E-TUTORIAL SYSTEM USING INTEROPERABLE LEARNING OBJECTS TECHNOLOGY

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ABSTRACT

E-learning is getting more important in education because of the rise of information technologies and their broad application in various fields, including education, to provide new or enhanced services. Learning objects play a major role in order to produce and deliver quality content for e-learning. By creating learning objects according to e-learning standards such as SCORM, it enables the learning objects to be reusable, accessible, interoperable and durable.

A ‘Virtual Learning Environment’ (VLE) or a learning platform is normally used to support e-learning by providing online courses and other learning activities. Moodle is one of the most widely used VLEs. However, the Moodle version 1.9.2+, released in October 2008, does not support the SCORM 2004 Sequencing and Navigation, which is an improvement over the previous versions of the SCORM standards. SCORM 2004 Sequencing and Navigation is intended to help to provide learning with more control on the learning sequences. This allows the learning process to be customised according to the learners’ progress.

This study proposes a new technique to create a SCORM module that can support a certain level of SCORM 2004 Sequencing and Navigation on Moodle version 1.9.2+. This technique uses a sequencing engine composed of multiple functions used to execute rules and behaviors of SCORM courses. With the technique, courses with sequencing and navigation rules in Moodle can be created. In addition, courses created by using sequencing rules can support an instructional strategy called remediation. This study experiments the technique by developing an e-tutorial module, which is one of the main services in e-learning. This study also shows the use of sequencing and navigation rules could improve learning. 83% of the users in the survey agreed that the use of sequencing rules in the tutorial is more time efficient compared to the tutorial without sequencing rules. Besides, the study shows that courses built with learning objects which
comply to the SCORM 2004 standards are interoperable between different Learning Management System (LMS).
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CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

To meet the growing demand for educational resources, colleges and universities around the world are turning to online technologies to replace or enhance the traditional classroom experience. E-learning has been widely used and many courses or trainings have been made available online. E-tutorial is one of the important components in e-learning. Tutorials, case studies, notes or exercises can be made available for students in the form of HTML pages, WORD documents, PDF files or video files. This method helps both the lecturers and students to convey and get knowledge and thus improve in learning efficiency. In Ireland, the University College Dublin (UCD) has developed an interactive, online, virtual patient case study on colorectal cancer and has been known as the Pathology e-Tutorial. It includes an online notebook where learners can record their observations and it also simulates a real-life doctor-patient interaction where the learners carry out a consultation, examination, differential diagnosis and clinical tests on a simulated patient (Watts, 2006).

Now, there are so many learning resources that can be gained through the use of the Internet, but most of the time, those resources are not fully utilised. The same learning content is created by different people, but in fact, it is not necessary to have thousands of iterations of the same teaching point. The question is, what can be done to avoid the same resources being created repeatedly, and thus wasting of development effort?

An important component that can be used to tackle this problem in this new learning environment is the use of learning objects. Learning object is the concept in which learning content is broken down into small chunks that can be independently created or maintained, and reused. A learning object is defined by the Institute of Electrical and Electronics Engineers, Inc. (IEEE) Learning Technology Standards
Committee (LTSC) as “any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning” (IEEE LTSC, 2000). There is no standard for the size or granularity of a learning object. A learning object can be as small as a paragraph of text and as large as a 3-month online course.

Many authors such as Wiley (2000) and Hodgins (2000) have used the metaphor of LEGO building blocks to describe learning objects. LEGOs are portable, durable, sharable, and interoperable and can be assembled into imaginative wholes by virtually everyone. The LEGO metaphor conveys the notion of “small pieces of instruction (the LEGO blocks) that can be assembled (stacked together) into some larger instructional structure (castle) and reused in other instructional structures (e.g., a spaceship)” (Wiley, 2000: 15).

The most well known reason for using learning objects is reusability. Once the knowledge content has been packaged as a learning object, it can be reused in multiple applications without much additional effort. This will save a lot of time and effort since the same content does not need to be recreated by other people. Other characteristics of learning objects are interoperability, accessibility and durability.

Interoperability refers to the use of instructional components developed in one location, with one set of tools or platforms, in another location, with a different set of tools or platforms. The learning objects can be mixed and matched from multiple sources and within multiple systems. This means the same learning object can be used in multiple courses or tutorials, and a tutorial can consist of multiple learning objects which are from different sources.

Accessibility of learning objects is an important characteristic because the instructional components are often accessed and delivered to many locations and their usage should not be restricted by factors such as tools or platforms. Durability ensures instructional components to be used without re-design or re-coding when base
technology changes. Besides, durable learning objects allow easy updates and republication due to technology changes. This is an important point because information technology is constantly evolving.

In order to support the reusability of learning objects, to facilitate search and acquisition of learning objects, and to facilitate learning object interoperability, metadata is used. Metadata, which often described as “data about data”, plays an important role in learning objects technology. Metadata includes a list of commonly defined fields for each learning object and it is essential for describing learning objects. When a learning object is needed for a particular course, metadata is the clue for finding the learning object. One of the purposes of learning object metadata is to support the interoperability of learning objects. By attaching metadata to learning objects according to a standard schema, the descriptive information of the learning objects can be accurately interpreted and efficiently processed and this enables learning objects to be used within various learning management systems.

A Learning Management System (LMS) is an automated system which uses Web technology to help users to plan, organize, implement, and control all aspects of the learning process. It helps to deliver e-learning courses and also tracking users and providing reports of who did what (Henderson, 2003). Learning objects together with the metadata can be packaged and imported into a LMS so that it can be shown to the learners as a course or part of a course depends on its design.

