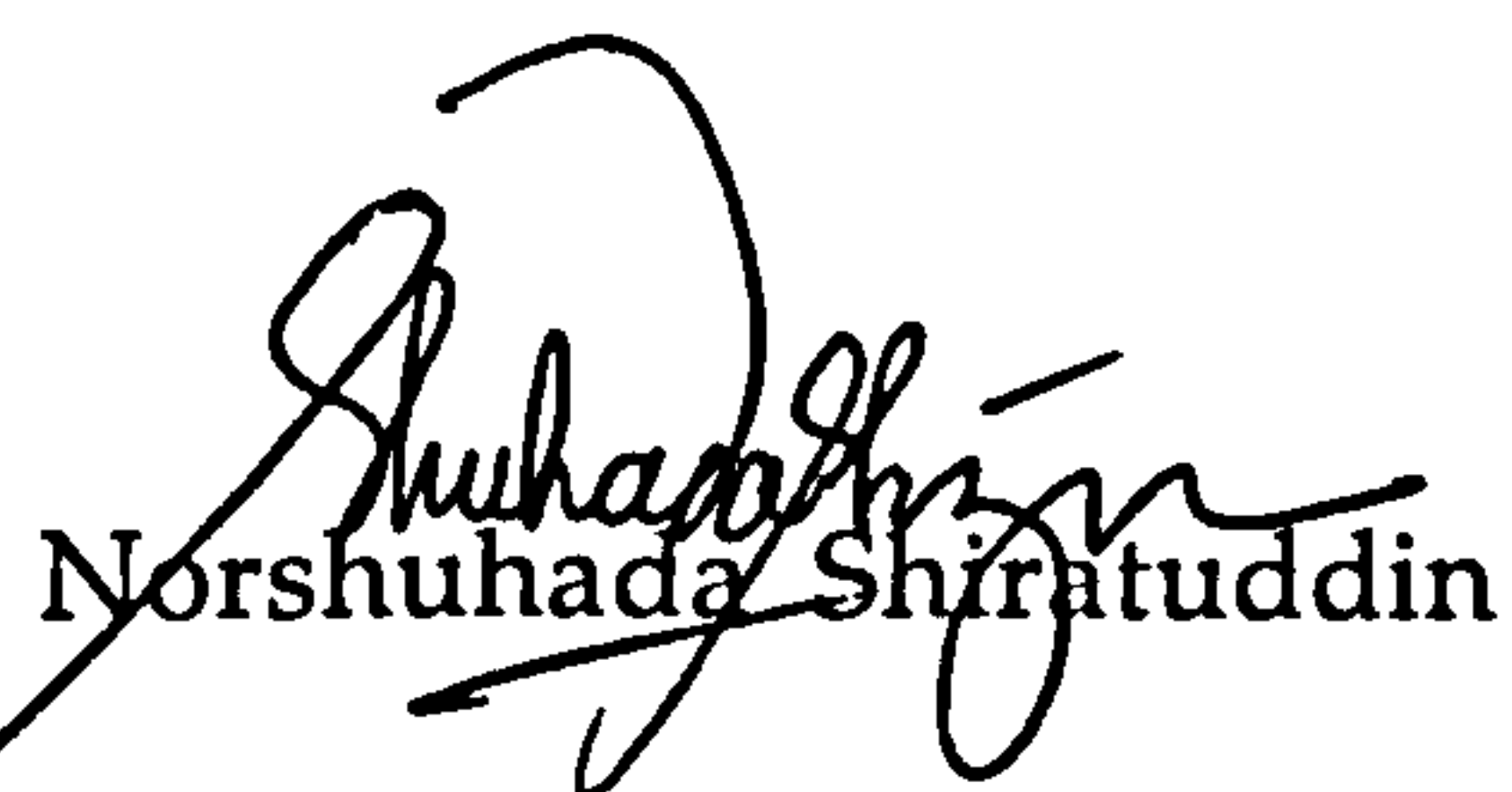
on \_\_\_\_\_ at \_\_\_\_\_

His/her participation is highly appreciated and acknowledged as a valuable contribution to a research (*Electronic Books for Children*) conducted by researchers' at the Department of Information Science, University of Strathclyde, Glasgow, Scotland, United Kingdom.

Thank you.

  
Monica Landoni, PhD

Date \_\_\_\_\_

  
Norshuhada Shiratuddin

Date \_\_\_\_\_

A PLACE OF USEFUL LEARNING SINCE 1796

Department of

**INFORMATION**  
*Science*



INVESTOR IN PEOPLE

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Web: <http://www.dis.strath.ac.uk/> 289

VAT No GB 261 3397 62



## APPENDIX C

### List of Schools and Institutions Involved in EBoChi

1. Sek. Keb. Tunku Abd. Halim, Alor Setar
2. Sek. Keb. Taman Rakyat, Alor Setar
3. Sek. Keb. Taman Uda, Alor Setar
4. Sek. Ren. Jenis Keb. (Tamil) Barathy, Alor Setar
5. Sek. Keb. Haji Mohd Shariff, Alor Setar
6. Sek. Keb. Sultan Ahmad Tajuddin, Jitra
7. Sek. Keb. Bandar Baru, Sungai Lalang
8. Sek. Keb. Seksyen 17, Shah Alam
9. Sek. Keb. Kampung Betong
10. Sek. Keb. Kem Lapangan Terbang
11. Sek. Keb. Guar Chempedak
12. Sek. Keb. Bukit Selarong
13. Sek. Keb. Sungai Pasir
14. Sek. Keb. Ara Rendang
15. Sek. Keb. Kota Kuala Muda
16. Sek. Keb. Jeneri
17. Sek. Keb. Simpang
18. Sek. Keb. Sri Gedong
19. Sek. Keb. Taman Ria, Padang Serai
20. Sek. Keb. Bayan Baru, Pulau Pinang
21. Sek. Keb. Tiak, Kupang
22. Sek. Keb. St. Theresa, Sungai Petani
23. Sek. Keb. Pendidikan Khas
24. Sek. Keb. Gurun
25. Sek. Keb. Jaya Setia, Selangor
26. Sek. Keb. Danglau, Sik
27. Sek. Keb. Tuan Syed Al-Jaffri, Sungai Petani
28. Sek. Keb. Keruh, Pengkalan Hulu, Perak
29. Sek. Ren. Jenis Keb. (Cina) Tai Tong, Sungai Pasir
30. Sek. Keb. Ulu Tawar, Karangan
31. Sek. Keb. Sik Dalam, Sik
32. Maktab Perguruan Sultan Abd. Halim
33. Maktab Perguruan Persekutuan, Pulau Pinang
34. Pusat Sumber Pendidikan Negeri Kedah
35. Sek. Keb. Dato' Wan Kemara, Changlun \*
36. Sek. Keb. Hosba, Jitra \*

