

**ONLINE LEARNING COURSEWARE FOR THE  
JAVA PROGRAMMING LANGUAGE**

**By**

**BING WANG**

**Bachelor of Science  
Gansu Agricultural University  
Lanzhou, China  
1982**

**Master of Science  
University of Arkansas  
Fayetteville, Arkansas  
1995**

**Submitted to the Faculty of the  
Graduate College of the  
Oklahoma State University  
in partial fulfillment of  
the requirements for  
the Degree of  
MASTER OF SCIENCE  
May, 2000**

**ONLINE LEARNING COURSEWARE FOR THE  
JAVA PROGRAMMING LANGUAGE**

**Thesis Approved:**

*Jacquie E. France*  
\_\_\_\_\_  
Thesis Adviser

*J. Chandler*  
\_\_\_\_\_

*M. Samadzadeh-H.*  
\_\_\_\_\_

*Wayne B. Powell*  
\_\_\_\_\_  
Dean of the Graduate College

## ACKNOWLEDGMENTS

I would like expressing my deepest appreciation to my thesis advisor, Dr. Jacques E. LaFrance, for allowing me the opportunity of doing this thesis project and for giving valuable constructive comments, encouragement, wisdom, and patience for preparation of this thesis and throughout my graduate study at the Oklahoma State University. A special thanks is extended to Dr. John P. Chandler, Dr. Mansur H. Samadzadeh, Dr. Jing Peng, and Dr. K. M. George for their guidance and participation in the thesis committee and review the thesis.

I am also grateful and thankful to Mr. and Mrs. LaVerne Kleine and Mr. and Mrs. Bill Kennedy for their consistent support, encouragement, and love that will always be remembered.

Most heartfelt gratitude to my wife, Ping and my daughter, Sarah, their understanding, patience, challenge, encouragement, and love made every bit of this possible.

## TABLE OF CONTENTS

<b>CHAPTER 1 INTRODUCTION</b> .....	<b>1</b>
1.1 BACKGROUND .....	1
1.2 OBJECTIVE OF THE PROJECT.....	3
1.3 ORGANIZATION OF THE THESIS.....	3
<b>CHAPTER 2 REVIEW OF THE LITERATURE</b> .....	<b>5</b>
2.1 DESCRIPTION AND DEFINITION OF DISTANCE LEARNING .....	5
2.2 WEB-BASED INSTRUCTION AND ONLINE LEARNING COURSEWARE.....	10
2.3 AUTHORING TOOLS FOR ONLINE LEARNING SYSTEMS.....	13
2.4 JAVA PROGRAMMING LANGUAGE .....	16
<b>CHAPTER 3 COURSEWARE DEVELOPMENT</b> .....	<b>19</b>
3.1 COURSE SPECIFICATION DESIGN .....	19
3.2 COURSE INSTRUCTIONAL DESIGN .....	23
3.3 COURSE LAYOUT DESIGN.....	27
3.4 COURSE DEVELOPMENT AND TEST ENVIRONMENTS.....	47
<b>CHAPTER 4 CONCLUSION AND DISCUSSION</b> .....	<b>48</b>
<b>REFERENCES</b> .....	<b>50</b>

## CHAPTER I

### LIST OF FIGURES

1	THE MAIN BOOK CONTAINS SEVEN CHATERS .....	21
2	LINK TO QUIZ BOOK AT THE END OF THE EACH CHAPTER.....	25
3	LINK TO MAIN BOOK AT THE END OF EACH QUIZ.....	26
4	ORIGINAL TEMPLATE BACKGROUND .....	28
5	NEW CUSTOM BACKGROUND .....	28
6	MAIN BOOK BACKGROUND WITH OBJECTS.....	29
7	A TYPICAL QUIZ BOOK BACKGROUND WITH OBJECTS.....	29
8	THE "CONVENTION USED IN THIS TUTORIAL" PAGE LINKED BY "HELP" BUTTON....	31
9	EACH CHAPTER HAS A BRIEF INTRODUCTION.....	33
10	EACH CHPATER HAS A SUBMENU .....	34
11	EACH CHAPTER CONTAINS MULTIPLE PAGES OF CONTENT .....	35
12	PAGE OFTEN CONTAINS GRAPHICAL ILLUSTRATION.....	36
13	JAVA CODE FRAGMENTS ARE USED EXPLAIN THE CONCEPTS .....	37
14	JAVA APPLLET USED TO SHOW AWT COMPONENTS .....	38
15	QUIZ TYPE: SELECT ORDER OF TEXT .....	40
16	QUIZ TYPE: MATCH ITEMS .....	41
17	QUIZ TYPE: MULTIPLE CHOICE.....	42
18	QUIZ TYPE: DROP TARGET .....	43
19	QUIZ TYPE: TRUE / FALSE .....	44
20	QUIZ TYPE: FILL IN BLANK .....	45
21	A TYPICAL SCEEN SHOT WHEN CLICK "SHOW ANSWER" BUTTON.....	46

learning and as a communication device to improve the quality of teaching and

## CHAPTER I

18

Computers have been used in a variety of ways in education since the 1960s.

### INTRODUCTION

Initially, the use of computers was confined to a particular subject as a study tool. For

example, they have been used for modeling, computer-aided design (CAD), statistical

#### 1.1 Background

analysis, and information management in organizations and services.

Learning is a “*persisting change in human performance or performance potential ... [brought] about as a result of learner’s interaction with the environment*” (Driscoll, 1994).

A conventional learning system, which has been used by people for thousands of years, involves traditional instructor-led methods and print-based methods in which a learner reads a text that was prepared far in advance. Its instructional environment, either instructor-centered or student-centered, generally lacks interactivity, encourages passive learning and underserves the development of problem solving and other higher order intellectual skill (Hannum and Briggs, 1982).

Alternative learning methods have emerged as the technology advances to extend the scope of the traditional education systems. It is not a surprise for educators to embrace the new technology as a medium for supporting the teaching systems (Adamson-Macedo, 1996). There has been a globally growing interest in the possibilities that new technology offers for distance education. Online learning is one such technology-based instructional systems and is playing the central role in today’s distance learning education. It is “an exciting new way to create, deploy, and manage instructional materials using computers linked to the Internet or ... intranet” (Asymetrix Learning Systems, Inc., 1997). In this innovative learning system, computers are used as a vehicle

for learning and as a communication device to improve the quality of teaching and learning, to supplement the instructor's in-classroom instructional methods, or even as a direct replacement. Computers have been used in a variety of ways in education since the 1960s. Initially, the use of computers was confined to a particular subject as a study tool. For instance, they have been used for modeling, computer-aided design (CAD), statistical analysis, data processing and information handling in engineering and sciences. However, the uses of computers have expanded since the rapid growth of information technology (IT) in the 1980s (Jones, *et al.*, 1993). The emergence of the Internet, particularly World Wide Web (Web), coupled with the development of multimedia technologies has changed the traditional educational system dramatically (Crossman, 1997; Laws, 1996) and has provided an opportunity to develop a new learning experience not possible previously (Relan and Gillani, 1997).

Before the Internet became the ubiquitous network in the recent few years, the term computer-based courseware has had a relatively broad definition which has included any material of instruction administered by computer delivery systems such as a floppy disk or magnetic tape; a filmstrip or color slides for use on a computer-controlled device; a set of microfiche cards, a videotape or audio tape, and a set of printed materials (Bunderson, 1981). However, courseware today involves more features of interactivity. The interactive characteristics form the fundamental aspects that distinguish current courseware from the traditional formats (Parrott and Kok, 1997). Courseware has become the basis of computer-assisted teaching programs and has a wide variety of applications in various fields including degree-level higher educational programs and industrial on-the-job training. When delivered over Internet, online learning courseware

can provide a flexible, robust and scaleable electronic teaching model that can complement the instructor-led, in-classroom instructional methods, or even as a direct replacement for certain types of lecturing in a higher educational degree program (Coleman, *et al.*, 1998).

## 1.2 Objectives of the Project

The purposes of this project were to review the current developments of online learning technology and design a distributable courseware for the Java programming language. Specifically, the objectives include:

1. Present an overview of basic aspects of distance learning and online learning technologies.
2. Examine the options of authoring software for online learning technology, particular interest is on the Asymetrix ToolBook II application package.
3. Develop a tutorial application for the Java programming language as an alternative approach for learning Java.

## 1.3 Organization of the Thesis

This thesis is organized into four chapters:

Chapter 1, "Introduction." This chapter provides a general introduction to computer based learning systems and some basic concepts about online learning courseware.

Chapter 2, "Review of the Literature." This chapter is a comprehensive review of the related works. It covers the fundamentals of distance learning and the practical



considerations applied to the online learning systems. It also offers a general description of authoring tools used for Web-based learning systems, particularly the ToolBook II authoring package provided by Asymetrix Learning System, Inc. This chapter also reviews the Java programming language which is chosen to be the course content of the tutorial application in this project.

Chapter 3, "Courseware Design and Development." This chapter deals with the details of the structural design and interface development of the application courseware. Specific procedures carried out in design and implementation processes will be examined. An outline of contents for the tutorial application as well as some graphic illustrations of the courseware interface are presented in this part of this thesis.

Chapter 4, "Results and Conclusion." This chapter presents a summary for the project. The limitations of this project and the considerations for the possible future work are discussed.

## REVIEW OF THE LITERATURE

### 2.1 Description and Definition of Distance Learning

Traditional teaching systems use classroom instruction as a model stretching from instructor-centered to student-centered curriculum (Cuban, 1993) and have been considered a cause of a dysfunctional and even an obsolete educational system (Banathy, 1994; Reigeluth, 1994). Distance learning provides a different pedagogical environment and is an evolving paradigm of instruction and learning that attempts to overcome both the distance and time constraints found in traditional classroom teaching environments (Minoli, 1996; Porter, 1997). It encompasses a set of technologies that allow for a more equitable distribution of resources, as well as a more personalized learning experience with unrivalled flexibility.

The basic characteristics of distance learning include: self-scheduled, self-motivated, self-paced, free of or less traveling, flexible didactic models; and it is often technology-based and offers better knowledge retention, continuous availability, and a “friendly” learning environment (Brandt, 1993; Minoli, 1996).

The concept of distance learning is not a new one; its history is probably as old as the history of education itself. The first structured distance learning or correspondence course was offered by the Pitman Organization at the end of 19<sup>th</sup> century (Distance Learning, 1998). The Open University in United Kingdom (Benyon, 1997), the New Jersey Institute of Technology (Turoff and Hiltz, 1995), the Oklahoma State University

(Oklahoma Electronic Campus, 1999), and the University of Phoenix in the United States (Thomas *et al.*, 1998), are some examples where the distance learning technologies have been practiced for years. With the advent of new Internet technology and the needs of learners in a fast-paced community, distance learning has become a hot topic again in recent years. Jones International University, an online distance-education provider in Englewood, Colorado, has become the first Internet-only institution in the United States accredited to grant bachelor's degree (U.S. News and World Report, 1999). The renewed interest in distance learning has the potential to change public perception of education and its ongoing importance through our lives (Porter, 1997)

In her book, Porker (1997) indicates that the concept of distance learning refers to the instruction for both education ranging from elementary school to higher educational university programs, and training, which includes skill development and knowledge geared toward practical applications. It can involve the use of new technologies, innovation materials, and interactive instructional methods. The aim of distance learning is to deliver education or training to those who need it at the time they are needed, without requiring travel. To emphasize that the learning experience is interactive and technology-based, distance learning is sometimes called interactive distance learning (Minoli, 1996).

The opportunity and the challenge for distance learning now is to integrate computers and other advanced technologies. From simple mail-order correspondence courses, to on-line asynchronous courses using email, and now to synchronous multimedia courses, the degrees and ranges of technologies incorporated in a course determine the type of the distance learning programs. Based on the technology applied,

the common types of distance learning courses can be grouped into the following categories (Minoli, 1996; Porter, 1997).

*Correspondence courses:* Correspondence courses and independent studies have long been used to provide mail-order education that learners can complete wherever and whenever it is easiest for them. The effectiveness of this type of distance learning depends on the learners. It is generally good for people who thrive on independence and are motivated by a genuine interest in the instruction, because they can manage to complete a course quickly. Today's correspondence courses employ more diverse formats such as audiotape, videotapes, CDs, disks, and conventional printed documents.

*Broadcast Education:* Even though the correspondence courses are using some new media, the uses of those are limited without live instruction. Broadcast education uses a communication device such as radio or television to broadcast the instructional materials on a regular schedule. It usually can reach more learners and has been used by many universities for certificates or degree-programs.

*Teleconferences and Desktop Videoconferences:* Teleconferencing allows educators and trainers to present information via audio and video in real time as the simulation and support of face-to-face group interaction when the participants are not in the same place at the same time (Collis, 1994). The most common ways of the teleconferencing are the room-based video display system such as the television screen, and telephone contact between two or more sites. They are very important for educational institutions to deliver instruction to remote locations at a great distance (Foldvik and Walling, 1993). Desktop videoconferencing delivers video to the desktop and can link participants working at standalone computers to see and hear each other (Georganas,

1997). It requires a multimedia computer as well as a camera, a microphone, and software for video and audio transmission. Participants may be able to send e-mail to each other during the videoconference and share online documents. Desktop videoconferencing may take place from either home or office computers as soon as the required hardware and software becomes available, so learners usually do not need to travel to a predetermined site as they do for a teleconference. However, both teleconferencing and desktop videoconferencing require the participants to meet at a specific time and location (Porter, 1997; Sheldon, 1998). They typically involved use of end-to-end circuit switched and packet transmitted ISDN (Integrated Services Digital Network) or high-bandwidth, low-delay switching and multiplexing ATM (Asynchronous Transfer Mode) technologies (Davis, 1995; Minoli, 1996).