While both educators and learners understand the importance of using learning objects in the e-learning experiences, several standards have been developed for the purpose of content distributions. The common standards used are SCORM (Sharable Content Object Reference Model), IMS (Instructional Management Standards) and AICC (Aviation Industry Computer-Based Training Committee). Standards are important to enable interoperability, to protect the investment on content development,
and enable the exchange of content locally and globally. Without these standards, learning objects cannot be easily reused, or to be mixed and matched to form a customized lesson for specific groups or individuals. The standards are described in detail in Section 2.5.

1.2 PROBLEM STATEMENT

E-tutorial has been used in universities, educational institutes and colleges. It is also a way to convey knowledge of certain topics in person. However, the adoption of e-tutorial has encountered several obstacles. Below are some of the obstacles:

- The creation of the content in e-tutorial might be time consuming if it is to deliver good quality content. Typically, e-learning companies quote development ratios such as 276 hours to develop one hour of complex e-learning (Watts, 2006). A media-rich simulation system would be an example of complex e-learning.

- A Learning Management System (LMS) might be used to create and manage e-tutorial. However, system requirements might change over time and hence different LMS will be needed at different stages in order to provide desired functionalities. Unfortunately, people tend to resist adoption of a new LMS because they were attached to what they had built in the first LMS (Mitchell, 2005).

The problems above have slowed down the adoption of e-tutorial and have to be resolved in order to allow more people or institutions to gain the benefits of using e-tutorial. In this project, we examine how to resolve or at least minimize the tutorial content creation problem by using the learning objects technology. Learning content was structured as learning objects and they are reusable.
Besides, learning objects that were created based on a standard will ensure their interoperability. Content creators can design and create the content of a tutorial once and use it over various types of standard compliant LMS.

The learning objects technology is not only welcomed by educators in helping them to save time and effort by using reusable learning content, but it is also good for the learners to easily get more personalized learning materials.

1.3 PROJECT SIGNIFICANCE

This project shows the usage of learning object technology in creating an e-tutorial. It shows an example on how learning objects were designed, developed, and then packaged together to compose a tutorial. The SCORM 2004 standard has been selected as the e-learning standard used in this project. The adoption of the SCORM standard ensures the learning objects interoperability. This project examines the interoperability of the learning objects by using them in different LMSs on different platforms.

Although there are a lot of open source LMSs in the market, but most of them do not support SCORM 2004 Sequencing and Navigation, including Moodle, Docebo, Claroline and ATutor. Moodle is a widely used LMS and by adding the support for part of the SCORM Sequencing and Navigation rules into Moodle, learners can experience the usage of the rules, which define how a learner’s interaction with the learning objects will affect navigation or completion of the tutorial. The Sequencing Definition Model in SCORM 2004 defines the order in which content is presented, how tests are used for sequencing, as well as providing remediation options. Remediation is a learning strategy that requires learners to repeat lessons based on their assessment results. By using questionnaire, the learners’ opinion or satisfaction on the usage of the rules and
remediation learning strategy can be collected. The information can be used to evaluate the usage of the rules and how the rules might improve online learning.

1.4 PROJECT OBJECTIVES

The objectives of this project are:

• To develop interoperable learning objects based on the SCORM standard.
• To create an e-tutorial system using the interoperable learning objects developed.
• To identify technologies required to develop interoperable learning objects.
• To enable the Moodle SCORM Module to support SCORM 2004 Sequencing and Navigation rules in order to provide an instructional strategy called remediation.
• To evaluate learners’ satisfaction on the usage of SCORM 2004 Sequencing and Navigation rules in online learning.

1.5 PROJECT SCOPE

The scope of the project is as below:

• Administrator Module: System administrator can login to the administrator module to manage all the users in the e-tutorial system.
• Course Module: Educators can login to the system as teachers and manage courses. Courses contain tutorials that consist of learning objects. Courses can be created, edited and deleted by the teachers.
• SCORM Module: SCORM module is a component in the course module. It is used to import, process, view and play SCORM contents in the tutorials.
• Forum Module: Forum is an activity that can be created in a course. It allows communication between the teachers and the students.
• Blog Module: A blog is associated with each student. It enables the students to express their ideas and opinions.

1.6 INTENDED AUDIENCE

The audience for this project are educators and learners. It is important for the educators to understand the concept and usage of learning objects and how the learning objects can be used to help them, such as providing a rich library of resources. It is also crucial to let the learners to get an idea about how the use of learning objects benefits them to make their learning easier and more efficient.

Besides, online education software developers should be one of the audience because they have to know the impact of using learning objects in online education and the importance of using them to provide a product for their customers. On the other hand, from an organization’s point of view, the adoption of learning objects technology might affect systems such as LMS used in an organization and also will impact the future development or enhancement of those systems. Hence, organization executives have to learn more about learning objects and related topics so that they can determine whether they should use standard-compliant products in the organization, and try to explore the possibilities associated with learning objects, especially those that reduce costs.

However, this project is also suitable for anyone else who is interested in learning objects technology.

1.7 EXPECTED OUTPUT

At the end of this project, an e-tutorial system using learning objects technology will be built based on SCORM standards. The name of the system is P-Learning. The letter P stands for programming.
Learning objects that compose tutorials will be packaged into zip files (SCORM packages) and will be imported into the system to create courses. SCORM 2004 Sequencing and Navigation rules that were set in the SCORM packages will be executed when the tutorial is view by the learners. The contents of the tutorial will focus on programming languages. Both theory and practical exercises will be included.

Questionnaires will be used to collect feedback from the learners and the responses will be analyzed. The analyzed results will show the students’ satisfaction level on the tutorials provided and the use of sequencing rules in online learning.