Note: \* school visited but did not participate

## APPENDIX D

### Results of Pilot Study

Five teachers were informed about the purpose of the study and the questionnaire (see Appendix F). The purpose of showing the pilot questionnaire to the teachers was to ascertain any ambiguous questions, appropriateness of the content of the questions, appearance and length of the questions. They were not presented with the early prototype of the e-book because the purpose of the pilot study with teachers was to find out the suitability of the questionnaire in collecting useful data to measure:

- relevance of e-book activities in children's development;
- perceived usefulness and ease of use of the e-book from the teachers' point of views.

### Result

All teachers agreed upon the questions asked in Part 1: Demographic data. However, after reading more on questionnaire design, question 6 was changed from

*Computer experience \_\_\_\_\_ years to*

*How often do you use a computer?*

- |             |                  |          |
|-------------|------------------|----------|
| <i>i.</i>   | <i>never</i>     | <i>1</i> |
| <i>ii.</i>  | <i>sometimes</i> | <i>2</i> |
| <i>iii.</i> | <i>daily</i>     | <i>3</i> |

The appearance and wordings of Part II, III, IV, V and VI were widely accepted. However, teachers were most of the time in the dark about the meaning of tools in Section V. For example, what does “*Animation*” in question V5 or “*Music Reading*” in question M4 mean? They suggested additional information or descriptions of each tool with examples to be included in the questionnaire or on a separate paper. In addition, teachers also requested the questions to be translated into Malay language (just to make sure they really understand the questions). In part VI, where questions asked are to measure teachers' perceived usefulness and ease of use, questions 9 (*My interaction with this e-book is clear and understandable*) and 10 (*I would find this e-book to be flexible to interact with*) were difficult to be interpreted by the teachers. They failed to understand the meaning of *clear*, *understandable* and *flexible* in the context of their job. In view of this, when the final evaluation took place, each statement in Part VI was first explained and examples of situation were described.



## APPENDIX E

Department of Information Science, Strathclyde University, Glasgow, UK

## Observation form – children use Book Builder

(Soal selidik pemerhatian kanak-kanak menggunakan Book Builder)

## Background (Latar belakang)

1. Gender (Jantina)      1.1 Male (Lelaki)      1.2 Female (Perempuan)
2. Age (Umur) \_\_\_\_\_ years (tahun)
3. Have you used a computer before (Pernah menggunakan komputer)?    3.1 No (Tidak)    3.2 Yes (Ya)
4. If yes, for how long (Jika ya, berapa lama)? \_\_\_\_\_ years (tahun)
5. If yes, for what purpose (Jika ya, apa tujuannya)?    5.1 Games (Permainan)    5.2 CD titles (CD-ROM pembelajaran)    5.3 Internet    5.4 Others (Lain-lain) such as typing, drawing

## Book Builder

6. Learning time (Masa belajar guna) \_\_\_\_\_ minutes  
(\_\_\_\_\_ begin (mula): \_\_\_\_\_ end (tamat))
7. Number of questions asked during learning (Jumlah soalan ditanya semasa sedang belajar)
8. Number of questions asked during building (Jumlah soalan ditanya semasa sedang membina)
9. Building time (Masa digunakan untuk membina buku) \_\_\_\_\_ minutes  
(\_\_\_\_\_ begin (mula): \_\_\_\_\_ end (tamat))
10. Ability to build book (Kebolehan membina buku):  
10.1 Fail (Gagal)    10.2 Good (Baik)    10.3 Excellent (Sangat baik)
11. Is Book Builder (Adakah Book Builder)?  
11.1 Hard (Susah)    11.2 Easy (Agak mudah)    11.3 Very easy (Sangat mudah)
12. Would you like to use it to build books or write stories (Adakah anda berminat menggunakannya untuk menulis buku atau mengarang cerita)?  
12.1 No (Tidak)      12.2 May be (Mungkin)      12.3 Yes (Minat)

## Additional Notes (Nota Tambahan)

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## APPENDIX F

Respondent No:



Department of Information Science, University of Strathclyde, Glasgow, UK.

**Teachers' Perceived Usefulness and Ease-of-Use  
of Electronic Textbook Prototype**

Thank you for participating in this research. The purposes of this questionnaire are:

- to collect information regarding teachers' perceived usefulness of a proposed electronic textbook concept in catering for children's different learning styles;
- to gather data about the usefulness of functions in a program called Book Builder;
- to measure teachers' opinion on new functions suggested in this study.

This questionnaire consists of 6 sections. Please read the instructions in each section carefully.

**Part I: PARTICIPANT BACKGROUND**

Please answer all questions by:

- Circling **only ONE** of the options for question 1,3,5,6, 8 and 9
- Writing the answer for question 2, 4 and 7

1. Gender:

Male = 1.1      Female = 1.2

2. Age \_\_\_\_\_ years

3. Ethnic origin

Malay = 3.1      Chinese = 3.2      Indian = 3.3      Others = 3.4

4. Teaching experience \_\_\_\_\_ years

5. Subject area/s:

- Malay language      5.1
- English language      5.2
- Mathematics      5.3
- Science      5.4
- Computer      5.5
- History      5.6
- Geography      5.7
- Religion      5.8
- Others      5.9:      please specify \_\_\_\_\_

6. How often do you use a computer?

Never = 6.1 (go to question 9)      Sometimes = 6.2      Daily = 6.3

7. How long have you been using computers? \_\_\_\_\_ years

8. Do you have experience in using multimedia authoring software (e.g. Director, Authorware, HyperCard)?

Yes = 8.1      No = 8.2

9. Your school location

Rural = 9.1      Urban = 9.2



## Part II: TASKS

Please read these instructions and conduct these tasks before continuing to other sections.