*Computerized Education and Training:* This category of instruction frequently relies on standalone personal computers and corporation's local area networks (LANs), including computer-based training (CBT) and computer-aided instruction (CAI). Learners can complete disk-based (or CD-based) or online assignments to supplement the discussion and lecture provided in a traditional classroom or training center. Practice activities, interactive assignments, and supplementary audiovisual materials let learners work at their own pace and repeat activities until the information is mastered. Some instructional materials such as disks or CDs can also be used in correspondence courses.

*The Internet and the World Wide Web:* With the constantly increasing popularity of the Internet, distance learning has taken on new meaning. The Internet is an international network that links one computer to another. Unlike a LAN, the Internet is a wide area network (WAN), one so large that virtually any computer anywhere in the

world can be linked to others via a modem. While participants' computers are linked via computer and WAN, information, generally text and data, can be transferred from one computer to another and the participants at any number of sites can engage in synchronous and asynchronous interaction by sending and reading messages. E-mail, or electronic mail, allows one person to write messages to an individual or a group. Electronic bulletin boards and mailing lists link individuals to more information and other people interested in similar topics. Online chat rooms promote discussion (Collis, 1994; Minoli, 1996).

The virtual classroom is a structured learning environment that uses the Internet as the primary technology for course interaction and delivery (Malikowski, 1996). Its aim is to imitate aspects of real life situations using elements of multimedia and interaction (Allen, 1998). Ginsberg, et al. (1998) have provided a good review about the virtual classroom with the PERSYST system.

Perhaps the most exciting part of the Internet based education is its Web-based instructional technology. Web-based instruction (WBI) encompasses the advanced technologies of multimedia and Internet and provides a learning environment that includes many resources, supports collaboration, implements Web-based activities as part of the learning framework, and supports both novices and experts (Ginsberg *et al.*, 1998; Porter, 1997; Sherry, 1996).

## **2.2 Web-Based Instruction and Online Learning Courseware**

Web is built on top of the Internet with the TCP/IP protocols and supported by hypertext and hypermedia interactive navigation tools. Hypertext refers to documents

containing only text and hypermedia refers to documents with text, audio, video, image, animation, or other active contents (Sheldon, 1998). Use of hypertext and hypermedia in Web technology can provide a way of representing and managing information in a flexible and non-linear way (Conklin, 1987; Jeffcoate, 1995).

The delivery of instruction via the Web can include a number of options, such as Web-enhanced instruction, Web-managed instruction, and Web-delivered instruction. Barron (1998) summarized the three types of Web-related instructional systems. Web-enhanced instruction is usually designed as a supplement to on-campus or on-site instruction. A Web page is created containing some useful links for a class. Web-managed instruction uses a Web-management tool such as Learning Space or WebCT to provide an architecture for course information and materials. The purpose of using these tools is to manage the course access or student progress information. Web-delivered instruction, represented by WBI or Web-based training (WBT), “*includes courseware in which the instruction, interaction, and feedback are delivered via the Web.*” It can be considered as fulfilling one of the stages of the learning process (Allen, 1998). The authoring tools for this type of instruction include ToolBook II with Neuron plug-in, and some Web-based languages such as HTML, JavaScript, and Java.

Hall (1999) defines WBT as the “*instruction that is delivered via a Web browser, such as Netscape Navigator, through the Internet or an intranet. Using the Web, or an intranet’s web, for training specifically refers to the visual environment and interactive nature of the Web.*” Other terms that have been used for WBT include WBI, Internet-based training (IBT), Web-based learning (WBL) online courseware, online learning or interactive courseware (BC WebWorks, 1999). Based on their definitions and

similarities of implementation, in the context of this thesis, the term of online learning courseware is used interchangeably with above terms. All of these terms are defined to exploit the Web technology and interactivity of the delivered instruction, and to be used as an approach in distance learning. WBL and WBI are commonly used in the academic areas, while industrial corporations seem to prefer WBT.

Some of advantages of online learning systems, as contrasting with traditional instruction methods, include:

- 1) While traditional instructional methods are often unable to keep up with changes of delivered information, take too long to revise the contents of text, and involve too much work to distribute to users, online learning can practically make the context to be revised “on the fly” and be distributed to anywhere immediately (Asymetrix Learning Systems, Inc., 1998a).
- 2) In traditional approaches that are space bound, learning occurs within a physical boundary, and is time bounded. Online learning can extend the boundaries of learning, so that users will be able to access it wherever a Web browser and Internet connection is available, regardless of one’s geographic location, and at any time. This will be extremely beneficial for business and distance educational training program (Relan and Gillani, 1997).
- 3) In traditional learning systems, the effectiveness of learning basically relies on the static textbook or the teaching of an instructor. However, since the interactive multimedia technologies, including image, audio, video and animation, can be embedded in courseware, an online learning system is able to provide a dynamic, diverse learning environment that helps the users to



learn faster and retain more knowledge (Allen, 1998; Relan and Gillani, 1997). Studies also showed that the “self-paced training, such as that in Online Learning, result in a higher level of understanding (Asymetrix Learning Systems, Inc., 1998b)” and consequently increase learner’s comprehension.

- 4) The presentation of content in a hypertext format in online learning system, especially Web-based delivery, allows users a flexible manipulation and rapid jump or search of the entire courseware. Many have favorably compared hypertext to the supposed fixed, linear formats of paper-based texts, and the general conclusion is that hypertext is a superior way of presenting textual information (McKnight *et al.*, 1991).
- 5) Online learning technique is more cost-efficient as compared to traditional training systems. The cost of developing, distributing, and maintaining an online application is often much less than the costs of an instructor-led training program. When distributed over the Internet, because of the multiplatform nature of the Internet, the courseware can be accessed with any type of computer platform. Any change or update of the delivered content can be made at any time in a single location and be effective immediately (Asymetrix Learning Systems, Inc. 1997).

As we have discussed above, while online learning is providing demands of a changing environment in the technologically transition era, some researches are exploring the possibilities to use it as a replacement for lecturing. However, it seems unlikely to replace the tradition methods completely. The best use of this technology is seen in

holistic approach, where it is used as an integral part of curriculum (Allen, 1998; Thomas et al., 1998). Additionally, bandwidth constraints are still an ongoing challenge for the online learning technology. The limitations make it difficult to include rich multimedia in instructional modules, a hurdle traditional computer-based training (CBT) had to cross when it emerged in the early 1980s.

### **2.3 Authoring Tools for Online Learning Systems**

The authoring tools available for online learning applications usually use a metaphor to make the use of the program more intuitive. Based on the types of metaphor used by the program, authoring tools may be grouped into three categories: icon-based programs, timeline-based programs, and card-based programs (Hall, 1997). Icon-based programs, such as Aimtech's IconAuthor and Macromedia's Authorware, use an iconic flow chart or a visual programming interface to structure course content (Koegel and Heines, 1993). The logic sequence of a courseware application is determined by the icon flowchart. The timeline-based programs, including Macromedia's Director, use the passage of time as the controlling metaphor. Events enter and exit presentation based on their own tracks of time duration. In card-based programs, also known as page-based or slide-based programs, authoring uses metaphor of index cards, or pages in a book. The Asymetrix's ToolBook II is a typical program of this type authoring tools.

Selection of the authoring programs for developing a particular application usually depends on several factors, including hardware platform, development environment of the tool, ease of use, etc., but more important consideration is whether the program is suitable to complete the designed tasks. Among these available programs,

Asymetrix ToolBook II authoring package has been considered a good choice for authoring training courseware (Brader and Dwyer, 1994; Hall, 1997). *“Asymetrix is one of very few companies in the industry that provides a single source learning solution that includes both a technology platform and related professional services that enable customers to create, distribute and manage learning applications for the enterprise (Asymetrix Learning Systems, Inc., 1998c).”*

ToolBook II, created by Asymetrix<sup>TM</sup> Learning Systems, Inc. (now known as Click2Learn Inc.), provides an authoring and training environment that consists of three application programs: Instructor<sup>TM</sup> (*Instructor*), Assistant<sup>TM</sup> (*Assistant*), and Librarian<sup>TM</sup> (*Librarian*). These three applications work together to form a complete authoring environment.

*Instructor* is “a high-end authoring tool designed for the flexible creation of content-rich online learning application (Asymetrix Learning Systems, Inc., 1997).” It provides an array of tools and predefined objects and templates, and a powerful object-oriented programming language, OpenScript<sup>®</sup> and allows developer to produce multimedia-based online learning application for training and education environment. *Instructor* comes with tools needed to deliver the online applications to users using the Internet (or intranet), a CD-ROM (or diskettes), a LAN, or a combination of these distribution methods. When distributed over the Internet or intranet, a ToolBook II application can be converted directly to an Internet-ready formats (in HTML only or HTML/Java) that work with a Web browser. With Asymetrix Neuron plug-in and ActiveX control, users can run in a browser a ToolBook II application previously created

to run on a CD-ROM or a LAN, which was saved in native ToolBook II format and has not been converted to an Internet format.

*Assistant* is a courseware-authoring program that allows developer to create and deliver the online applications without programming with OpenScript facilitated in *Instructor*. It has an intuitive interface with a Catalog of preprogrammed interactive objects and provides developer a drag-and-drop-authoring environment. *Assistant* has all authoring capabilities like *Instructor* except for not being able to create customized objects with OpenScript programming (Asymetrix Learning Systems, Inc., 1997; 1998d).

*Librarian* is a learning management environment that allows administrators to create and manage database of lesson and learners so that the online learning applications are organized with a consistent learning management system (Asymetrix Learning Systems, Inc., 1997).

Since ToolBook II offers a flexible and versatile authoring environment, it has been selected as authoring program for online training by many organizations in various areas such as manufacturing – the Boeing Corporation, services – Price Waterhouse, and education – Central Community College, Nebraska (Asymetrix Learning Systems, Inc., 1998a) and Oklahoma State University (Online Training Zone, 1999; Wang, 1998). It has also been successfully used to delivery up-to-date information to factory through intranet, set up a virtual university Web site for training consultants over the world and track student progress and help them to learn quicker. TRW Inc., a major government contractor, is standardizing its training on Asymetrix ToolBook II and reports that ToolBook II enables the company to offer training that is more effective than classroom training while saving time and money (Asymetrix Learning Systems, Inc., 1998e).

## 2.4 Java Programming Language

*"Java: A simple, object-oriented, network-savvy, interpreted, robust, secure, architecture neutral, portable, high-performance, multithreaded, dynamic language (Sun Microsystems, Inc., 1998a)."*

Since its release to the world in late 1995, Java has been widely accepted by the community of Internet users and professional software developers and programmers.

As a class-based object-oriented programming (OOP) language, every Java program involves the application of the principles of OOP: encapsulation, inheritance, and polymorphism. These features allow programmers to create modular, flexible programs with the frequent possibility of code reuse, and make it possible to bring the various parts of a complex program together to form a cohesive, robust, maintainable whole.

Unlike C and C++ that compile the programs to produce operating system dependent machine instructions directly, the Java compiler produces a set of instructions in Java bytecode that is the machine language for Java and can be executed by the Java Virtual Machine (JVM). JVM includes an interpreter that reads the Java bytecode and translates the instruction into native machine code. The nature that Java programs are interpreted rather than compiled, makes Java a platform-independent language. This allows Java applications to be run in a wide variety of environments without recompiling the source code (Lindholm and Yellin, 1997).

Because Java programs are compiled to Java bytecode that is architecturally neutral, a Java application will run on any system with different hardware and operating

system configurations as long as the system implements JVM. This makes Java programs completely portable and can be transported over the Internet. Being embedded in an Internet web page, a Java application (applet) can perform tasks and interact with the users on their Java-compatible web browser. Its distributed nature, ability to provide high-level support for networking, and dynamic class loading capabilities make it possible for a Java interpreter to download and run code from across the Internet without using resources from the Web server (Lindholm and Yellin, 1997; Gosling and McGilton, 1996).

Aside from the ability to be a valuable distributed network environment, Java is also capable of being a general purpose programming language. However, since Java was designed to be a simple language, it employs only a small set of constructs as compared with C and C++ but keeps their most low-level familiar syntax. This makes Java relatively easy to learn. Java's operating system abstraction (through its APIs), elimination of the use of pointers from the language, and automatic implementation of garbage collection memory management capabilities make it a productive and a more comfortable environment to work with for C and C++ programmers (Gosling and McGilton, 1996; Arnold and Gosling, 1998; Tyma, 1998).

Being a powerful programming language, Java itself provides an environment to develop dynamic presentation of delivered materials. Researchers have successfully used Java applets in computer science education to assist in teaching the theory of computing (Ross, 1997) and algorithms of data structure (Weiss, 1997). Cole *et al.* (1998) have presented an example of using Java applets to build GUI interface to demonstrate genetic algorithms.

Because Java is not only an innovative programming language for creating applets for World Wide Web (Web) distribution but also a powerful general purpose OOP language useful for a wide variety of applications, many educational institutions are considering using it or have used it to replace C or C++ as the first programming language in computer science education (Tyma, 1998; Schaller *et al.*, 1997).

## CHAPTER III

### COURSEWARE DEVELOPMENT

Previous reviews in this thesis have provided sufficient evidences that online learning technology has many advantages as compared to conventional instruction systems. The potential to use Internet to deliver online learning applications appears to be good. As part of this project, a tutorial application for Java programming language has been created using Asymetrix ToolBook II Instructor. It was not the author's intention that using this tutorial application to replace the conventional lecturing and print-based materials in the process of learning Java, instead, the application could provide users an alternative approach in learning and using Java that may serve as a supplement for the traditional learning methods.