1.8 DISSERTATION STRUCTURE OUTLINE

The dissertation is divided into eight chapters. Chapter One is the Introduction; Chapter Two reviews the literature on online learning and learning objects related topics; Chapter Three discusses the methodology used to conduct this research; Chapter Four covers the system analysis while Chapter Five discusses the design of the system and the learning objects; Chapter Six focuses on the development of the P-Learning system and the SCORM packages; Chapter Seven explains the testing activities performed in this project and also the deployment and maintenance of the P-Learning system. The last chapter discusses and summarizes the research findings.

1.9 SUMMARY

Learning objects technology is very useful in online education and is getting more attention from the industry. The characteristics of learning objects especially reusability, interoperability, accessibility and durability really help in reducing costs and saving time for developing online learning systems. It will benefit not only the developers, but also the educators, learners and organizations.
In order to maximize the advantages of using learning objects in education and training, a standard should be adopted and SCORM has been chosen in this project. By following the standard, learning objects will become easier to be reused and integrated into other standard compliant systems.

An e-tutorial system using learning objects technology was developed in this project and its usage and advantages have been clearly seen.
CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

E-learning is a major component in education today. This chapter discusses on various types of e-learning and the activities or features in each type of e-learning. A few existing e-tutorial systems are reviewed and the features in those systems are compared. This chapter also discusses on learning object which is an important concept in e-learning. Some characteristics of learning objects, especially the interoperability of learning objects are discussed. Besides, e-learning standards and organizations that are involved in developing these standards will be addressed.

2.2 E-LEARNING

“E-learning is the delivery of a learning, training or education program by electronic means. E-learning involves the use of a computer or electronic device (e.g. a mobile phone) in some way to provide training, educational or learning material” (Stockley, 2003). E-learning is the use of technology to enable people to learn anytime and anywhere. It can include training, delivery of just-in-time information and guidance from experts. E-learning can be CD-ROM-based, network-based, intranet-based or internet-based and it can include text, graphics, video, audio or animation.

Before e-learning was introduced, training was done using video tape and CD but these methods were lacking in user customization, difficult to upgrade, expensive to maintain and also lacked the ability to track learners’ performance. All these problems would disappear with the use of the Internet as a means of delivering content. As technology continues to evolve and the dependency on computers grew, newer and more efficient features turned e-learning into an important aspect in education.

Besides, in the educational field, students nowadays demand new learning approaches and teaching methods in order to keep their attention and motivation to work
at school. They show very short attention spans and cannot listen for more than five minutes in the classroom (Veen & Vrakking, 2006). All these problems can be solved by using e-learning. E-learning enables students to learn at their own pace at any time, or even through different tools such as audio, video and games, depends on their preferences.

Collaborative learning is a useful approach in e-learning. “Collaborative learning is an umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together. Usually, students are working in groups of two or more, mutually searching for understanding, solutions, or meanings, or creating a product” (Smith & MacGregor, 1992). By using collaborative learning approach, students will be able to create new ideas other than just taking in information or ideas from the teachers and this is crucial to learning. Group discussions, group projects, debates and forums are some examples of collaborative learning activities.

E-learning has been used very effectively in education especially for higher education. Many universities provide students on many courses with Web access to the lecture notes and also digital resources to support their study. Besides, it has enabled universities to expand on their current geographical reach and establish themselves as global educational providers. By using e-learning, part time students can access to courses more easily and this in turn supports the objectives of wider participation. The Sloan Consortium, a consortium of institutions and organizations committed to quality online education, has reported that there were nearly 20 percent of all U.S. higher education students, which was almost 3.5 million students, taking at least one online course in the fall of 2006, and it is nearly 10 percent increase over the number in 2005 (Allen & Seaman, 2007).
There are three types of e-learning. They are synchronous learning, asynchronous learning, and blended learning (Panebianco, 2008). Each type has their advantages and also disadvantages as explained in the following sections.

2.2.1 SYNCHRONOUS LEARNING

This type of learning involves interaction of participants with an instructor in real time. It uses the Internet to experience classroom interaction in a virtual environment. Synchronous learning sessions can be recorded and played back but the main focus is on the live interaction and the collaborative learning process.

Below are some examples of this type of learning:

- Virtual classroom: A virtual classroom duplicates the capabilities found in a real classroom. Students and teachers use their computers to go to a virtual meeting place instead of a classroom.
- Shared whiteboard: A shared whiteboard lets a group of people communicate by typing comments, drawing and highlighting.
- Instant messaging: One person can communicate to another through typing. Users can keep a list of people that they might like to chat with and is able to know whether they are online or offline.

The advantages of synchronous learning are immediate feedback, real-time demonstrations, continuous monitoring and track of learning activities. On the other hand, the disadvantages of synchronous learning are time constraints, network connection problems, and audio tool related problems (Park & Bonk, 2007).

2.2.2 ASYNCHRONOUS LEARNING
This type of learning involves self-paced learning. It provides information that is accessible 24 hours a day, 7 days a week and hence the participants can get the information whenever they need it. In an asynchronous learning environment, the instructor only interacts with the student intermittently and not in real time (Munindar, 2004). It may include interaction amongst students or with the instructor through message boards, e-mail and discussion forums.

Below are some examples of this type of learning:

- Discussion forums: A discussion forum is a collection of conversations that occur over time. It might start out as a question from an individual and another individual responds later.

- E-mail: E-mail is the exchange of computer-stored messages by telecommunication.

One of the advantages of asynchronous learning is the flexibility of time and place. The course contents remain stored within the system at all times, and each student can access this information at any time. Another advantage is related to technology. Asynchronous course implementation is relatively simple compared to synchronous learning because asynchronous learning usually only necessitating the use of an off-the-shelf software package such as Learning Management System (LMS), personal computers, and an Internet connections (Tomei & Morris, 2008). Asynchronous learning has some disadvantages as well. One of the disadvantages is that it is generally more difficult for people being trained to discuss ideas with each other (Tobin, 2000). Besides, students can find it difficult to motivate themselves to complete the programs.