- i. Open Book Builder program by double clicking this icon on the desktop.



- ii. When you are ready to use the program, please create a book made of 4 pages following these steps:
- Insert first page of type **text and graphic** (type any text and import any graphic file);
  - Insert second page of type **text only** (type any text);
  - Insert third page of type **text and audio** (type any text and import any audio file);
  - Insert fourth page of type **text and video** (type any text and import any video file);
- iii. Add a cover and back page.
- iv. Add a Table of Contents (TOC).
- v. Set hyperlinks from TOC to appropriate page.
- vi. Go to Read Mode and read your book using 3 different types of page turning approach (with arrows, space and automatic).
- vii. Set a bookmark on page 2.
- viii. Without deleting the bookmark on page 2, set another bookmark on page 4.
- ix. Go to page 3, then use the read-aloud function.
- x. Insert an annotation on page 1.
- xi. Perform a text search activity (for any word that you have written).
- xii. Print your book.
- xiii. Finally, export your book into HTML mode and try using it.

**Part III: BOOK CREATE MODE**

Please answer all questions by circling only **ONE** of the options. All listed questions refer to functionality provided in the program. Words written in *italics* are functions, which are NOT currently available in the program. Please give your opinion.

10. How useful are the following functions in the **File** menu for creating a multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
cf1	New book	1	2	3	4	5
cf2	Open book	1	2	3	4	5
cf3	Save book	1	2	3	4	5
cf4	Save book as	1	2	3	4	5
cf5	Close book	1	2	3	4	5
cf6	Export as HTML	1	2	3	4	5
cf7	Print	1	2	3	4	5
cf8	Printer Setting	1	2	3	4	5
cf9	Exit	1	2	3	4	5
cf10	<i>Export as HTML &amp; maintain book metaphor (i.e. has front cover, TOC, chapters, sub sections, two-page display, etc.)</i>	1	2	3	4	5

Other suggestions? \_\_\_\_\_

11. How useful are the following functions in the **Edit** menu for creating a multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
ce1	Undo	1	2	3	4	5
ce2	Cut	1	2	3	4	5
ce3	Copy	1	2	3	4	5
ce4	Paste	1	2	3	4	5
ce5	<i>Hyperlink (add)</i>	1	2	3	4	5
ce6	<i>Hyperlink (remove)</i>	1	2	3	4	5

Other suggestions? \_\_\_\_\_



12. How useful are the following functions in the **Book** menu for creating a multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
cb1	Background music (add/remove)	1	2	3	4	5
cb2	Show page numbers	1	2	3	4	5
cb3	Read book	1	2	3	4	5
cb4	Lock book	1	2	3	4	5
cb5	Import book	1	2	3	4	5
cb6	<i>Read aloud</i> (make the function easily visible to users, possibly with an icon, because currently this function is activated only by right clicking the mouse button)	1	2	3	4	5
cb7	<i>Option of not wanting page number on Cover page</i>	1	2	3	4	5

Other suggestions? \_\_\_\_\_

13. How useful are the following functions in the **Page** menu for creating a multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
cp1	Insert new page	1	2	3	4	5
cp2	Delete page (left/right/undo)	1	2	3	4	5
cp3	First page	1	2	3	4	5
cp4	Previous page	1	2	3	4	5
cp5	Next page	1	2	3	4	5
cp6	Last page	1	2	3	4	5
cp7	Go To page	1	2	3	4	5
cp8	Choose sound (left/right)	1	2	3	4	5
cp9	Choose video (left/right)	1	2	3	4	5
cp10	Bookmark	1	2	3	4	5
cp11	<i>Insert cover or back page</i>	1	2	3	4	5
cp12	<i>Insert verso page</i>	1	2	3	4	5
cp13	<i>Insert TOC page</i>	1	2	3	4	5
cp14	<i>Insert background image</i>	1	2	3	4	5

Other suggestions? \_\_\_\_\_

14. How useful are the following functions in the **Tools** menu for creating a multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
ct1	Picture tool	1	2	3	4	5
ct2	Text tool	1	2	3	4	5
ct3	Sound tool	1	2	3	4	5
ct4	Video tool	1	2	3	4	5
ct5	<i>Animation tool</i>	1	2	3	4	5
ct6	<i>3D tool</i>	1	2	3	4	5
ct7	<i>Activity tools</i> (these will be tools that help teachers create activities for children such as: <i>jigsaw puzzle builder; word puzzle builder; colouring games builder; music making builder; mathematics and logic games; sing along builder; interactive quiz builder; interactive games builder, etc.)</i>	1	2	3	4	5

Other suggestions? \_\_\_\_\_



**Part IV: BOOK READ MODE**

Please answer all questions by circling **only ONE** of the options. All listed questions refer to functionality provided in the program. Words written in *italics* are functions, which are NOT currently available in the program. Please give your opinion.

15. How useful are the following functions in the **File** menu for reading a created multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
rf1	Edit book	1	2	3	4	5
rf2	Exit Book Builder	1	2	3	4	5
rf3	<i>Read in HTML mode (i.e. using browsers)</i>	1	2	3	4	5
rf4	<i>Print book</i>	1	2	3	4	5

Other suggestions? \_\_\_\_\_

16. How useful are the following functions in the **Page** menu for reading a created multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
rp1	First page (+ icon)	1	2	3	4	5
rp2	Previous page (+ icon)	1	2	3	4	5
rp3	Next page (+ icon)	1	2	3	4	5
rp4	Last page (+ icon)	1	2	3	4	5
rp5	Go To page (+ icon)	1	2	3	4	5
rp6	<i>Insert annotation (+ icon)</i>	1	2	3	4	5
rp7	<i>Insert notes (+ icon)</i>	1	2	3	4	5
rp8	<i>Bookmark /s (insert/remove)</i> <i>(make it possible to insert more than one bookmark) (+ icon)</i>	1	2	3	4	5
rp9	<i>Zoom (+ icon)</i>	1	2	3	4	5
rp10	<i>Go To TOC (+ icon)</i>	1	2	3	4	5
rp11	<i>Search (+ icon)</i>	1	2	3	4	5

Other suggestions? \_\_\_\_\_

17. How useful are the following functions in the **Settings** menu for reading a created multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
rs1	Turn page (with arrows, space, automatic turning)	1	2	3	4	5
rs2	Background music (add/remove)	1	2	3	4	5
rs3	<i>Read aloud</i>	1	2	3	4	5

Other suggestions? \_\_\_\_\_

18. Overall how would you rate this program for children's and schoolteachers' use?

- poor and inadequate 1
- adequate, needs enhancement 2
- excellent, does not need modification 3

19. Should this program be implemented in schools?

No = 1                      Not sure = 2                      Yes = 3

20. Would you consider using this program?

No = 1                      Yes = 2

### Part V: BOOK ACTIVITIES

Please answers all questions by circling **only ONE** of the options.