The process of developing a courseware involves a number of phases depending on the models proposed by researchers (Andrews and Goodson, 1980; Benyon, 1997; Grabowski and Droms, 1994). Courseware specifications and instructional design (ID) are generally considered crucial processes in courseware development.

#### **3.1 Course Specification Design**

Courseware specification is the process of identifying the aims and objectives of the materials that are to be included in the context (Benyon *et al.* 1997). Since the purpose of this tutorial is to provide an intuitive application that can be distributed over the Internet and exploit the advantages of Web technology so that users are able to learn



the Java programming language in a different approach. Therefore, it is not difficult and ineffective to include too much detail of the language specifications in the courseware. To ensure that the fundamental constructs of the Java programming language can be covered in this application, the author has chosen the “Objectives for the Sun Certified Programmer Java™ Examination for Java 2 Platform” (Sun Microsystems, Inc., 1999) as the outline of the contents of lessons. References for writing the script of lessons were mainly from the publications of Sun’s “The Java Series” books and Sun’s Web site (Sun Microsystems, Inc., 1998b). This provides clear learning objectives. However, because of the differences between this tutorial and traditional print-based method, the users of this courseware are assumed those who have had some backgrounds in using programming languages previously. This expectation is supposed to let the users to take the maximum benefits form the context of the courseware.

The tutorial consists of seven chapters (figure. 1); each chapter includes various numbers of units (pages).

Chapter 1. “Language Fundamentals” discussed the fundamentals of the Java programming language: Java source file; Java keyword and identifiers; variable declaration and initialization, and Java literals.

Chapter 2. “Operators and Assignments” introduced all operators used in Java and behavior of assignment expressions.

Chapter 3. “Java Modifiers” covered the topics of all modifiers currently used in Java 2, including the three most common modifiers are public, protected and private, and other 7 modifiers.

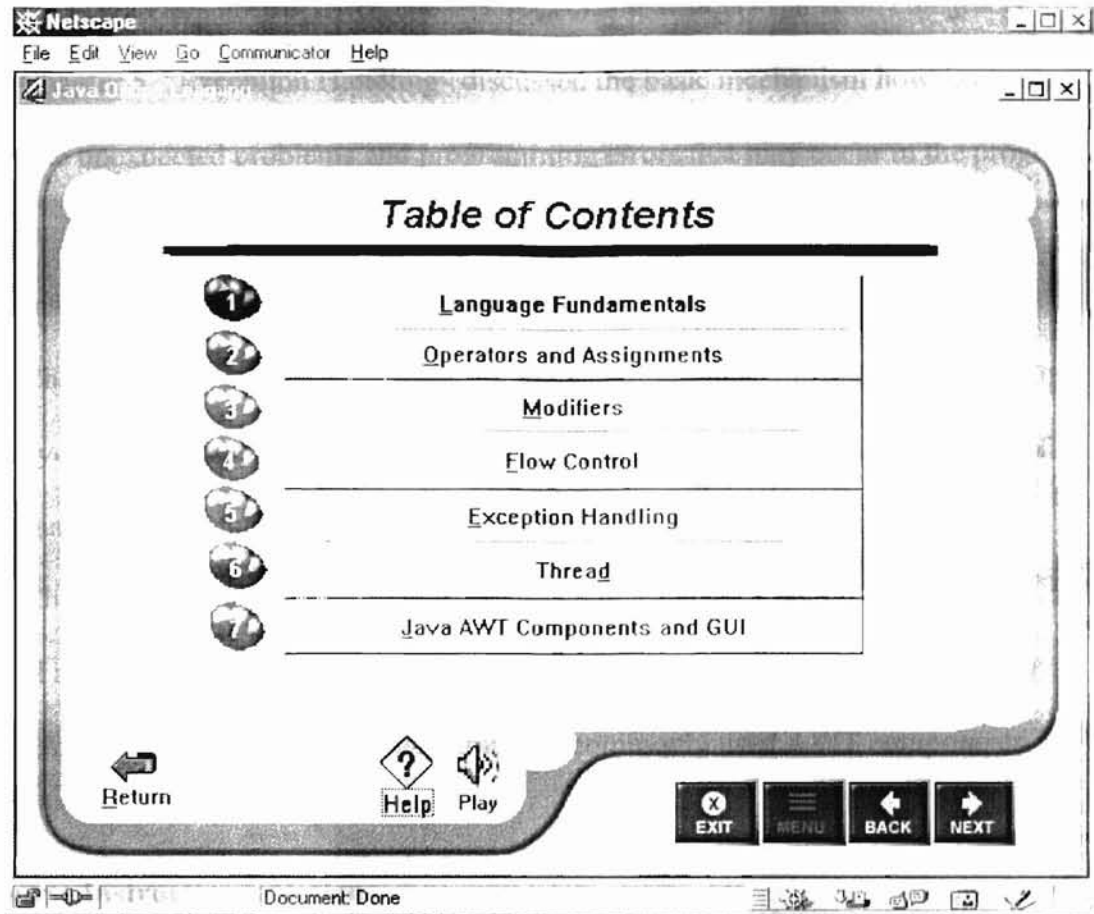


Figure 1. The main book contains seven chapters

Chapter 4. “Flow Control” introduced the flow control facilities of Java, such as `for()`, `while()`, and `do` constructions, and `if()` / `else()` and `switch()` selection constructs.

Chapter 5. “Exception Handling” discussed the basic mechanism how Java handles the unexpected problems and programming errors that may occur in the program. The contents covers *Throwable* class, catching exception, checked and unchecked exceptions and the *try*, *catch()* and *finally* constructs.

Chapter 6. “Java Thread” introduced the idea of multitasking and multithreading, the life cycle of a thread, the mechanisms for creating and controlling the behaviors of threads, and the communicating between threads.

Chapter 7. “Java AWT Components and GUI” discussed Java Applet and graphical application, and the differences between them; the methods used in Java Applet. Applets were created to demonstrate the commonly used AWT components.

### **3.2 Course Instructional Design**

Instructional design is concerned with the pedagogic approach taken to the courseware. Major factors that influence instructional design include time constraints, cost constraints, nature of users’ population, delivery technology and availability of authoring tools (Benyon, 1997; Grabowski and Droms, 1994). In the process of developing this tutorial application, limitations from all above factors were obvious.

There are several instructional approaches that can be used to design the an online learning application with ToolBook II package (Asymetrix Learning Systems, Inc. 1997), including:

1. **Presentation:** It delivers the course content in a linear mode and is usually used to introduce a concept or a process. This approach often does not include questions and practice. Examples of this approach include slide shows, tours, feature reviews, and demonstration of techniques and behaviors. Presentation
2. **Tutorials:** Tutorials often involve more interactive and can support questions and exercises. They use the hyperlinks and menus to help users to navigate the content. Tutorials are sometimes combined with linear presentation to provide a fixed sequence presentation with interactivity embedded.
3. **Simulations:** These approaches often simulate the real world behaviors and attributes of a process or concept and provide highest levels of mastery. They are commonly used for demonstrating equipment operations and case studies.
4. **Quizzes:** Quizzes are used to help users to review the course materials and master the concepts and tasks presented.

Since the purpose to design this courseware was to provide users an interactive alternative to learn Java programming language, based the nature of the course contents and the desires of applying interactive features to the course, a combination of above approaches were designed and applied in this project.

The courseware comprised of a main book and seven supplementary books of quizzes that were linked to the end of each chapter of the main book. The main book was designed to present the concepts and mechanisms involved in the Java programming language in a combined model of linear presentation and interactive tutorial. It allowed users to work through the courseware sequentially and master the prerequisite materials before starting the advanced session. The combined interactive features from tutorial

approach provided a means to users to use hyperlinks and main menu and chapter's sub-menus to jump around the course for better understanding of the context.

To help users to master the materials offered in the tutorial, a set of quiz questions was provided in a separate book that is linked at the end of each chapter of the main book. When completing a chapter, users can decide to choose one of the two options: either starting a new chapter or going to the linked quiz book to take a short quiz (figure 2). From the end of a quiz book, users also can select either exit the tutorial or return to the main book for next chapter (figure 3).

These combined techniques of linear presentation, interactive tutorial and quiz provide users great flexibility, make the learning process less stressful, and aid memory retention.

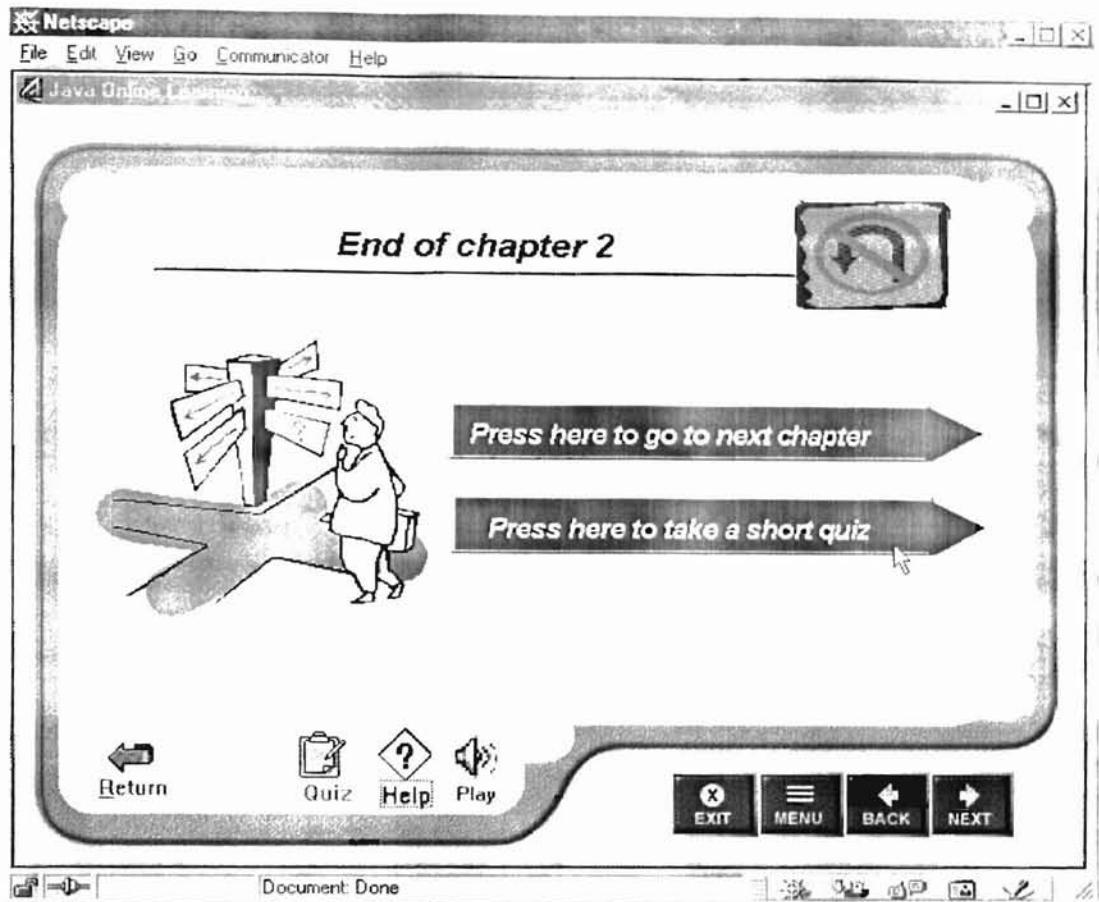


Figure 2. Link to quiz book at the end of each chapter

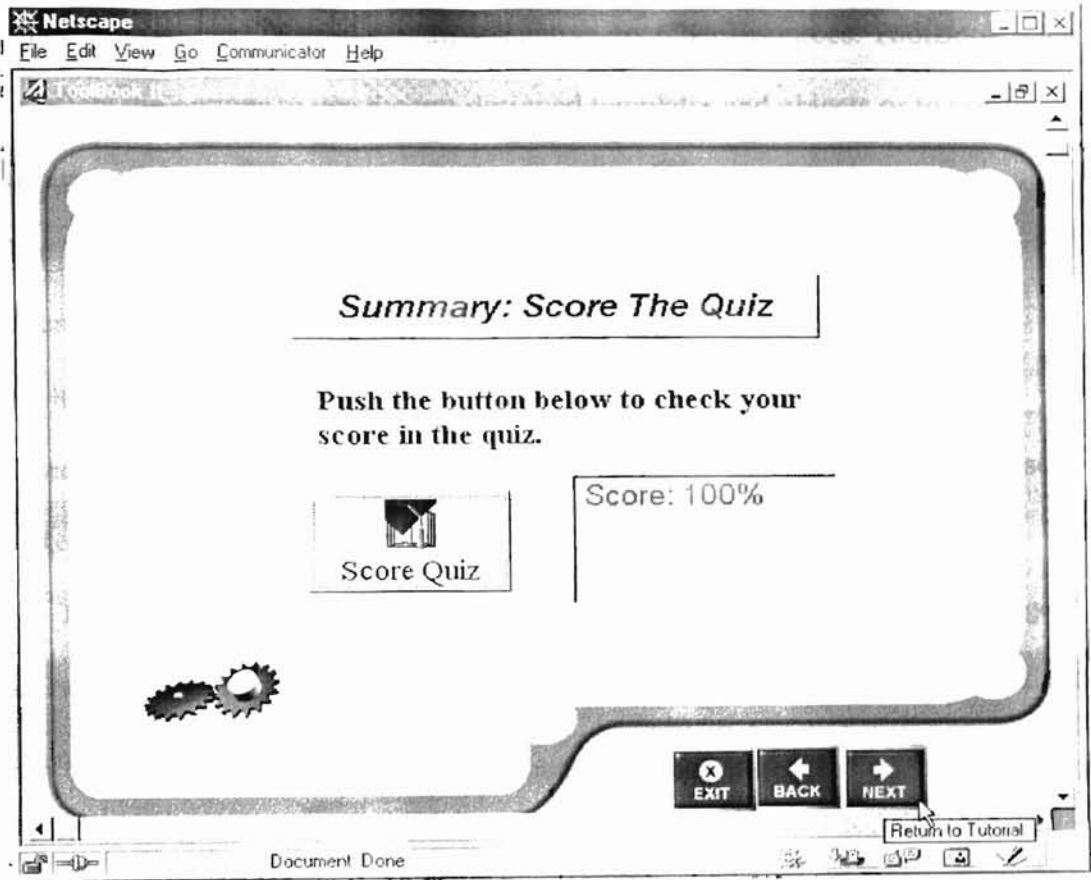


Figure 3. Link to main book at the end of each quiz book

### 3.3 Course Layout Design

An appropriate layout design of a courseware requires the effective uses of multimedia elements, navigational paradigms, and many other resources. ToolBook Instructor offers the options to use the pre-designed templates and objects or to create custom design.