2.2.3 BLENDED LEARNING
Blended learning is the combination of synchronous and asynchronous learning methods. It can be accomplished through the blending of virtual and physical resources. An example of this would be a combination of technology-based materials and face-to-face sessions used together to deliver instruction. This type of learning is getting more attention as people believe that the combination can provide a more complete training.

There are a number of advantages of using blended learning. Blended learning can make use of a variety of techniques by maximizing different technologies and make learning more targeted, focused, and just-in-time. Besides, it also widens reach of training, meets diverse needs and improves training responsiveness (Thorne & Mackey, 2003; Wilson & Smilanich, 2005). Blended learning also has its disadvantages. Technology problems may occur especially at the beginning of the adoption of blended learning in order to support various components and tools such as virtual classroom, whiteboard, voice chat and discussion forum. Besides, poor integration or planning in using blended learning will cause instructors and students’ confusion during the learning process.

### 2.2.4 LEARNING TYPES COMPARISON

Both synchronous and asynchronous learnings have their advantages and disadvantages. Table 2.1 shows summary of comparison between those two types of learning.

<table>
<thead>
<tr>
<th>Features</th>
<th>Synchronous</th>
<th>Asynchronous</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Real time.</td>
<td>- Self-paced.</td>
</tr>
<tr>
<td></td>
<td>- Collaborative.</td>
<td>- Individual or collaborative.</td>
</tr>
<tr>
<td></td>
<td>- Usually immediate feedback.</td>
<td>- Intermittent interaction.</td>
</tr>
<tr>
<td></td>
<td>- Instructor directed.</td>
<td>- Time to reflect.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Standardized content.</td>
</tr>
<tr>
<td>Challenges</td>
<td>- Inconvenience caused by time zones.</td>
<td>- Lack of immediacy.</td>
</tr>
<tr>
<td></td>
<td>- No time to reflect.</td>
<td>- Self-discipline.</td>
</tr>
</tbody>
</table>
2.2.5 BENEFITS OF E-LEARNING

E-learning does not preclude the use of the traditional classroom but provides an option to facilitate different styles of learning. There are a few advantages of using e-learning.

- **Self-paced**: E-learning allows users to go through the course at their own pace. It lets learners control what information to be accessed and avoid missed information.

- **Interactivity**: Interactivity can be in the form of responding to a question, completing a quiz, clicking to start a video or posting a question during the online chat session. This type of interactivity helps learners retain more information.

- **Flexibility**: Learners can go through courses from anywhere at anytime. This solves the geographical problem because learners from different places can meet virtually and access standardized information at anytime.

- **Motivation**: Convenience that e-learning offers such as flexibility and interactivity can motivate learners to learn.

The e-learning system designed using learning objects potentially increase the speed and efficiency of e-teaching. The idea is the usability and reusability of learning objects can lead to important savings in time and money and enhance the quality of digital learning experiences and it leads to faster, cheaper and better learning (Jayanthi et al., 2007).
2.2.6 DRAWBACKS OF E-LEARNING

Although there are a lot of advantages of using e-learning, there are also some drawbacks that should not be neglected. Below are some of the disadvantages of e-learning:

- Efficiency: E-learning activities such as discussion forum can be an efficient way to allow learners to convey and share their knowledge. However, it could be not efficient on the other hand if the discussion is carried out without supervision. Learners might deviate from the topic and post irrelevant information that will lead to confusion or unanswered questions.

- Demotivated learners: Although the rise of technology has made online learning easier than ever, there are certain activities such as virtual classroom and instant messaging that might still facing technology problems, for example bandwidth limitation and stable network connection. If a learner keeps getting disconnected during a virtual classroom session, the learner might get demotivated and feel reluctant to continue the session.

2.3 E-TUTORIAL

E-tutorial is one of the main activities in e-learning. It is the use of email, discussion boards, real-time chat or any other synchronous or asynchronous communication methods to provide self-paced, independent learning, and to discuss problems or suggest actions. Online tutorials can be used as stand-alone learning tools or as an adjunct to traditional classroom instruction.

Case studies had been carried out by Zubas et al. (2006) to identify the impact of online tutorial and student learning. Students completing a Web-based tutorial as a supplement to classroom lecture displayed greater improvement in pre- to post-test scores compared with students who attended lecture only. The study found that online
tutorial provides a learning tool that students can use at their own time and at their own pace. Images, animations, interactive problems and quizzes can maintain student interest in online learning. Students have control over when and what content they can access and this gives students greater sense of engagement in the learning process. However, the study also emphasised that adequate computer skill and prior online learning experience are important for the success of online learning.

2.3.1 CURRENT E-TUTORIAL SYSTEMS

2.3.1.1 W3 SCHOOLS (http://www.w3schools.com)

This is a free website that provides all the Web-building tutorials, from basic HTML and XHTML to advanced XML and SQL. It was started in 2000 and in 2007, it served more than 2 million page views every day.

In this system, different kinds of Web-building languages and technologies are nicely grouped into categories. It is to ease learners to have a view on what tutorials are provided and allows them to pick one that they are interested in. Hyperlinks can be found within a subject’s tutorials to enable learners to get more details when they come across unfamiliar but related topics. It also has a search function that allows learners to search for related tutorials by using keywords. For most of the subjects’ tutorials, working examples are provided to let the learners to see the actual results of the code samples.