21. How useful are the following tools for catering for children's **visual** development?

N	Tool	Not useful at all	Not useful	Not sure	Useful	Very useful
v1	Draw programs (i.e. allow users to draw)	1	2	3	4	5
v2	Paint programs (e.g. colouring activity)	1	2	3	4	5
v3	Electronic puzzle kits (e.g. jigsaw puzzle)	1	2	3	4	5
v4	Clip Art programs (i.e. users can select clip arts for their purpose)	1	2	3	4	5
v5	Animation (animation that goes with content of page)	1	2	3	4	5

Other suggestion? \_\_\_\_\_



## 22. How useful are the following tools for catering for children's musical development?

N	Tool	Not useful at all	Not useful	Not sure	Useful	Very useful
m1	Music making instrument (e.g. play digital guitar or piano)	1	2	3	4	5
m2	Sing along activity (e.g. karaoke activity)	1	2	3	4	5
m3	Music Games (e.g. computer play a tune, then users try to copy the tune)	1	2	3	4	5
m4	Music Reading (e.g. learn how to read music notes)	1	2	3	4	5
m5	Audio/music Listening (e.g. content is read aloud by computer)	1	2	3	4	5
m6	Dancing Notes (e.g. computer play a tune then users learn how to dance to the tune)	1	2	3	4	5
m7	Voice recorder (e.g. users can record their voice and then playback)	1	2	3	4	5
m8	Background music	1	2	3	4	5
m9	Sound effect	1	2	3	4	5

Other suggestion? \_\_\_\_\_

## 23. How useful are the following tools for catering for children's verbal development?

N	Tool	Not useful at all	Not useful	Not sure	Useful	Very useful
vb1	Word processing programs (e.g. ask users to write a story)	1	2	3	4	5
vb2	Typing tutors (e.g. teach users to type or detect misspelled words)	1	2	3	4	5
vb3	Interactive storybooks (e.g. digital storybooks where users can read, may be their own work)	1	2	3	4	5
vb4	Word Games (e.g. word puzzles)	1	2	3	4	5

Other suggestion? \_\_\_\_\_

24. How useful are the following tools for catering for children's **mathematical and logical** development?

N	Tool	Not useful at all	Not useful	Not sure	Useful	Very useful
m11	Mathematical skills tutorials	1	2	3	4	5
m12	Strategy game (e.g. tic tac toe)	1	2	3	4	5
m13	Solving mysteries (e.g. digital treasure hunt activity)	1	2	3	4	5
m14	Math Paint (e.g. for every correct answer to a math question, users select an area to paint)	1	2	3	4	5

Other suggestion? \_\_\_\_\_

25. How useful are the following tools for catering for children's **physical** development?

N	Tool	Not useful at all	Not useful	Not sure	Useful	Very useful
py1	Motion-simulation games (e.g. car racing games)	1	2	3	4	5
py2	Virtual-reality game (e.g. 3D games)	1	2	3	4	5
py3	Eye-hand co-ordination games (e.g. car racing games)	1	2	3	4	5
py4	Input-device games (e.g. games using joystick)	1	2	3	4	5
py5	Physical activity tutorials (e.g. ask users to do gym activity)	1	2	3	4	5

Other suggestion? \_\_\_\_\_

26. How useful are the following tools for catering for children's **personal** development?

N	Tool	Not useful at all	Not useful	Not sure	Useful	Very useful
ps1	Self-paced drill and practice (e.g. quiz)	1	2	3	4	5
ps2	Digital Diary (e.g. a section where users write down their own thoughts)	1	2	3	4	5
ps3	Game, computer is opponent (e.g. spot the difference games, digital chess)	1	2	3	4	5

Other suggestion? \_\_\_\_\_



27. How useful are the following tools for catering for children's **communicative** development?

N	Tool	Not useful at all	Not useful	Not sure	Useful	Very useful
ip1	Email (e.g. allow users to communicate with friends)	1	2	3	4	5
ip2	Multi Player games (e.g. play chess with friends in other schools)	1	2	3	4	5
ip3	Chatting programs	1	2	3	4	5
ip4	Links to other learning sites	1	2	3	4	5

Other suggestion? \_\_\_\_\_

28. Tools which let teachers build all the above activities **automatically** (e.g. jigsaw puzzle builder, word puzzle builder, colouring games builder, music making builder, sing along builder, interactive quiz builder, interactive games builder, etc.) should be made available in the program?

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
1	2	3	4	5





## APPENDIX G



**Department of Information Science, University of Strathclyde, Glasgow, UK.**

### Expert Reviewers Questionnaire

The electronic version of this questionnaire can be found at  
<http://personal.dis.strath.ac.uk/people/shuhada/Projck/online-survey/ebook.html>

Thank you for participating in this research. The purpose of this questionnaire is to collect information regarding your reviews as an expert on the features and functions in Book Builder, an authoring program for children to create multimedia books. An apparent difference of this program compared to others is its feature which lets users create electronic contents and present them using a book metaphor. We are trying to find the usefulness of existing and additional functions that are suggested here for an e-textbook builder. This questionnaire is divided into 4 sections: Background, Tasks, Book Create-Mode and Book Read-Mode.