The background of this courseware was originally selected from an Instructor resizable template. However, since its dark gray color (figure 4) was not suitable for displaying large amount of textual content and providing less stressful interface, the author added a new grouped objects including one “RoundedRectangle”, three “Ellipse”, and one “RecordField”, and a custom color to create the desired background layout (figure 5). The light custom color made it much easy to add other objects into the pages later. This new custom background has been consistently used through the main book and for all seven quiz books.

After creating the background, the next step was to design and add the objects into background that will be used for all pages of the courseware. Since the navigational purposes are different between main book and quiz books, the objects appeared in their backgrounds were not same. The background of main book included a same set of grouped navigational buttons, a return button, a help button, a play, and a title bar on the top part of page (figure 6). Quiz books contained only a set of custom navigational buttons in their backgrounds, which varies among different pages (figure 7).



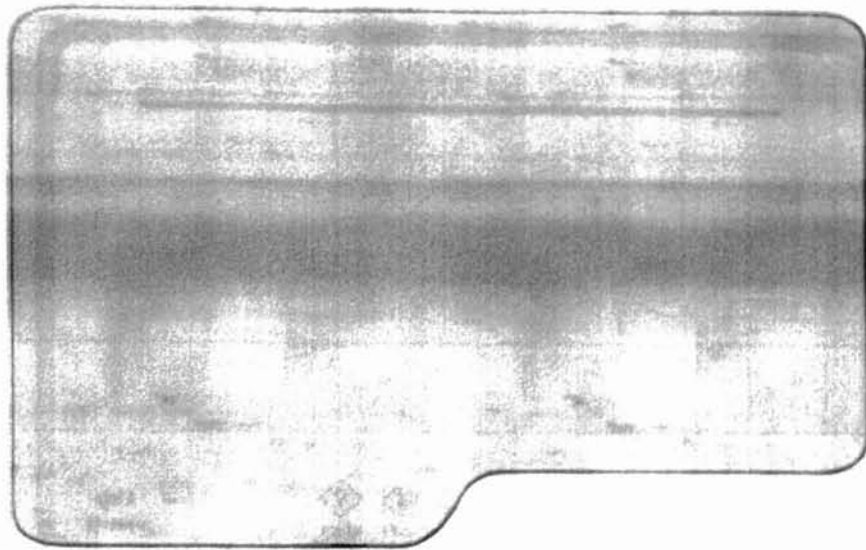


Figure 4. Original template background

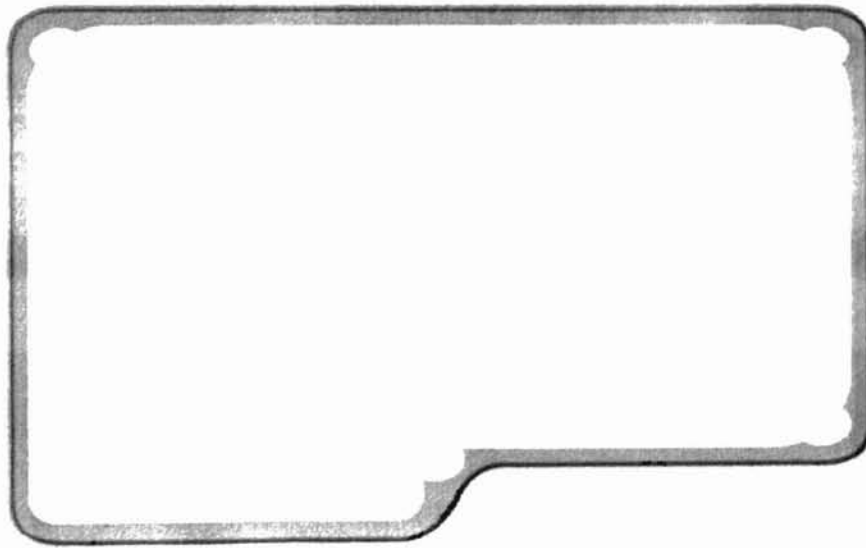


Figure 5. New custom background

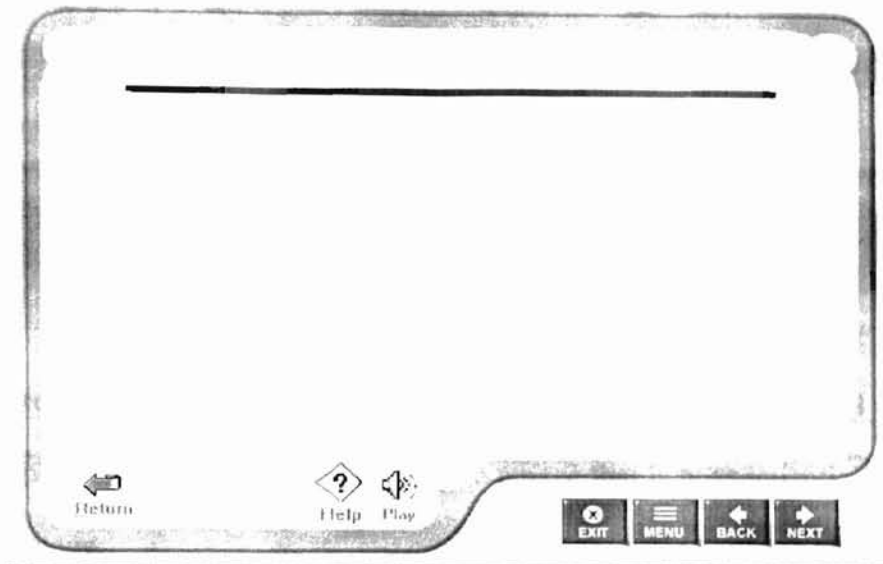


Figure 6. Main book background with objects

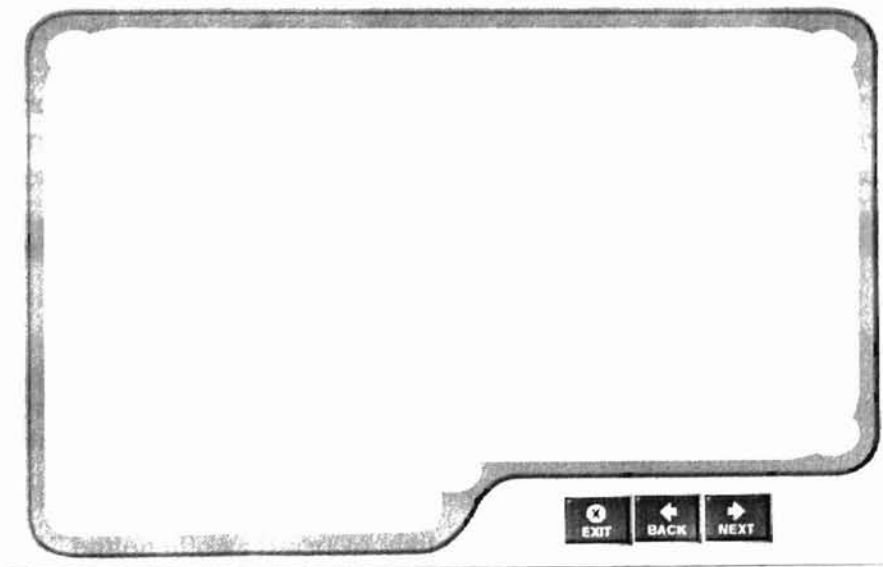


Figure 7. A typical quiz book background with objects

To simplify the informational paths and effectively use the navigational paradigm, an intuitive design model was applied. In most pages of the main book, there are five buttons that allow users to move around the book:



The “Return” button allows user go back to last page visited. It is useful when users use the hyperlink such as hotword to jump to a page that is not sequentially previous or next page.

The “Exit” buttons allow users to exit the book on any point within the lesson.

The “Menu” button allows users to return to main menu of the book at any point within the lesson.

The “Next” and “Back” buttons offer users the option to move either forward to next page or back to a previous page.

In addition to above five basic buttons, the following buttons were added to the background page:



The “Help” button allows users to visit the “Convention Used in This Tutorial” page (figure 8),during the lesson.

The “Play” button allows users to paly or turn off a backgroud music.

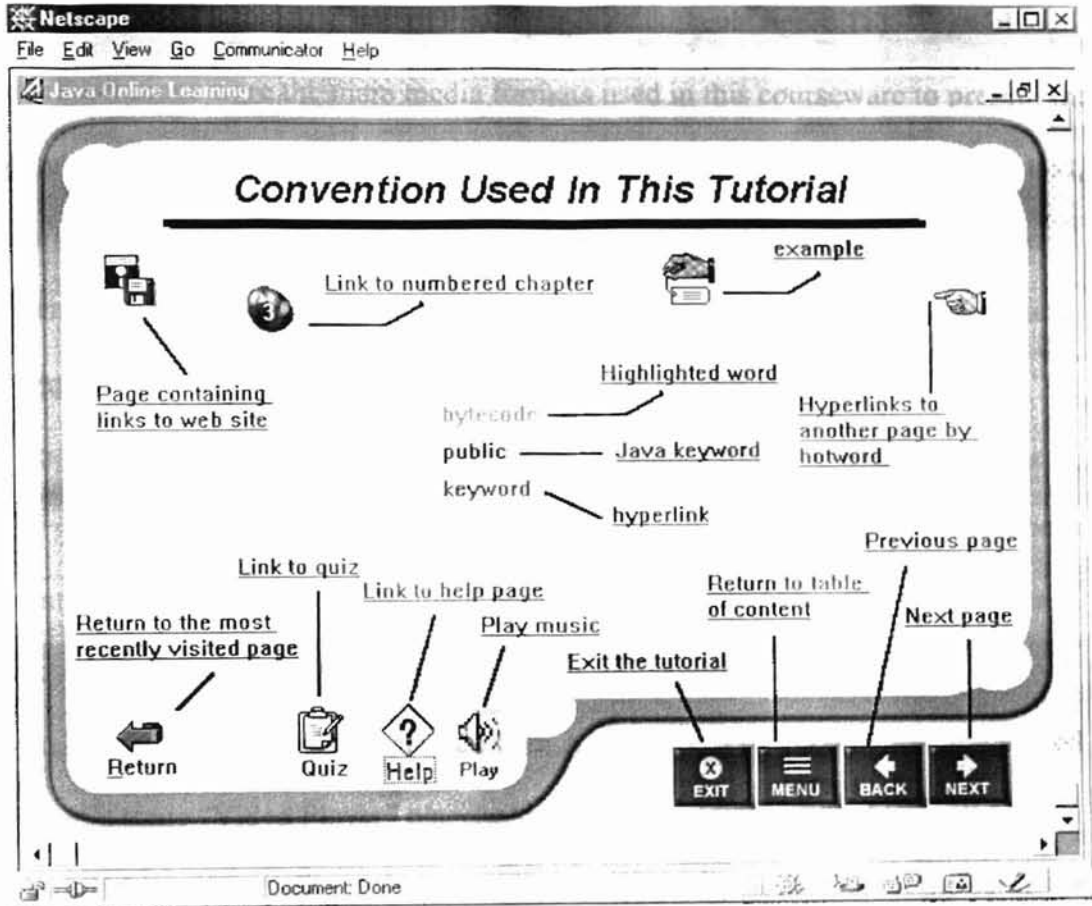


Figure 8. The “Convention Used in This Tutorial” page linked by “Help” button

The main menu in the main book was used to offer the links to each chapter in the book (figure 1). Each individual chapter contained a chapter introduction page (figure 9), a chapter menu page (figure 10), and multiple pages of content (figure 11). Textual and graphical illustrations were the main media formats used in this courseware to present the concepts and mechanisms of lessons (figure 12). To help users to understand the context, short Java program code fragments were created and embedded in some pages (figure 13). Screen shots were made for chapter 7 (Java AWT Components and GUI) to capture the Java Applets for each component's illustration code (figure 14).