For each main subject, the learners can take the quizzes. Although those are not complicated quizzes but it is a nice way to let the learners to examine how much they know. Besides, editable examples are provided. Learners can not only read the sample codes, see the actual results, but also edit the codes and see the new results immediately. This will be very helpful in understanding the examples. The system also provides a discussion forum where multiple topics can be discussed in the forum. Learners can
either search the forum for information needed by using keywords or by category. This is one of the asynchronous methods to let learners to interact with each other and it also shows collaborative learning.

Most of the subjects’ tutorials are categorized and divided into sub topics with different levels of difficulty. This enables the learners to pick only those topics that they are interested in and learn with self pace at anytime. Although the learners are free to navigate and select tutorials in the system, suggestions are given to the learners on some main topics that are related to what they are learning in order to make the learning process more efficient. Figure 2.1 shows the main page of the W3 Schools system.

![W3 Schools main page](image)

**Figure 2.1 W3 Schools main page**

### 2.3.1.2 FREE-ED.NET (http://www.free-ed.net/free-ed/)

This system provides quality online education at no cost to the users. It helps the students by supplementing their studies through providing resources and helps the teachers by acting as a source of study guides and teaching ideas. It delivers over 1.5 million pages of educational material to 400,000 users each month.
This system has a “How it works” section which tells the learners how to learn at Free-Ed.net. It provides a whole list of courses and subjects available and courses are divided into few parts covering different scopes. There is a Google search box within some of the tutorials which enables the users to get additional resources on the subject from the Web. Quizzes and exercises can be found and the learners are encouraged to take part. Apart from simple text and images, audio and video clips can be found in some of the subjects’ tutorials. These will make the tutorials more interactive and interesting. The learners can give comments about the tutorials by sending emails to the system administrator.

Learners can choose up to 120 available courses and choose only their interested topics within the course. When a learner is learning using audio or video clips, he or she can pause or replay the clips at anytime. This enables the learners to study with their own pace and take control in their learning. Figure 2.2 shows the main page of the Free-ed.net system.

Figure 2.2 Free-Ed.net main page
This system contains well-organized tutorials, examples and also links to great resources. It contains a collection of articles and links to information about developing World Wide Web sites. It also includes in-depth tutorials on the software technology available.

There is a site map in the system that shows a comprehensive site directory. It helps the learners to identify tutorials available in the system. Other than the tutorials in the system, a learner can use the search box to get more information from the Web. The “Top 100” shows the most popular list of articles to help the learners to quickly locate the most visited pages and also to help the system administrator to know what the learners were looking for.

This system provides a discussion forum. Learners can post a thread and let other learners to reply and discuss about the topic. Each reply has a rating which gives the learners an idea on how good or useful the reply is. If the learners have a question that cannot be answered in the discussion forum, they can try the mailing list method. Mailing list is not an open discussion but it is an attempt to answer questions that are left unanswered on the site. Both discussion forum and mailing list enable the learners to interact and learn form each other. Learners can also subscribe to the newsletter so that they will be informed on the latest articles and tutorials.

All the tutorials or topics in the discussion forum are categorized nicely to enable the learners to easily gain information which is useful to them. Basic navigation options such as Previous and Next buttons can be used to revise or skip certain parts of the content. Figure 2.3 shows the top part in the main page of the Web Developer’s Virtual Library system while Figure 2.4 shows the bottom part in that main page.
2.3.1.4 DEV CENTRAL (http://devcentral.iftech.com/default.php)

Dev Central provides free tutorials and articles on software development. It is targeted to students and professional software engineers. Registered users can get totally free and private access to all the contents in the system. Tutorials are grouped by
subjects and the menu shows the list of all subjects. It enables the learners to easily select a subject and get the list of tutorials belongs to the selected subject. A few popular articles are shown in the main page to allow faster access to those frequently-accessed articles.

Some of the tutorials contain workable examples which the learners can click to view the real results. There are also some sample projects that are available as downloadable zip files for the learners to run the projects in real environment with full source codes. Besides, some articles can be downloaded into PDF files for further reference even when the learners are not online. Learners can give comment on the articles or give suggestions through emails by clicking the links provided in the articles.

Figure 2.5 shows the main page of the Dev Central system.

![Dev Central main page](image)

Figure 2.5 Dev Central main page

2.3.1.5 WEB DEVELOPERS NOTES (http://www.webdevelopersnotes.com/)

Web Developers Notes is a Web resource for tutorials, tips, and articles on Web design and development. It offers free Web programming tutorials and tips on HTML,
JavaScript, Flash and other Web technologies. The system has been established since 2000.

All the learning resources in this system are grouped under a number of headings including Tutorials, Tips and Tricks, Articles and Resources. When learners select one of those groups, a list of all the contents in the group will be shown. The learners can select a subject to view the contents. Working examples and assignment can be found in certain tutorials. At the end of most tutorials, there is an ‘online workspace’ box that lets the learners to ‘play with the code’ and put what they have read into practice. In addition, comments and questions can be posted by the learners. Basic Next and Back navigation buttons are provided within a tutorial. Besides, breadcrumb navigation which helps the learners to reveal their location and enhance the way the learners find their way around is used in this system.

On the main page of the system, recent articles and popular articles are listed. This makes the learners to be aware of new added articles and also articles that are most popular in the system. There is also a Google search box on every page which enables the learners to search for additional information. Figure 2.6 shows the main page of the Web Developers Notes system.
2.3.2 E-TUTORIAL SYSTEMS COMPARISON

High quality learning is characterized by being able to discover knowledge for oneself, long-term retention of the knowledge, being able to apply one’s knowledge to solving problems and being able to communicate one’s knowledge to others (Nightingale & O’Neil, 1994). An easy to use system with adequate navigation aids and controls can help learners to concentrate on the learning material and spend more time in gaining knowledge than in technicalities problems of using the system. Besides, collaborative learning is an effective approach to discover and communicate knowledge, problem solving and also provide better retention of knowledge. Hence, the quality of an e-tutorial system should be evaluated based on the aspects of ease of use, interactivity, collaborative learning and learner-control. Table 2.2 shows the summary of comparison of all the e-tutorial systems studied in Section 2.3.1 based on these four aspects. The ordering of aspects in Table 2.2 does not represent their level of importance in e-tutorial systems.