Please take time to go through the tasks in Part II. Your contribution is highly appreciated. If you need more information regarding this study (e.g. its objectives, purposes and so on), please go to <http://personal.dis.strath.ac.uk/people/shuhada/personal-web-pages/phdresearch.htm>

#### **Part I: EXPERT BACKGROUND**

Please answers all questions by:

- Circling only **ONE** of the options for question 1,3,5,6, 8 and 9
- Writing the answer for question 2, 4 and 7

1. Gender:

Male = 1.1      Female = 1.2

2. Academic level:      PhD = 2.1      Masters = 2.2      Bachelor = 2.3

3. Experience in e-book area (either using or developing): \_\_\_\_\_ years

4. How do you rate your expertise in e-book issues (such as current technology, design and development, evaluation)?

Moderate = 4.1      Expert = 4.2      Highly expert = 4.3

5. What is your current position in your workplace? \_\_\_\_\_

**Part II: TASKS**

Please read these instructions and conduct these tasks before continuing to sections III and IV.

- i. Go to <http://www.spasoft.co.uk/bookbuilder.html> and download the Free Demo version of the program. Please NOTE that this program runs only in Windows 95 and above environments.
- ii. When you are ready to use the program, please create a book made of 4 pages following these steps:
  - Insert first page of type **text and graphic** (type any text and import any graphic file);
  - Insert second page of type **text only** (type any text);
  - Insert third page of type **text and audio** (type any text and import any audio file);
  - Insert fourth page of type **text and video** (type any text and import any video file);
- iii. Add a cover and back page.
- iv. Add a Table of Contents (TOC).
- v. Set hyperlinks from TOC to appropriate page (take note whether you are able to do it or not).
- vi. Go to Read Mode and read your book using 3 different types of page turning approach (with arrows, space and automatic).
- vii. Set a bookmark on page 2.
- viii. Without deleting the bookmark on page 2, set another bookmark on page 4 (take note whether you are able to do it or not).
- ix. Go to page 3, then use the read-aloud function.
- x. Insert an annotation on page 1 (take note whether you are able to do it or not).
- xi. Perform a text search activity (for any word that you have written) (take note whether you are able to do it or not).
- xii. Print your book.
- xiii. Finally, export your book into HTML mode and try using it.



**Part III: BOOK CREATE MODE**

Please answer all questions by circling **only ONE** of the options. All listed questions refer to functionality provided in the program. Words written in *italics* are functions, which are NOT currently available in the program. Please give your opinion.

6. How useful are the following functions in the **File** menu for creating a multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
cf1	New book	1	2	3	4	5
cf2	Open book	1	2	3	4	5
cf3	Save book	1	2	3	4	5
cf4	Save book as	1	2	3	4	5
cf5	Close book	1	2	3	4	5
cf6	Export as HTML	1	2	3	4	5
cf7	Print	1	2	3	4	5
cf8	Printer Setting	1	2	3	4	5
cf9	Exit	1	2	3	4	5
cf10	<i>Export as HTML &amp; maintain book metaphor (i.e. has front cover, TOC, chapters, sub sections, two-page display, etc.)</i>	1	2	3	4	5

Other suggestions? \_\_\_\_\_

7. How useful are the following functions in the **Edit** menu for creating a multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
ce1	Undo	1	2	3	4	5
ce2	Cut	1	2	3	4	5
ce3	Copy	1	2	3	4	5
ce4	Paste	1	2	3	4	5
ce5	<i>Hyperlink (add)</i>	1	2	3	4	5
ce6	<i>Hyperlink (remove)</i>	1	2	3	4	5

Other suggestions? \_\_\_\_\_

8. How useful are the following functions in the **Book** menu for creating a multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
cb1	Background music (add/remove)	1	2	3	4	5
cb2	Show page numbers	1	2	3	4	5
cb3	Read book	1	2	3	4	5
cb4	Lock book	1	2	3	4	5
cb5	Import book	1	2	3	4	5
cb6	<i>Read aloud</i> (make the function easily visible to users, possibly with an icon, because currently this function is activated only by right clicking the mouse button)	1	2	3	4	5
cb7	<i>Option of not wanting page number on Cover page</i>	1	2	3	4	5

Other suggestions? \_\_\_\_\_

9. How useful are the following functions in the **Page** menu for creating a multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
cp1	Insert new page	1	2	3	4	5
cp2	Delete page (left/right/undo)	1	2	3	4	5
cp3	First page	1	2	3	4	5
cp4	Previous page	1	2	3	4	5
cp5	Next page	1	2	3	4	5
cp6	Last page	1	2	3	4	5
cp7	Go To page	1	2	3	4	5
cp8	Choose sound (left/right)	1	2	3	4	5
cp9	Choose video (left/right)	1	2	3	4	5
cp10	Bookmark	1	2	3	4	5
cp11	<i>Insert cover or back page</i>	1	2	3	4	5
cp12	<i>Insert verso page</i>	1	2	3	4	5
cp13	<i>Insert TOC page</i>	1	2	3	4	5
cp14	<i>Insert background image</i>	1	2	3	4	5

Other suggestions? \_\_\_\_\_



## 10. How useful are the following functions in the Tools menu for creating a multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
ct1	Picture tool	1	2	3	4	5
ct2	Text tool	1	2	3	4	5
ct3	Sound tool	1	2	3	4	5
ct4	Video tool	1	2	3	4	5
ct5	<i>Animation tool</i>	1	2	3	4	5
ct6	<i>3D tool</i>	1	2	3	4	5
ct7	<i>Activity tools</i> (these will be tools that help teachers create activities for children such as: <i>jigsaw puzzle builder; word puzzle builder; colouring games builder; music making builder; mathematics and logic games; sing along builder; interactive quiz builder; interactive games builder, etc.</i> )	1	2	3	4	5

Other suggestions? \_\_\_\_\_

**Part IV: BOOK READ MODE**

Please answer all questions by circling **only ONE** of the options. All listed questions refer to functionality provided in the program. Words written in *italics* are functions, which are NOT currently available in the program. Please give your opinion.