To avoid the network bandwidth problem, the author intended to minimize the uses of large size media such as video and audio files. Only one video program has been inserted into the main book as the "startup" movie to draw users' attention and interest before they really start navigating the course. This video program was in AVI (Audio Visual Interleaved) format and was created with Asymetrix Web 3D program and placed into the page's stage "Video Player" placeholder. A background music file in WAV (Wave Audio) format was added to a button "Media Player" placeholder on the same page. When users enter this page at any time, both video and background music will play simultaneously. Another music file in MIDI (Music Instrument Digital Interface) format was used on the users' control to provide a relaxed learning environment.

Quizzes for each of the seven chapters were created and organized in separate books (files). Each quiz contained 4 to 6 questions. Users are allowed to try answering a question for more than one time. Each time after users has chosen an answer and pressed the "Check Answer" button, an immediate feed back by human voice and a pop-up message returned to notify the users whether they have answered the question correctly.

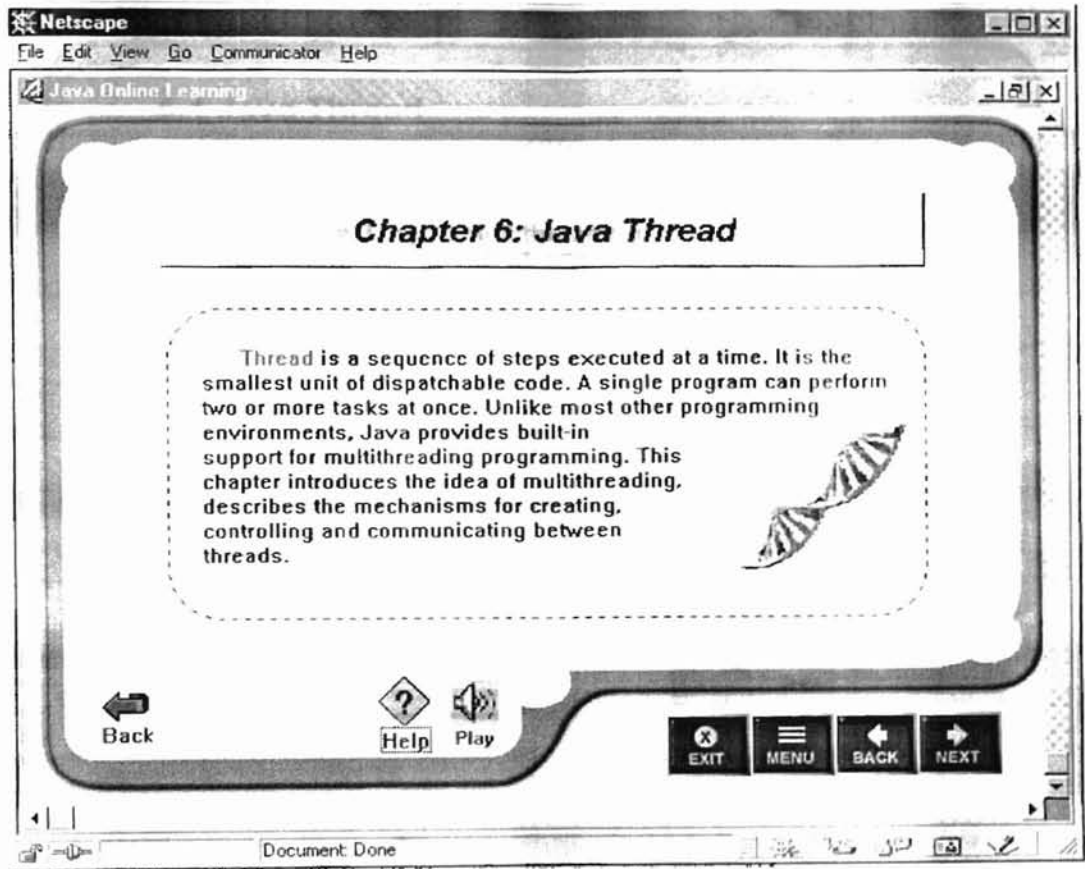


Figure 9. Each chapter has a brief introduction on the chapter content

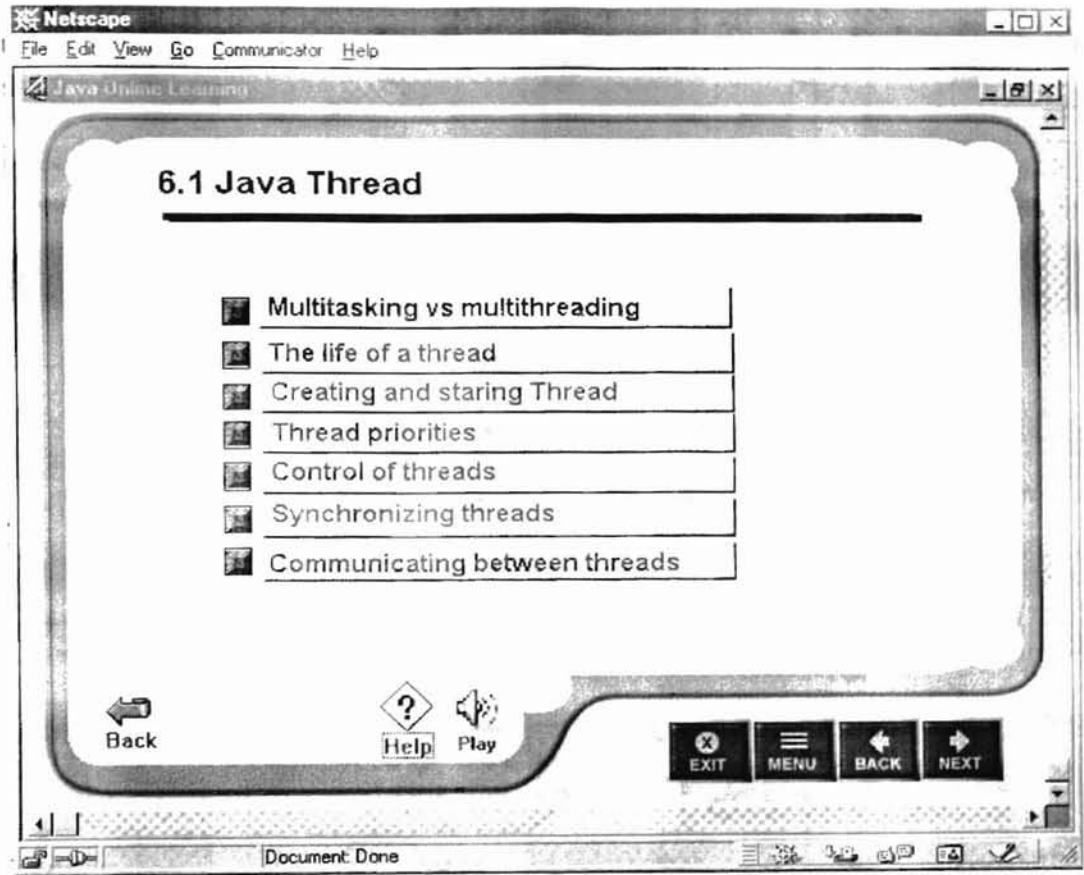


Figure 10. Each chapter has a sub menu

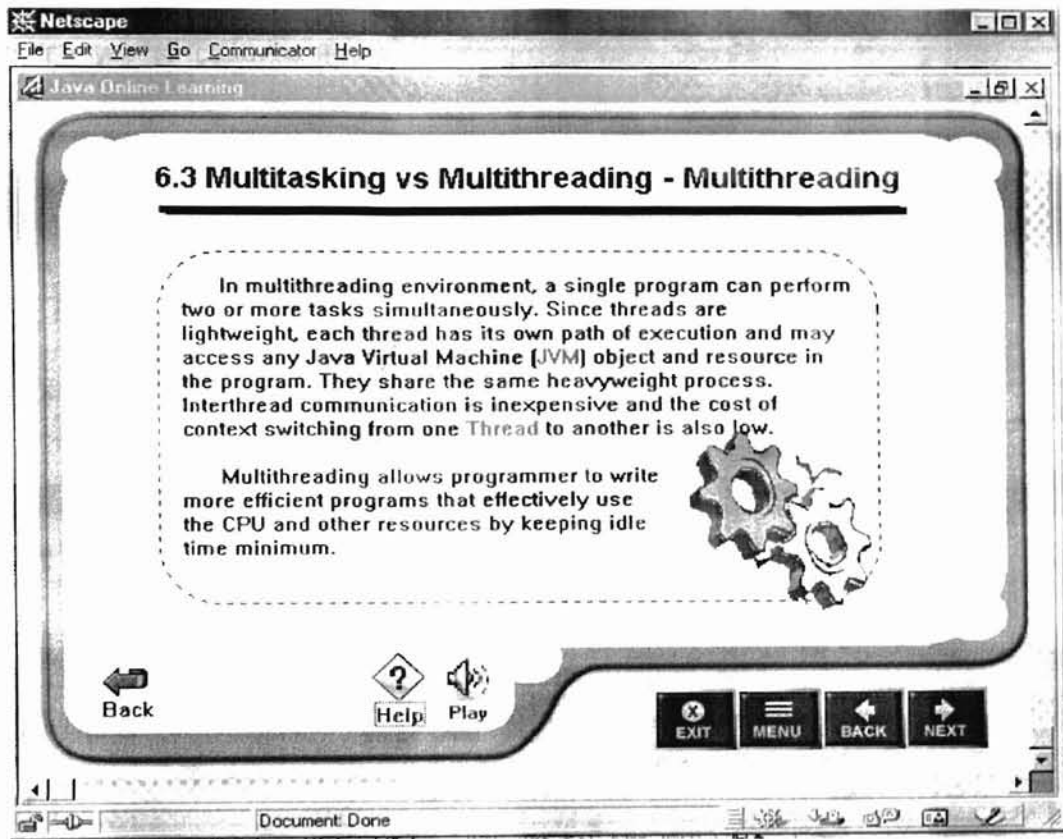


Figure 11. Each chapter contains multiple pages of content



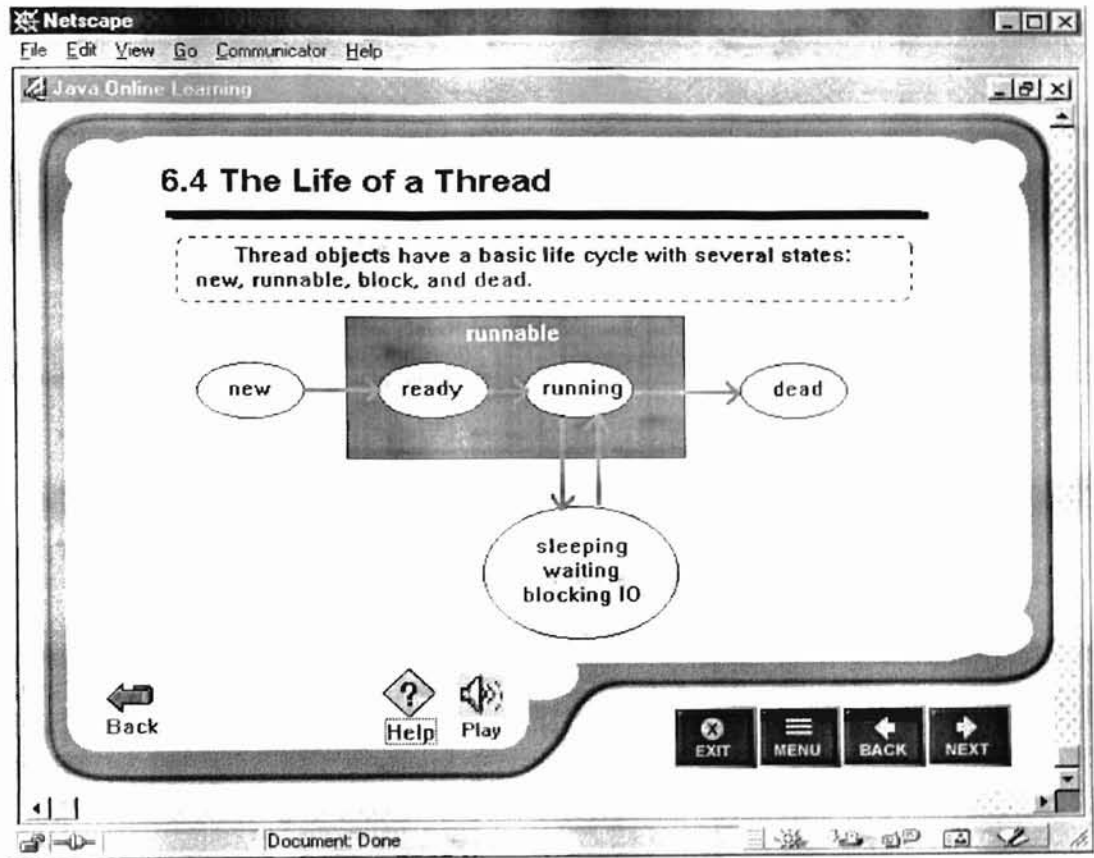


Figure 12. Page often contains graphical illustration

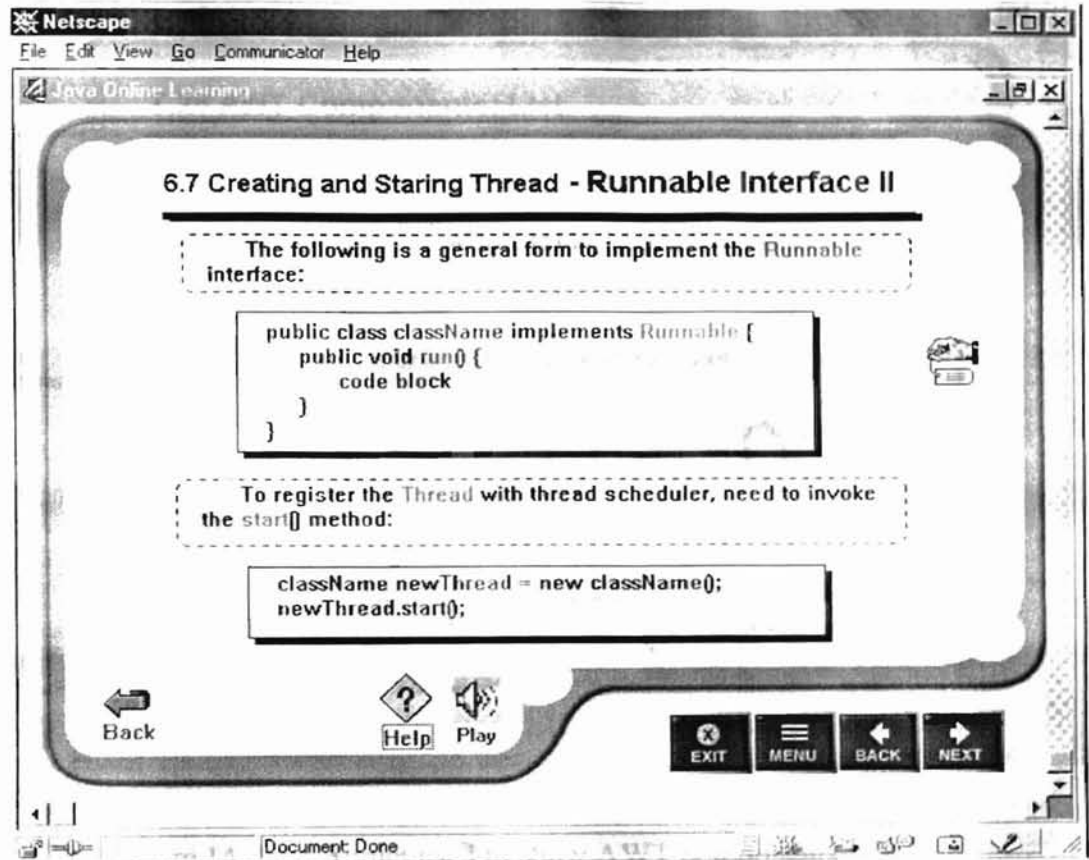


Figure 13. Java code fragments are used to explain the concepts

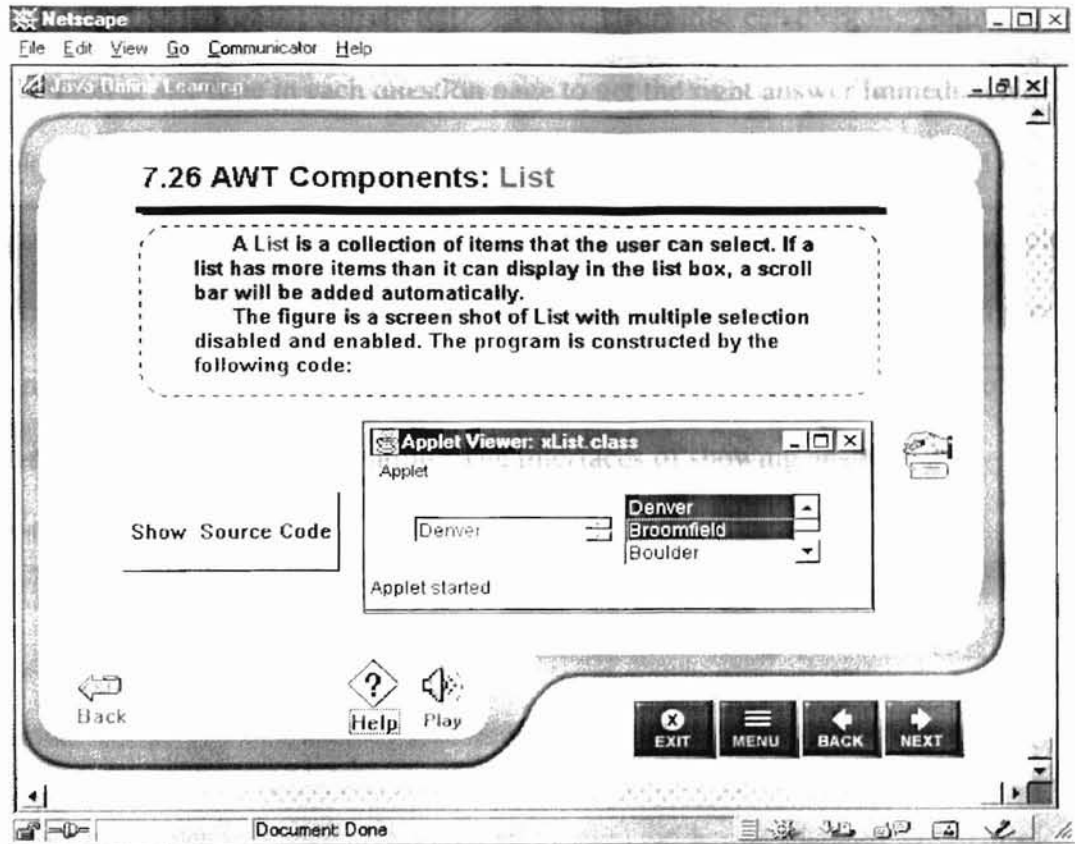


Figure 14. Java Applet used to show AWT components

When users decide to leave for another page, the last answer was recorded to calculate the final scores of the current quiz session. Users also can click the “Show Answer” button at any time in each question page to get the right answer immediately. ToolBook II provides many types of interactive quizzes. The types of quizzes used in this courseware included: Select text order (figure 15), Match Items (figure 16), Multiple Choice (figure 17), Drop Target (figure 18), True/False (figure 19), Fill In Blank (figure 20), and many of custom variations of these types. Figure 21 is a typical screen shot when users click “Show Answer” button. The interfaces of showing answers are different from question to question.