Table 2.2 Comparison of system aspects

<table>
<thead>
<tr>
<th>System Aspect</th>
<th>W3 Schools</th>
<th>Free-Ed.net</th>
<th>Web Developer’s Virtual Library</th>
<th>Dev Central</th>
<th>Web Developers Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of use</td>
<td>● Site map. • Categorized menu for easy access. • Search function. • Hyperlinks to related topics. • Printer friendly function.</td>
<td>● Help information in using the system. • Google search box. • Full course and subject listing.</td>
<td>● Site map. • Search function. • Listing of most popular articles.</td>
<td>● Categorized menu based on programming language. • Listing of most popular articles.</td>
<td>● Site map. • Categorized menu for easy access. • Listing of recent and popular articles. • Google search box.</td>
</tr>
<tr>
<td>Interactivity</td>
<td>● Quizzes. • Editable examples make learning more effective. • Discussion forum. • Search function.</td>
<td>● Quizzes and exercises. • Search function. • Email on comments. • Audio and video lectures.</td>
<td>● Discussion forum with post rating. • Mailing list. • Newsletter.</td>
<td>● Downloadable article in PDF file. • Downloadable sample project with source code in ZIP file. • Email on comments or suggestions.</td>
<td>● Assignment. • Questions and comments. • ‘Online Workspace’.</td>
</tr>
</tbody>
</table>
Other than compare all the five e-tutorial systems studied in this project based on the aspects described above, these systems can also be compared based on their overall strengths and weaknesses. Table 2.3 shows the summary of comparison of strengths and weaknesses for those systems.

Table 2.3 Comparison of system strengths and weaknesses

<table>
<thead>
<tr>
<th>System</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
</table>
| W3 Schools                                  | • Well-organized content.  
• Simple and neat user interface.  
• Broad-coverage content.  
• Categorized menu provides easy access of tutorials to learners who have a clear idea of tutorial topics to be studied.  
• Support collaborative learning by using discussion forum.                                                                                                                                                                                                                                               | • Lack of audio or video type of lectures which can make the learning session more attractive and interesting.  
• Lack of information on latest popular topics or new added lectures as suggestion for study to learners.                                                                                                                                                                                                     |
| Free-Ed.net                                  | • Provide external resources on topics selected by learners. This enables learners to refine or extend their understanding on what they are learning.  
• Provide option for audio or video type of lectures that enables more learners’ interaction during a learning session.                                                                                                                                                                                                                                         | • Overloaded of external resources might prevent learners from completing a single course.  
• Lack of tools to support collaborative learning.  
• A lot of online advertising banners that might distract learners’ concentration on learning.                                                                                                                                                                                                                     |
| Web Developer’s Virtual Library             | • Well-organized content.  
• Learners are aware of new added and latest popular topics or articles easily. This information enriches learners’ knowledge on popular or new technology.  
• Provide sufficient tools to support collaborative learning.                                                                                                                                                                                                                                               | • Lack of audio or video type of lectures.  
• Provide sufficient depth on a single topic or subject but the number of topics provided is limited compared to other systems such as W3 Schools.                                                                                                                                                     |
| Dev Central                                 | • Learners are aware of the most popular resources in the system.  
• Articles and projects are downloadable. This enables learners to retain the articles or projects even after they went offline.                                                                                                                                                                                                  | • Lack of tools to support collaborative learning.  
• Learners need to register to be a member in order to access more articles and to receive newsletter.                                                                                                                                                                                                             |
Those five e-tutorial systems were built on different platforms with different programming languages. Table 2.4 shows comparison of technology used in those systems. The row on technical support in Table 2.4 indicates how the learners can find help or support when they face any technical issues in using the system.

<table>
<thead>
<tr>
<th>System</th>
<th>Technology</th>
<th>W3 Schools</th>
<th>Free-ed.net</th>
<th>Web Developer’s Virtual Library</th>
<th>Dev Central</th>
<th>Web Developers Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating system</td>
<td>Windows Server 2003</td>
<td>Windows 2000</td>
<td>Linux</td>
<td>FreeBSD</td>
<td>Linux</td>
<td></td>
</tr>
<tr>
<td>Server</td>
<td>Microsoft IIS 6.0</td>
<td>Microsoft IIS 5.0</td>
<td>Apache</td>
<td>Apache</td>
<td>Apache</td>
<td></td>
</tr>
<tr>
<td>Main programming language</td>
<td>ASP</td>
<td>ASP</td>
<td>HTML</td>
<td>PHP</td>
<td>PHP</td>
<td></td>
</tr>
<tr>
<td>Technical Support</td>
<td>Forum</td>
<td>FAQ</td>
<td>Forum</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

2.4 LEARNING OBJECTS

2.4.1 DEFINITION AND CONCEPT

Learning objects are the core concept in online education. The Institute of Electrical and Electronics Engineers, Inc. (IEEE) Learning Technology Standards Committee (LTSC) defines a learning object as “any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning” (IEEE LTSC, 2000). However in practice, learning objects are normally in digital format and are usually created and stored in a content management system (CMS).