11. How useful are the following functions in the **File** menu for reading a created multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
rf1	Edit book	1	2	3	4	5
rf2	Exit Book Builder	1	2	3	4	5
rf3	<i>Read in HTML mode (i.e. using browsers)</i>	1	2	3	4	5
rf4	<i>Print book</i>	1	2	3	4	5

Other suggestions? \_\_\_\_\_

12. How useful are the following functions in the **Page** menu for reading a created multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
rp1	First page (+ icon)	1	2	3	4	5
rp2	Previous page (+ icon)	1	2	3	4	5
rp3	Next page (+ icon)	1	2	3	4	5
rp4	Last page (+ icon)	1	2	3	4	5
rp5	Go To page (+ icon)	1	2	3	4	5
rp6	<i>Insert annotation (+ icon)</i>	1	2	3	4	5
rp7	<i>Insert notes (+ icon)</i>	1	2	3	4	5
rp8	<i>Bookmark /s (insert/remove)</i> <i>(make it possible to insert more than one bookmark) (+ icon)</i>	1	2	3	4	5
rp9	<i>Zoom (+ icon)</i>	1	2	3	4	5
rp10	<i>Go To TOC (+ icon)</i>	1	2	3	4	5
rp11	<i>Search (+ icon)</i>	1	2	3	4	5

Other suggestions? \_\_\_\_\_



13. How useful are the following functions in the Settings menu for reading a created multimedia book?

N	Tool	Not useful at all	Not useful	Neither	Useful	Very useful
rs1	Turn page (with arrows, space, automatic turning)	1	2	3	4	5
rs2	Background music (add/remove)	1	2	3	4	5
rs3	Read aloud	1	2	3	4	5

Other suggestions? \_\_\_\_\_

14. Overall how would you rate this program for children’s and school teachers’ use?

- poor and inadequate 14.1
- adequate, needs enhancement 14.2
- excellent, does not need modification 14.3

15. Would you consider using this program?

No = 15.1

Yes = 15.2

Please write any comments or suggestions here

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# Thank you for your time and cooperation

**Note:**

The electronic version of this questionnaire can be found at  
<http://personal.dis.strath.ac.uk/people/shuhada/Projek/online-survey/ebook.html>

## APPENDIX H

## Children's Tasks

1. Open the Book Builder program by double clicking this icon on the desktop.



2. When you are ready to use the program, please insert the first page of type **text only**.
3. Type "Once upon a time, there was a black spider. Its name was Mimi".
4. Insert the second page of type **text and graphic**.
5. Type "Mimi lived in a huge house in a small village".
6. Draw a spider using the drawing program (or you can import a spider image from the file c:\spider.jpg);
7. Insert the third page of type **text and audio**;
8. Type "Mimi had a younger sister. Her name was Mili".
9. Choose **Edit sound**.
10. Click on the **Record** icon and read this sentence "Hello. My name is Mini".
11. Press the **Stop** button.
12. Press the **Play** button.
13. Using the function **Save as** under **File**, save your audio file.
14. Insert the fourth page of type **text and video**.
15. Type "Both Mimi and Mili liked to make huge web. This is how they make the web".
16. Insert the video file c:\spiderweb.avi.
17. Insert the fifth page of type **text only**.
18. Type "A story by (write your name). The end".
19. Add a cover and back page.
20. Go to page 5. Change the size and colour of the words "The end".
21. Save your book.
22. Go to **Read Mode** and read your book using all 3 different types of page turning approach (with arrows, space and automatic).
23. Set a bookmark on page 2.
24. Go to page 3, then use the **Read aloud** function.
25. Print your book.



**APPENDIX I**

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## Reliability of USADDFN index (Teachers)

### RELIABILITY ANALYSIS - SCALE (ALPHA)

		Mean	Std Dev	Cases
1.	CF10	4.1351	.7514	37.0
2.	CED5	4.0270	.7633	37.0
3.	CED6	3.6757	.8836	37.0
4.	CB6	4.4865	.6507	37.0
5.	CB7	3.5676	1.0419	37.0
6.	CP11	4.3514	.6756	37.0
7.	CP12	3.9189	.6402	37.0
8.	CP13	3.8378	.6015	37.0
9.	CP14	4.2432	.5480	37.0
10.	CT5	4.3514	.7156	37.0
11.	CT6	4.2162	.7124	37.0
12.	CT7	4.5676	.5548	37.0
13.	RF3	4.0541	.7433	37.0
14.	RF4	4.0811	.6823	37.0
15.	RP6	4.1622	.7270	37.0
16.	RP7	4.1081	.7373	37.0
17.	RP8	4.2162	.8211	37.0
18.	RP9	4.1081	.8091	37.0
19.	RP10	3.8919	.7740	37.0
20.	RP11	4.1622	.7643	37.0
21.	RS3	4.5135	.6065	37.0

N of Cases = 37.0

Item Means Variance	Mean	Minimum	Maximum	Range	Max/Min
.0661	4.1274	3.5676	4.5676	1.0000	1.2803

Reliability Coefficients 21 items

Alpha = .8560                      Standardized item alpha = .8582



## Reliability of USACTYFN index (Teachers)

### RELIABILITY ANALYSIS - SCALE (ALPHA)

		Mean	Std Dev	Cases
1.	V1	4.3409	.6450	44.0
2.	V2	4.3409	.5258	44.0
3.	V3	4.3636	.5743	44.0
4.	V4	4.3864	.5377	44.0
5.	V5	4.4318	.5866	44.0
6.	M1	4.0909	.7093	44.0
7.	M2	4.1818	.6567	44.0
8.	M3	4.0682	.6954	44.0
9.	M4	3.9773	.6283	44.0
10.	M5	4.1364	.5537	44.0
11.	M6	3.6136	.7223	44.0
12.	M7	4.1591	.6801	44.0
13.	M8	4.1136	.7223	44.0
14.	M9	3.9091	.7414	44.0
15.	VB1	4.3409	.6450	44.0
16.	VB2	4.4318	.5866	44.0
17.	VB3	4.4091	.5421	44.0
18.	VB4	4.5000	.5498	44.0
19.	ML1	4.4773	.5902	44.0
20.	ML2	4.3636	.6503	44.0
21.	ML3	4.3636	.5743	44.0
22.	ML4	4.3636	.6135	44.0
23.	PY1	3.9545	.7138	44.0
24.	PY2	3.9545	.6804	44.0
25.	PY3	4.1364	.7342	44.0
26.	PY4	3.9091	.7721	44.0
27.	PY5	3.8409	.7759	44.0
28.	PS1	4.3864	.6182	44.0
29.	PS2	4.1136	.6547	44.0
30.	PS3	4.0909	.7093	44.0
31.	IP1	4.0227	.8209	44.0
32.	IP2	4.1136	.6893	44.0
33.	IP3	3.9318	.7894	44.0
34.	IP4	3.9318	.8183	44.0