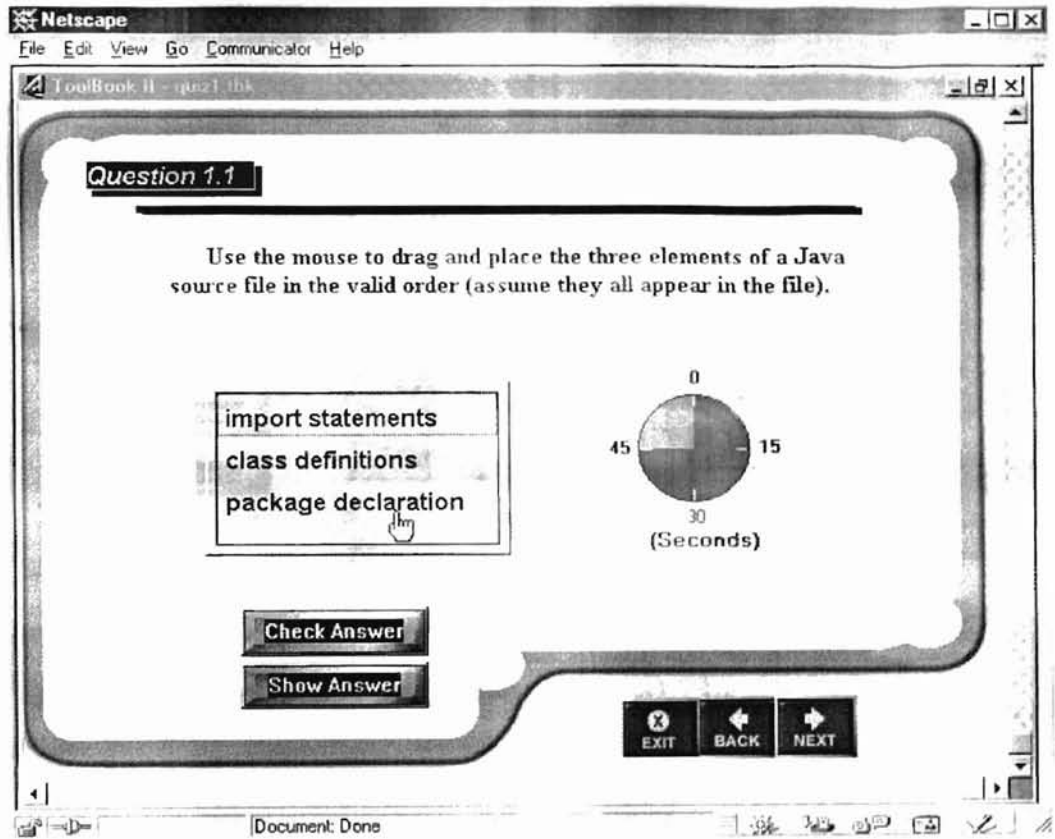


Figure 15. Quiz type: select order of text

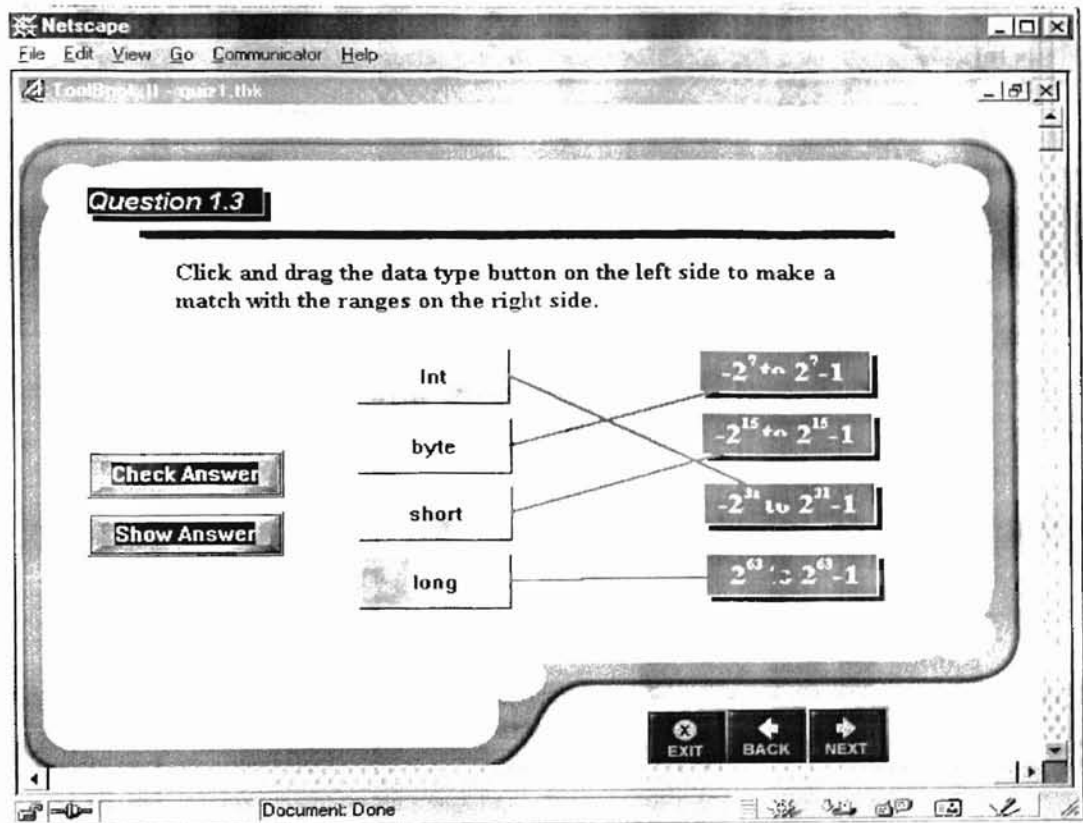


Figure 16. Quiz type: match items

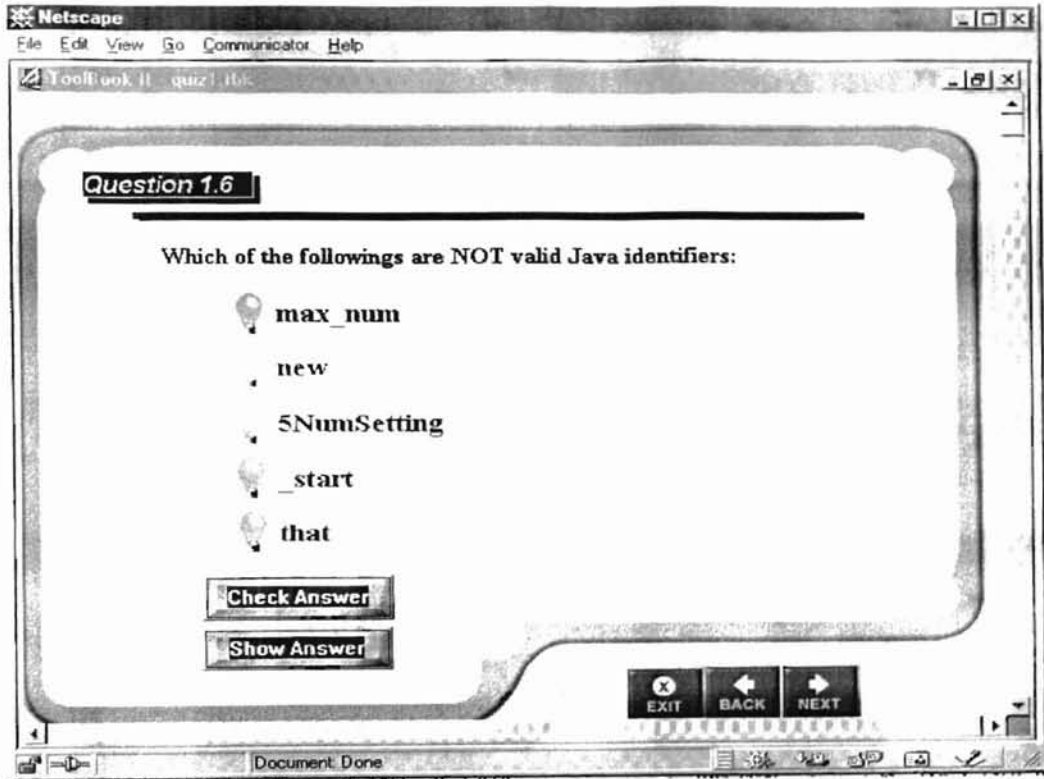


Figure 17. Quiz type: multiple choice

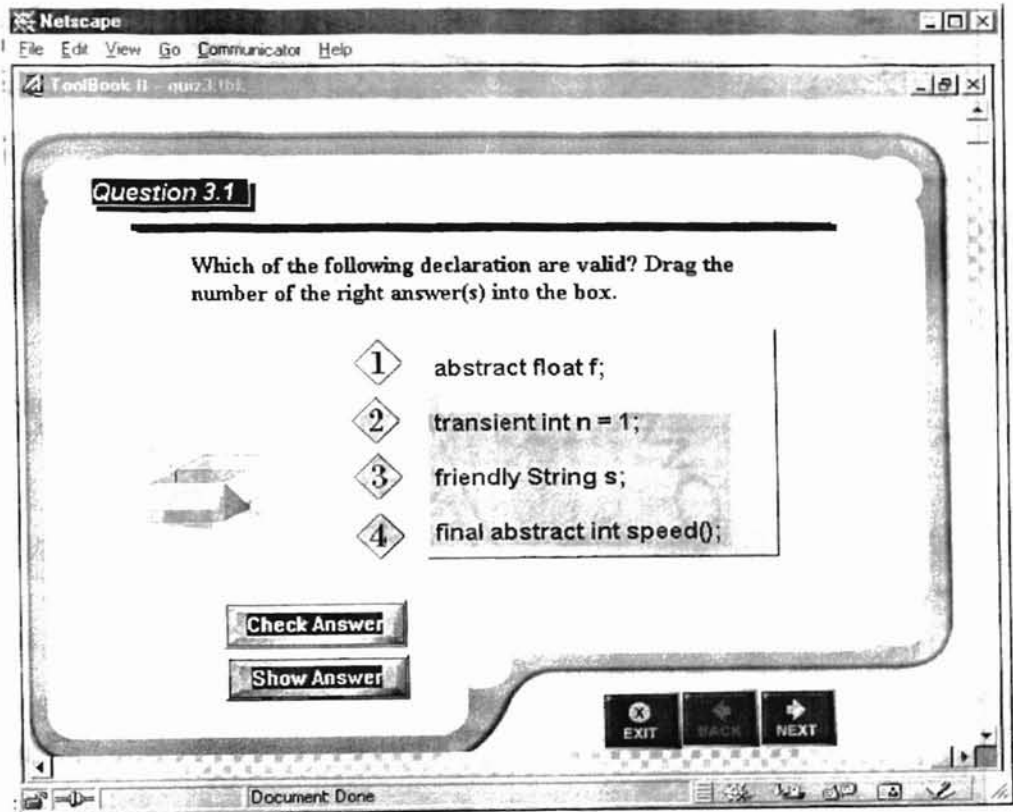


Figure 18: Quiz type: drop target



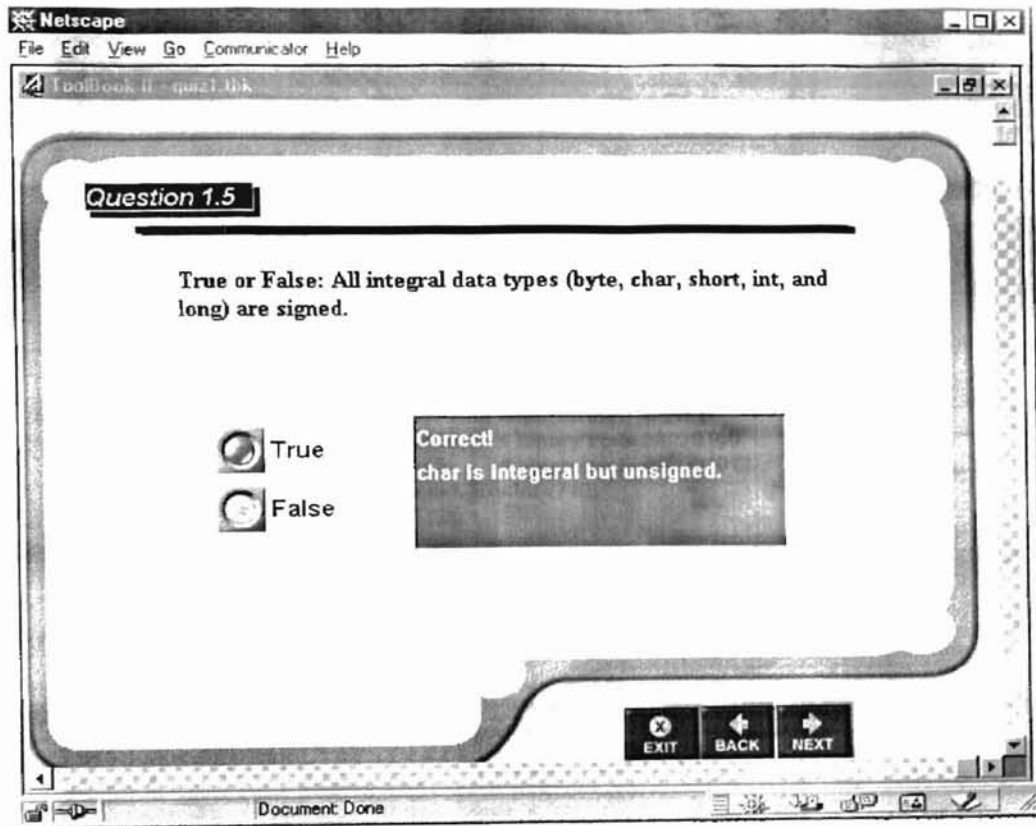


Figure 19. Quiz type: True / False

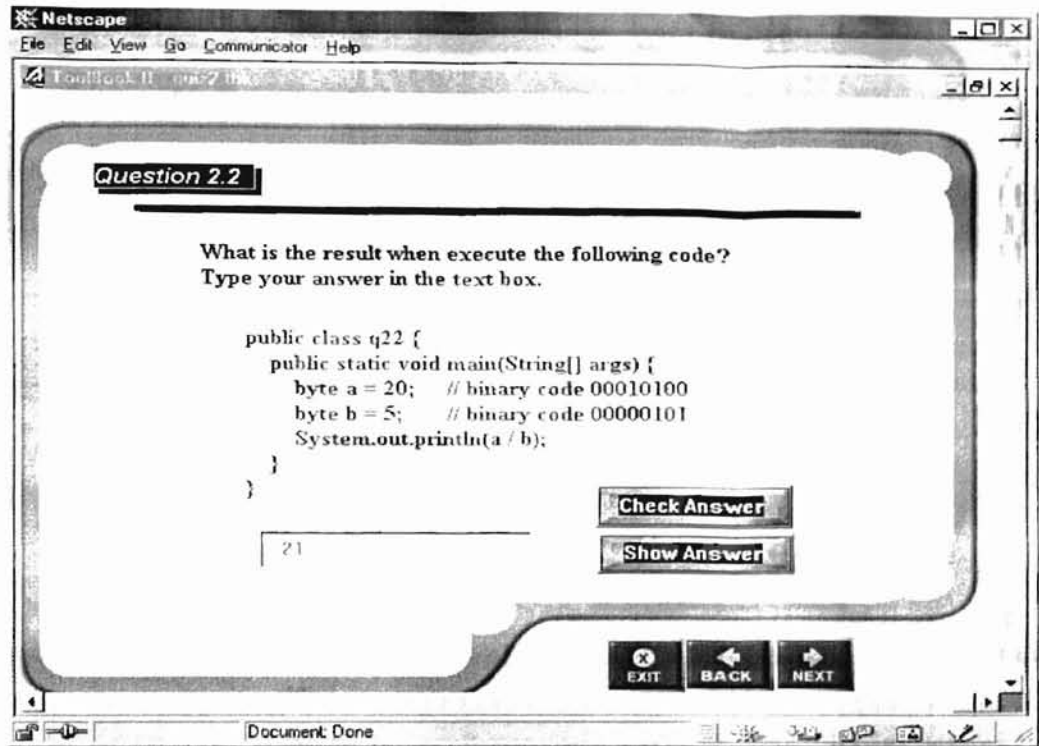


Figure 20. Quiz type: Fill in blank

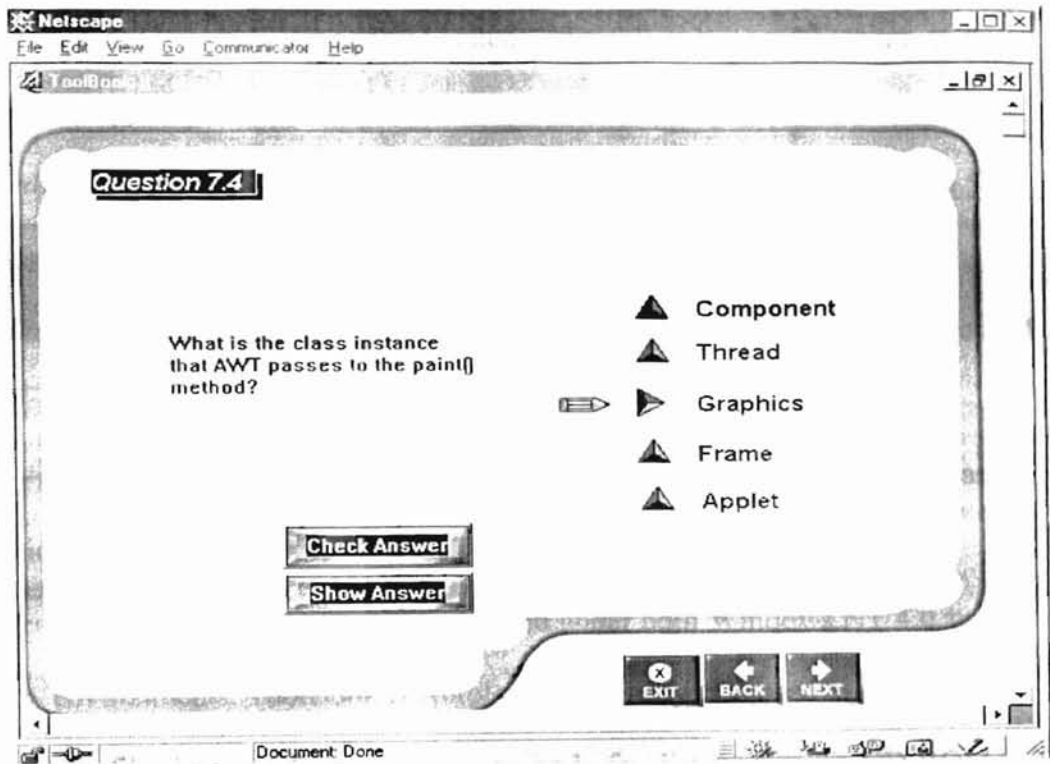


Figure 21. A typical screen shot when click "Show Answer" button

### 3.4 Course Development and Test Environments

The courseware was developed and tested under following environments with various software applications:

*Hardware:* Hitachi Pentium 166 MXX with Windows NT 4.0; HP Pentium 500 with Windows 98;

*Authoring Tools:* Asymetrix ToolBook II Instructor 6.1a, Asymetrix ToolBook II Neuron 6.0, Asymetrix Web3D 2.0, Microsoft PhotoDraw 2000, Sun JDK 1.2.2, Microsoft Visual J++ 6.0, Netscape Navigator 4.7, Microsoft Internet Explore 5.0, and other graphic and media utilities come with ToolBook II instructor.

After the courseware was created and tested under both Windows NT 4.0 and Windows 98 environments, ToolBook II AutoPackager utility was used to package all books and media files into two formats that were ready for distributing via CD-ROM and Internet with Neuron plug-in. When packaged the courseware for CD-ROM delivery, the run time program files of ToolBook II were included into the package so that users can set up and run the courseware without the need of ToolBook II application program. Using the Neuron plug-in with the popular Web browsers such as Internet Explorer and Netscape Navigator allows the courseware to be executed within browsers with full features as a native ToolBook II application. Since the volume of the courseware and lack of Web server support, the courseware has not been uploaded to server site for Internet publishing.

## CHAPTER 4

### CONCLUSION AND DISCUSSION

The courseware created in this project was to demonstrate the interactive features of an online learning application that can be delivered via Internet and CO-ROM. The major authoring tool used in the design and implementation phase was Asymetrix Instructor 6.1a. There were totally 190 screen pages included in the application; among them 150 pages were created for the main book and 40 pages for seven quiz books. The book structure designs were based on several considerations. Firstly, breaking a large size courseware into several small book files would be helpful for reducing the network bandwidth problems, thus, consequently to speed up the access execution time with Internet browsers or CD-ROM player. This seemed more important when designing a book for Internet publishing. Secondly, the practice of organizing quiz books separately from main book offers more authoring flexibility to customize book and page objects, especially the background objects, with desired variations of layouts; this also made the maintenance of book components much easier during the design and test time. Finally, since the quizzes were designed as an option parts for users to navigate, it would be very difficult to include all pages of the seven quiz books in main book and make all of them "Skip this page when navigating". To do so, a manual control of each single page was required; and tremendous design and maintenance work could be involved as the book size increases. Making each quiz book separately from main book allowed users to determine whether to work through the supplementary quiz session after their completion of a chapter of main book.