According to Watson (2001) as cited by Bratina et al. (2002) the term learning object originates from “object-oriented programming” and essentially describes an
object or small section of content that is designed for a specific purpose and can be organized using what is called metadata (i.e., data about data). The fundamental idea of learning object is that learning contents can be broken down into “bite size” chunks which can be created, maintained, reused, and pulled apart and stick together, just like the LEGO\(^1\). This method aims to lower the production costs. It eliminates thousands of iterations of the creation of the same learning content. In addition, learning objects can be tailored based on individual requirements to meet specific goals. There is no standard for the size of a learning object.

Other than using LEGO to explain learning objects, David Wiley uses another metaphor to describe learning objects as being comparable to atoms. Atoms are small, self-contained units made up of protons, neutrons, and electrons. They can be combined to make molecules. However, not every atom can be combined at random with every other atom. Learning objects, like atoms, can only be combined within a closed set of objects to support viable learning.

### 2.4.2 CHARACTERISTICS

There are many characteristics of learning objects, for example reusability, interoperability, accessibility, reusability, granularity, scalability and adaptability. According to Sicilia & Garcia (2003) learning object specifications often refer to durability, interoperability, accessibility and reusability. Besides, granularity, interoperability and reusability help define what a “good” learning object should be (Koohang & Harman, 2007). Although there are some other characteristics, the focus of this project is those characteristics explained below.

- **Reusability**: A well designed learning object should allow users to incorporate it into multiple applications without much additional effort. It should be able to be

\(^1\) LEGO consists of colorful interlocking plastic bricks and an accompanying array of gears, minifigures and various other parts.
assembled and used in a context other than that originally designed. Storing, searching, and retrieving learning resources are major challenges in traditional teaching and learning media. Learning object repositories provide solutions to the problems in distributing and reusing the knowledge sources.

- **Interoperability**: Allows mix and match content from multiple sources and within multiple systems. Integrity of the objects is well preserved in the transferring. Metadata and learning object standards enhance the interoperability of learning objects.

- **Accessibility**: A learner can access the appropriate content at the appropriate time on the appropriate device. It is very important because learning objects are often accessed from one remote location and delivered to many other locations in the distributed learning environment.

- **Durability**: Learning objects can be used when base technology changes, without redesign and re-coding. Learning contents will not easily become obsolete. Easy updates and re-publication would extend the durability of the learning objects.

- **Granularity**: Refers to how rigorously learning objects are broken down and stored. The unit of a learning object can be a program, a course, a module, a lesson or a raw object. Generally a finer level of granularity will promote reusability, by allowing learning objects to be used in multiple contexts. However, a great number of smaller objects requires more cataloguing and therefore increases the costs associated with manageability.

- **Scalability**: Learning technologies can be configured to have expanded functionality to serve broader populations and organizational purposes.

- **Adaptability**: Ensures a learning object is tailored perfectly for the individual and situational needs.
2.4.3 ADVANTAGES AND DISADVANTAGES OF USING LEARNING OBJECTS

There are pros and cons in using learning objects. Table 2.5 shows a summary of the advantages and disadvantages of using learning objects. Part of the information in Table 2.5 is adopted from Robson (2001).

Table 2.5 Advantages and disadvantages of using learning objects

<table>
<thead>
<tr>
<th></th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production cost</td>
<td>By breaking learning content into learning objects, it can be reused or modified and new content does not need to be created, hence cost can be saved.</td>
<td>Switching to learning objects approach is not an easy job and need the use of new systems, hence need retraining costs.</td>
</tr>
<tr>
<td>Flexibility</td>
<td>With the large amount of standards-based learning objects available, designers will have more choices and thus gain flexibility.</td>
<td>In order to ensure interoperability, the use of standards-based learning objects restricts the scope of learner information that is accessible by content.</td>
</tr>
<tr>
<td>End user cost</td>
<td>Learning object approach prevents consumers from being locked in to specific systems. Consumers can have more choices with lower cost.</td>
<td>The cost of converting existing content to a learning object approach may be significant.</td>
</tr>
<tr>
<td>Customizability</td>
<td>Modular learning objects allow them to be reused or edited and to be combined easily to meet different needs.</td>
<td>The process in searching for suitable learning objects may be time consuming and requires certain tools or software and skills.</td>
</tr>
</tbody>
</table>

Although the use of learning objects can provide advantages such as reduction of production cost and end user cost as explained above, these advantages can only be gained with careful selection of learning objects available. A learning content may consists of multiple learning objects created by different people. This may result in different terminologies used to reference a single concept and also different formats used to display information, such as tables or charts. Hence, some effort is needed in selecting
or customizing reusable learning objects in order to produce easy to understand content together with consistent look and feel.

2.4.4 INTEROPERABLE LEARNING OBJECTS

Reusability is an essential and arguably the most important characteristic of learning objects. However, interoperability is a precondition for reusability (Sicilia & Garcia, 2003; Boyle & Cook, 2001). Learning objects’ interoperability can be defined as the ability for objects from multiple and unknown or unplanned sources to work or operate technically when put together with other objects (Koohang & Harman, 2007). One example is learning object is able to work properly when moved from one infrastructure (operating system, tools, etc.) to another. It is a key to the successful implementation of an e-learning environment.

Interoperable content not only gives developers the freedom to move between LMS when a more competitive product is available, it also allows content to be traded between companies who do not use the same LMS. As the standards become popular and interoperability becomes common, teachers and students would be expected to begin using learning objects developed by other institutions which have different administrative structure, hardware and software, as well as assumed work practices around these objects (Woo et al., 2004). This sharing of resources provides economic advantages for institutions.

Interoperability can exist at different scales:

- Between learning objects: Interoperability focuses on interactions between learning objects based on a common Application Program Interface (API).
- Between learning objects and Learning Management System (LMS): Learning objects being able to work properly when moved from one standard-compliant LMS to another.
• Between learning objects repositories: Learning objects stored in one learning objects repository can be discovered, previewed, and transferred to another learning object repository. Learning object repositories are the storehouses of learning objects (Richards & Hatala, 2003).