N of Cases = 44.0

Item Means Variance	Mean	Minimum	Maximum	Range	Max/Min
.0480	4.1691	3.6136	4.5000	.8864	1.2453

Reliability Coefficients 34 items

Alpha = .9192                      Standardized item alpha = .9233

## Reliability of USBOOKFN index (Teachers)

### RELIABILITY ANALYSIS - SCALE (ALPHA)

		Mean	Std Dev	Cases
1.	CF1	4.5111	.5055	45.0
2.	CF2	4.3333	.5222	45.0
3.	CF3	4.2222	.5988	45.0
4.	CF4	4.2222	.6356	45.0
5.	CF5	3.9778	.6212	45.0
6.	CF6	4.1333	.7862	45.0
7.	CF7	4.1333	.6606	45.0
8.	CF8	4.0000	.6742	45.0
9.	CF9	4.3556	.5290	45.0
10.	CED1	4.3778	.6138	45.0
11.	CED2	4.1556	.7372	45.0
12.	CED3	4.3333	.6396	45.0
13.	CED4	4.1778	.7772	45.0
14.	CB1	4.4667	.5477	45.0
15.	CB2	4.4222	.6567	45.0
16.	CB3	4.5111	.5055	45.0
17.	CB4	4.1778	.7474	45.0
18.	CB5	4.3111	.6682	45.0
19.	CP1	4.5556	.5025	45.0
20.	CP2	4.3556	.6089	45.0
21.	CP3	4.4222	.5431	45.0
22.	CP4	4.4667	.5045	45.0
23.	CP5	4.4667	.5045	45.0
24.	CP6	4.2889	.5055	45.0
25.	CP7	4.4667	.5477	45.0
26.	CP8	4.3556	.5290	45.0
27.	CP9	4.3333	.5641	45.0
28.	CP10	4.4444	.5459	45.0
29.	CT1	4.5333	.5477	45.0
30.	CT2	4.4222	.6212	45.0
31.	CT3	4.2889	.5886	45.0
32.	CT4	4.2667	.6179	45.0
33.	RF1	4.2222	.4204	45.0
34.	RF2	4.2667	.4472	45.0
35.	RP1	4.0667	.4954	45.0
36.	RP2	4.1111	.6113	45.0
37.	RP3	4.1778	.5347	45.0
38.	RP4	3.9333	.7804	45.0
39.	RP5	4.1333	.6252	45.0
40.	RS1	4.3556	.6089	45.0
41.	RS2	4.4222	.4995	45.0

N of Cases = 45.0

Item Means Variance	Mean	Minimum	Maximum	Range	Max/Min
.0253	4.2970	3.9333	4.5556	.6222	1.1582

Reliability Coefficients 41 items

Alpha = .9342

Standardized item alpha = .9389



## Reliability of USEBOOK index (Teachers)

RELIABILITY ANALYSIS - SCALE (ALPHA)

### Correlation Matrix

	USADDFN	USACTYFN	USBOOKFN
USADDFN	1.0000		
USACTYFN	.6284	1.0000	
USBOOKFN	.6676	.7314	1.0000

N of Cases = 57.0

### Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
USADDFN	8.5309	.4348	.6940	.4880	.8363
USACTYFN	8.4426	.4682	.7351	.5704	.7815
USBOOKFN	8.3839	.5400	.7733	.6064	.7696

Reliability Coefficients 3 items

Alpha = .8522 Standardized item alpha = .8621

## Reliability of USASSTTK index (Teachers)

### RELIABILITY ANALYSIS - SCALE (ALPHA)

#### Correlation Matrix

	US1	US2	US3	US4	US5
US1	1.0000				
US2	.6054	1.0000			
US3	.5109	.4144	1.0000		
US4	.5633	.5603	.5822	1.0000	
US5	.5736	.5319	.4935	.7618	1.0000
US6	.3165	.4044	.4908	.6271	.6876

#### US6

US6	1.0000
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N of Cases = 57.0

#### Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
US1	21.4561	7.1096	.6354	.5284	.8637
US2	21.2456	7.4029	.6246	.4459	.8660
US3	21.2982	7.3559	.6174	.4229	.8667
US4	21.3158	6.1485	.8041	.6658	.8336
US5	21.4737	5.9323	.7916	.6923	.8370
US6	21.2807	7.0269	.6424	.5475	.8626

Reliability Coefficients 6 items

Alpha = .8771 Standardized item alpha = .8764



## Reliability of EASETEAC index (Teachers)

RELIABILITY ANALYSIS - SCALE (ALPHA)

### Correlation Matrix

	ES1	ES2	ES3	ES4	ES5
ES1	1.0000				
ES2	.7463	1.0000			
ES3	.6081	.6850	1.0000		
ES4	.5212	.5841	.5462	1.0000	
ES5	.4067	.3949	.5088	.5103	1.0000
ES6	.4955	.6816	.6422	.5946	.4478
ES7	.2224	.3569	.3661	.5064	.3498

	ES6	ES7
ES6	1.0000	
ES7	.5404	1.0000

N of Cases = 54.0

### Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
ES1	24.3889	8.7327	.6614	.6000	.8620
ES2	24.2222	8.8176	.7752	.7100	.8417
ES3	24.1667	9.2736	.7439	.5818	.8470
ES4	24.1667	9.6887	.7085	.5210	.8528
ES5	24.1111	10.0629	.5513	.3536	.8716
ES6	24.1481	9.8267	.7429	.6143	.8505
ES7	24.0185	10.6223	.4730	.3673	.8795