The content of this courseware covered most fundamentals of Java programming language, but not all aspects of the language. No single book could include everything about this growing language. The size and coverage of an online learning courseware may be limited by many factors such as resource availability, network bandwidth, and time constraints. This courseware was supposed to be used as a complement to instructor-led class lesson or printed-book study. Further improvements on this application may include: expanding coverage of content; furnishing voice narration to code fragments or important concepts; and use of the ToolBook II Library application to manage the lesson accesses and users profiles.

## REFERENCES

- Adamson-Macedo, C. (1996). "PCs. The Bandwidth Revolution And Engineering Curricula". IEEE Computing and Control Engineering Journal. 7 (3) pp. 129-135.
- Allen, R. (1998). "The Web: Interactive and Multimedia Education". Computer Networks and ISDN Systems. Vol. 30 pp. 1717-1727.
- Andrews, D. and Goodson, L. (1980). "A Comparative Analysis of Models of Instructional Design". Journal of Instructional Development. Vol. 3(4) pp. 2-16.
- Arnold, K. and Gosling, J. (1998). The Java™ Programming Language. (2<sup>nd</sup> Ed.). Reading, MA: Addison-Wesley
- Asymetrix Learning Systems, Inc. (1997) The Asymetrix Guide to Interactive Online Learning. Bellevue, WA
- Asymetrix Learning Systems, Inc. (1998a). It's Working. Bellevue, WA
- Asymetrix Learning Systems, Inc. (1998b). (accessed on Nov. 15, 1998). The Benefits of Online Learning. URL: <http://www.asymetrix.com/oll/index.html#benefits>
- Asymetrix Learning Systems, Inc. (1998c). (accessed on Nov. 15, 1998). Online Learning and Asymetrix. URL: [http://hugin.asymetrix.com/~mikef/tank/m109\\_44.htm](http://hugin.asymetrix.com/~mikef/tank/m109_44.htm)
- Asymetrix Learning Systems, Inc. (1998d). ToolBook II User Guide. (Part 1) Bellevue, WA
- Asymetrix Learning Systems, Inc. (1998e). (accessed on Nov. 15, 1998). Asymetrix at Work: A Case Study – TRW Inc. URL: <http://www.asymetrix.com/showcase/toolbook/casestud/trw/>
- Banathy, B. (1994). "Designing Educational Systems: Creating Our Future in a Changing World". In C.M. Reigeluth and R.J. Carfinkle (Ed.) Systemic Change in Education (pp 27-34). Englewood Cliffs, NJ: Educational Technology Publications.
- Barron, A. (1998). "Design Web-based Training". British Journal of Educational Technology. Vol. 29 (4) pp 355-370.
- BC WebWorks. (1999). (accessed on March 12, 1999). URL: [http://www.bcwebworks.com/\\_onlinecourse.htm](http://www.bcwebworks.com/_onlinecourse.htm)

- Benyon, D. Stone, D. and Woodroffe, M. (1997). "Experience with Developing Multimedia Courseware for the World Wide Web: The Need for Better Tools and Clear Pedagogy". International Journal of Human-Computer Studies. Vol. 47 pp. 197-218.
- Brader, L.L. and Dwyer, C.A. (1994). "ToolBook". In Milheim, W.D. (Ed.) Authoring-Systems Software for Computer-Based Training (pp. 45-60). Englewood Cliffs, NJ: Educational Technology Publications.
- Brande, L. V. D. (1993). Flexible and Distance Learning (pp. 1-34). NY: John Wiley & Son, Inc.
- Bunderson, C. V. (1981). "Courseware". In H. F. O'Neil, Jr. (Ed.). Computer-Based Instruction: A State-of-the-Art Assessment. New York: Academic Press, Inc.
- Cole, D. Wainwright, R. and Schoenefeld, D. (1998). "Using Java to Develop Web Based Tutorials". Twenty-ninth SIGCSE Technical Symposium on Computer Science Education (SIGCSE Bulletin), Vol. 30 (1) pp. 92-96
- Coleman, J.N., Kinniment, D.J., Burns, F.P., Butler, T.J., and Koelmans, A.M. (1998). "Effectiveness of Computer-Aided Learning as a Direct Replacement for Lecturing in Degree-Level Electronics". IEEE Transactions on Education. Vol. 41 (3) pp. 177-184.
- Collins, B. (1994). "An Analysis of Conferencing as Technology for Distributed Training: Perspectives on Functionality, Instrumentation, Organizational Integration, and Cost-Effectiveness". In R.J. Seidel and P.R. Chatelier (Ed.) Learning Without Boundaries: Technology to Support Distance / Distributed Learning (pp. 7-25).
- Conklin, J. (1987). "Hypertext: An Introduction and Survey". IEEE Computer. Vol. 2 (9) pp17-41.
- Crossman, D.M. (1997). "The Evolution of the World Wide Web as an Emerging Instructional Technology Tool". In B.H. Khan (Ed.) Web-Based Instruction (pp. 19-23). Englewood Cliffs, NJ: Educational Technology Publications.
- Cuban, L. (1993). How Teachers Taught (2<sup>nd</sup> ed.). New York: Teachers College Press.
- Davis, N. (1995). "Corporative Work Between Schools and University with ISDN Multimedia Communications". IFIP Transactions A-Computer Science and Technology. Vol. 61 pp. 123-128.
- Distance Learning (accessed on March 10, 1999). Open University, UK. URL: <http://www.distance-learning.co.uk>



- Driscoll, M.P. (1994). Psychology of Learning for Instruction. Boston: Allyn & Bacon. pp. 8-9.
- Foldvik, F., and Walling, W. (1993). "Distance Learning and ATM: A Trial at the University of Minnesota". Proceedings of the 18<sup>th</sup> Conference on Local Computer Networks. IEEE. pp.77-79.
- Georganas, N. (1997). "Multimedia Applications Development: Experiences". Multimedia Tools and Applications. Vol. 4 pp 313-332
- Ginsburg, A., Hodge, P., Lindstrom, T. Sampieri, B., and Shiao, D. (1998). (Accessed on March 10, 1999). "'The Little Web Schoolhouse' Using Virtual Rooms to Create a Multimedia Distance Learning Environment". ACM Multimedia 98 – Electronic Proceedings. URL: [http://www.acm.org/sigmm/MM98/electronic\\_proceedings/ginsberg/](http://www.acm.org/sigmm/MM98/electronic_proceedings/ginsberg/)
- Gosling, J. and McGilton, H. (1996). (accessed on Nov. 15, 1998). The Java Language Environment: A White Paper. URL: <http://www.javasoft.com/docs/white/langenv/>
- Grabowski, B. and Karen, D. (1994). "The Instructional Design Process and the Use of Authoring Systems for Computer-Based Training". In Milheim, W.D. (Ed.) Authoring-Systems Software for Computer-Based Training (pp. 3-22). Englewood Cliffs, NJ: Educational Technology Publications.
- Hall, B. (1997). Web-Based Training Cookbook. New York: John Wiley & Sons, Inc.
- Hall, B. (1999). Branson Hall Resources (accessed March 10, 1999). URL: <http://www.multimediatraining.com>
- Hannum, W. and Briggs, L. (1982) "How Does Instructional System Design Differ From Traditional Instruction?" Educational Technology. 22(1) pp. 9-14.
- Koegel, J.F., and Heines, J.M. (1993) "Improving Visual Programming Languages for Multimedia Authoring". In H. Maurer (Ed.) Proc. of ED-MEDIA '93. Assoc. for the Advancement of Computing in Education (pp. 286-293).
- Jeffcoate, J. (1995). Multimedia in Practice: Technology and Applications. Englewood Cliffs, NJ: Prentice Hall, Inc.
- Jones, A., Kirkup, G., and Kirkwood, A. (1993). Personal Computers and Distance Education. New York: St. Martin's Press.
- Laws, R. (1996). "Distance Learning's Explosion on the Internet". Journal of Computing in Higher Education. Vol. 7 (2) pp. 48-64.

- Lindholm, T. and Yellin, F. (1997). The Java™ Virtual Machine Specification. Reading, MA: Addison-Wesley
- Malikowski, S. (1996). (accessed on March 12, 1999). Virtual Classrooms in Distance Learning. URL: <http://php.indiana.edu/~smalikow/cbc.html>
- McKnight, C., Dillon, A., and Richardsson, J. (1991). Hypertext in Context (pp. 15-41). Cambridge: Cambridge University Press.
- Minoli, D. (1996). Distance Learning Technology and Application. Boston, MA: Artech House, Inc.
- Oklahoma Electronic Campus. (accessed on March 14, 1999). URL: <http://www.ok-electroniccampus.org/>
- Online Training Zone. (accessed on March 14, 1999). URL: <http://home.okstate.edu/homepages.nsf/toc/Nbt-Office97>
- Parrott, L. and Kok, R. (1997). "Design and Development of Multimedia Courseware: An Overview". Canadian Agricultural Engineering. Vol. 39 (2) pp 131-137.
- Porter, L.R. (1997). Creating Virtual Classroom: Distance Learning with the Internet. New York: John Wiley & Sons, Inc.
- Reigeluth, C.M. (1994). "Introduction: An Imperative for Systemic Change". In C.M. Reigeluth and R.J. Carfinkle (Ed.) Systemic Change in Education. Englewood Cliffs, NJ: Educational Technology Publications.
- Relan, A. and Gillani, B.B. (1997). "Web-Based Instruction and the Traditional Classroom: Similarities and Differences". In B.H. Khan (Ed.) Web-Based Instruction (pp. 41-46). Englewood Cliffs, NJ: Educational Technology Publications.
- Ross, R.J. (1997). "WebLab! A Universal and Interactive Teaching, Learning, and Laboratory Environment for the WWW". Twenty-eighth SIGCSE Technical Symposium on Computer Science Education (SIGCSE Bulletin). Vol. 29 (1) pp. 199-203
- Schaller, N.C., Nixon, P., Berman, M., Rozanski, E. Bishop, J. and Welch, P. (1997). "Panel Report: Using Java in Computer Science Education". ACM 1-58113-012-0/97/0010
- Sheldon, T. (1998). Encyclopedia of Networking (pp. 1073-1074). Berkeley, CA: Osborne McGraw-Hill.

- Sherry, L. (1996). "Raising the Prestige of Online Articles". Intercom. Vol. 43(7) pp 24-43.
- Sun Microsystems, Inc. (1998a). (accessed on Nov. 15, 1998). The Java Language: An Overview. URL: <http://java.sun.com/docs/overviews/java/java-overview-1.html>
- Sun Microsystems, Inc. (1998b). (accessed on Nov. 15, 1998). URL: <http://www.javasoft.com/>
- Sun Microsystems, Inc. (1999). (accessed on April. 12, 1999). Objectives for the Sun Certified Programmer for the Java™ 2 Platform. URL: [http://suned.sun.com/usa/cert\\_test.html?content=scpj2\\_obj](http://suned.sun.com/usa/cert_test.html?content=scpj2_obj)
- Thomas, P., Carswell, L., Price, B. and Petre, M. (1998). "A Holistic Approach to Supporting Distance Learning Using the Internet: Transformation, Not Translation". British Journal of Educational Technology. Vol. 29 (2) pp 149-161.
- Turoff, M. and Hiltz, S. (1995). "Software Design and the Future of the Virtual Classroom". Journal of Information Technology for Teacher Education. Vol. 4 (2) pp.197-215.
- Tyma, P. (1998). "Why Are We Using Java Again". Communications of the ACM. Vol. 41 (6) pp. 38-42.
- U.S. News and World Report, (1999). "Giving Credit to a Cybercollege". March 22, 1999.
- Weiss, M.A. (1997). "Experiences Teaching Data Structures with Java". Twenty-eighth SIGCSE Technical Symposium on Computer Science Education (SIGCSE Bulletin), Vol. 29 (1) pp. 164-168.
- Wang, M. (1998). "Creating a Web-based Tutorial for IBM VisualAge for COBOL". OSU Thesis.

## VITA

Bing Wang

Candidate for the Degree of

Master of Science

**Thesis:** ONLINE LEARNING COURSEWARE FOR THE JAVA PROGRAMMING LANGUAGE

**Major Field:** Computer Science

### **Biographical:**

#### **Education:**

Received Bachelor of Science degree in Animal Science from Gansu Agricultural University, Lanzhou, China in July 1982 and Master of Science degree in Animal Science from University of Arkansas, Fayetteville, Arkansas in December 1995, respectively. Completed the requirements for the Master of Science degree with a major in Computer Science at Oklahoma State University in May 2000.

#### **Experience:**

Employed by Lanzhou Animal Industry and Commerce Company, Lanzhou, China as an engineer and department director from 1982 to 1992. Employed by the Department of Animal Sciences, University of Arkansas, Fayetteville, Arkansas, as a research scholar, graduate assistant, and senior graduate assistant from 1993 to 1996. Employed by the Maxell Library, Bridgewater State College, Bridgewater, Massachusetts, as a graduate assistant from 1996 to 1997. Employed by Corporate Express, Inc. as a System Analyst since August 1999.

#### **Professional Certification:**

Sun Certified Programmer for the Java 2 Platform (July 1999).