Reliability Coefficients 7 items

Alpha = .8762 Standardized item alpha = .8794

## Reliability of USBOOKFN index (Experts)

### RELIABILITY ANALYSIS - SCALE (ALPHA)

		Mean	Std Dev	Cases
1.	CF1	4.5714	.5071	21.0
2.	CF2	4.3333	.4830	21.0
3.	CF3	4.4762	.5118	21.0
4.	CF4	4.2381	.7003	21.0
5.	CF5	4.5714	.5071	21.0
6.	CF6	4.1905	.4024	21.0
7.	CF7	4.5238	.5118	21.0
8.	CF8	4.2381	.5390	21.0
9.	CF9	4.3810	.4976	21.0
10.	CED1	4.0000	.7071	21.0
11.	CED2	4.1429	.4781	21.0
12.	CED3	4.1905	.5118	21.0
13.	CED4	4.3810	.4976	21.0
14.	CB1	4.0476	.7400	21.0
15.	CB2	4.1905	.5118	21.0
16.	CB3	4.4286	.5071	21.0
17.	CB4	4.3810	.6690	21.0
18.	CB5	4.1429	.4781	21.0
19.	CP1	4.3810	.4976	21.0
20.	CP2	4.3810	.5896	21.0
21.	CP3	4.5238	.6016	21.0
22.	CP4	4.3333	.5774	21.0
23.	CP5	4.4286	.5976	21.0
24.	CP6	4.2857	.4629	21.0
25.	CP7	4.4286	.5071	21.0
26.	CP8	4.3810	.5896	21.0
27.	CP9	4.2857	.4629	21.0
28.	CP10	4.4762	.5118	21.0
29.	CT1	4.5714	.5071	21.0
30.	CT2	4.5238	.5118	21.0
31.	CT3	4.2381	.6249	21.0
32.	CT4	4.3333	.4830	21.0
33.	RF1	4.3810	.7400	21.0
34.	RF2	4.3810	.5896	21.0
35.	RP1	4.2381	.4364	21.0
36.	RP2	4.2857	.4629	21.0
37.	RP3	4.1905	.4024	21.0
38.	RP4	4.2857	.4629	21.0
39.	RP5	4.2857	.4629	21.0
40.	RS1	4.5238	.5118	21.0
41.	RS2	4.6190	.4976	21.0

#### Reliability Coefficients

N of Cases = 21.0

N of Items = 41

Alpha = .9280



## Reliability of USADDFN index (Experts)

### RELIABILITY ANALYSIS - SCALE (ALPHA)

		Mean	Std Dev	Cases
1.	CF10	4.1905	.6796	21.0
2.	CED5	4.2381	.7003	21.0
3.	CED6	4.3810	.7400	21.0
4.	CB6	4.3333	.6583	21.0
5.	CB7	4.0000	1.0000	21.0
6.	CP11	4.3810	.5896	21.0
7.	CP12	4.3333	.4830	21.0
8.	CP13	4.1429	.7270	21.0
9.	CP14	4.5238	.6016	21.0
10.	CT5	4.5238	.6796	21.0
11.	CT6	4.3810	.5896	21.0
12.	CT7	4.4762	.6016	21.0
13.	RF3	4.2857	.6437	21.0
14.	RF4	4.3333	.5774	21.0
15.	RP6	4.3810	.5896	21.0
16.	RP7	4.4286	.5071	21.0
17.	RP8	4.5238	.5118	21.0
18.	RP9	4.2857	.7171	21.0
19.	RP10	4.5714	.5071	21.0
20.	RP11	4.5238	.5118	21.0
21.	RS3	4.4286	.5071	21.0

#### Reliability Coefficients

N of Cases = 21.0

N of Items = 21

Alpha = .8049

## Reliability of EASECHIL index (Children)

### RELIABILITY ANALYSIS - SCALE (ALPHA)

		Mean	Std Dev	Cases
1.	LEARNT	36.5333	14.5988	15.0
2.	QLEARN	8.7333	9.4224	15.0
3.	QBUILD	12.0667	8.2155	15.0
4.	BUILD	26.0000	8.9043	15.0

#### Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Alpha if Item Deleted
LEARNT	46.8000	438.8857	.8173	.6949
QLEARN	74.6000	716.2571	.6879	.7463
QBUILD	71.2667	836.2095	.5225	.8162
BUILD	57.3333	761.2381	.6338	.7721

#### Reliability Coefficients

N of Cases = 15.0

N of Items = 4

Alpha = .8140



Appendix J

EBoCHI (E-Books for Children)  
Teachers' Response Coding Form

Page No:

Respondent  
No.

Gd	Age	Etn	TE	SA	CE1	CE2	CE3	SL	CF1	CF2	CF3	CF4	CF5	CF6	CF7	CF8	CF9	CF10	CE1	CE2	CE3	CE4	CE5	CE6
CB1	CB2	CB3	CB4	CB5	CB6	CB7	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	CP9	CP10	CP11	CP12	CP13	CP14	CT1	CT2	CT3	CT4
CT5	CT6	CT7	RF1	RF2	RF3	RF4	RP1	RP2	RP3	RP4	RP5	RP6	RP7	RP8	RP9	RP10	RP11	RS1	RS2	RS3	Ovr1	Impl	Use	V1
V2	V3	V4	V5	M1	M2	M3	M4	M5	M6	M7	M8	M9	VB1	VB2	VB3	VB4	ML1	ML2	ML3	ML4	PY1	PY2	PY3	PY4
PY5	PS1	PS2	PS3	IP1	IP2	IP3	IP4	Atm	Us1	Us2	Us3	Us4	Us5	Us6	Es1	Es2	Es3	Es4	Es5	Es6	Es7			

Gd	Age	Etn	TE	SA	CE1	CE2	CE3	SL	CF1	CF2	CF3	CF4	CF5	CF6	CF7	CF8	CF9	CF10	CE1	CE2	CE3	CE4	CE5	CE6
CB1	CB2	CB3	CB4	CB5	CB6	CB7	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	CP9	CP10	CP11	CP12	CP13	CP14	CT1	CT2	CT3	CT4
CT5	CT6	CT7	RF1	RF2	RF3	RF4	RP1	RP2	RP3	RP4	RP5	RP6	RP7	RP8	RP9	RP10	RP11	RS1	RS2	RS3	Ovr1	Impl	Use	V1
V2	V3	V4	V5	M1	M2	M3	M4	M5	M6	M7	M8	M9	VB1	VB2	VB3	VB4	ML1	ML2	ML3	ML4	PY1	PY2	PY3	PY4
PY5	PS1	PS2	PS3	IP1	IP2	IP3	IP4	Atm	Us1	Us2	Us3	Us4	Us5	Us6	Es1	Es2	Es3	Es4	Es5	Es6	Es7			