• Between metadata schemas: Several metadata schemas such as Dublin Core Metadata Element Set (DCMES) and the Learning Object Metadata (LOM) Base Schema can be used to describe learning objects. In order to enable automatic mapping between metadata schemas, the descriptions of the interrelationships between metadata elements need to be made available for machine processing (Duval & Hodgins, 2003).

Interoperability relies upon communication of information between application programs and this normally requires the use of standardized protocols and formats. Metadata is a key component for the learning objects’ interoperability. Efforts to create standards for the interchange of information or metadata have produced a number of national and international standards.

2.5 E-LEARNING STANDARDS AND SPECIFICATIONS

As mentioned in the previous sections, learning objects have the characteristics of reusability, interoperability, accessibility and durability. In order to ensure a learning object has those capabilities, standards must be followed. Those e-learning standards are formed by a group of organizations through complicated standards development process.

2.5.1 STANDARDS ORGANIZATIONS
Many organizations are involved in developing, applying and testing, and monitoring e-learning specifications and standards. The following is a summary of some of those organizations and a description of their roles.

- **ADL – Advanced Distributed Learning**
  ADL is a U.S. government-sponsored organization that researches and develops specifications to encourage the adoption and advancement of e-learning.

- **IEEE – Institute for Electrical and Electronics Engineers Learning Technologies Standards Committee**
  IEEE is one of the most well known committees in the technology industry, they have initiated, sustained and promoted multiple standards in various technology fields. It has working groups related to e-learning in the areas of system architecture, digital rights, and computer managed instruction, metadata and competency definitions.

- **AICC – Aviation Industry CBT (Computer-Based Training) Committee**
  The AICC is an international association of technology-based training professionals that develops guidelines for the aviation industry in the development, delivery, and evaluation of CBT and related training technologies. It promotes interoperable e-learning standards and specifications that software vendors can use not only in the aviation industry, but also in other industries.

- **IMS – Instructional Management System Global Learning Consortium**
  The focus of IMS work includes metadata, content packaging, question and test interoperability, digital repositories, accessibility, vocabularies, and e-portfolios.

- **ARIADNE – Alliance of Remote Instructional Authoring and Distribution Networks for Europe**
The basic mission of ARIADNE is to enable better quality learning through the development of learning objects, tools and methodologies that enable a “share and reuse” approach for education and training.

2.5.2 STANDARDS CATEGORIES

E-learning standards can be grouped into three main general categories, which are metadata, content packaging, and learner profiles (Ellis, 2005).

2.5.2.1 METADATA

Learning object metadata is data used to describe learning content in order to ensure that the learning content can be kept, found and retrieved by multiple tools across multiple repositories. Learning content’s author, title, version number, educational context and intent are the information that can be kept as metadata. “Metadata, literally ‘data about data’, is descriptive information about a resource. Metadata allows you to locate an item very quickly without investigating all the individual items through which you are searching.” (Wiley, 2000: 10).

Example for this type of standard is the Learning Object Metadata (LOM) created by IEEE. The ADL Sharable Content Object Reference Model (SCORM) also incorporates the IEEE LOM into their application.

2.5.2.2 CONTENT PACKAGING

Content packaging standards describe how educational content can be packaged so that it can be transferred within multiple learning systems. This is important because learning content might be created by one tool and then modified or transported into different tools or systems. A content package can consist of learning objects, the organization information which describes how the learning objects are structured to be a
bigger learning unit, and also the sequencing rules which define how the learning content will be delivered.

Examples for this type of standard are:

- IMS Content Packaging specification
- IMS Simple Sequencing specification
- IMS Question and Test Interoperability specification (QTI)

The standards are described in Section 2.5.3.

2.5.2.3 LEARNER PROFILE

Learner profile standards enable sharing of learners’ information among different system components. The information includes learners’ profile, learning experiences, learning plans and the participant’s status in current learning. Personalized learning can become a reality when a learner’s profile, determined by preliminary assessment, is used to structure and sequence the learning components (Metros & Bennett, 2002).

One example for this type of standard is the IMS Learner Information Package (LIP) specification. The IMS LIP standard is described in Section 2.5.3.

2.5.3 STANDARDS

E-learning standards and specifications are technical protocols which promote easy exchange of content or data between different systems. Once standards are well defined and widely adopted, consumers are prevented from lock-in to particular products and vendors. Development costs can be lower because content that has been created according to the standard can be used by any delivery systems. Besides, large storehouses of reusable content will help content creator by re-using content and create modular content that can be updated and maintained more easily.
The following is a brief introduction to some common e-learning standards:

- **IEEE LOM**: It specifies the syntax and semantics of learning object metadata required to fully and effectively describe a learning object. Some attributes of learning objects that can be captured in metadata include the type and description of object, creator of the object, technical format and location of the object.

- **IMS Content Packaging**: It describes how to package learning objects in standardized format, what are the resources used by the learning objects, and also provides information to LMS on the organization of learning objects in the package. ADL has adopted the IMS Content Packaging as part of SCORM.

- **IMS Simple Sequencing**: It is used to describe navigation paths through a set of learning activities. An instructional designer or the learner, given the right software tools, can use simple sequencing to describe many learning paths using the same set of learning activities.

- **IMS QTI**: It is designed to allow the transfer of assessment items and results between testing software applications. The assessment items developed according to the QTI specification are sharable within and between organizations that are using software that is compliant with the specification.

- **IMS LIP**: It provides a means by which information about learners can be recorded and then be used to customize a learning experience. It defines XML structures to allow learners’ information to be transported and shared across multiple systems.

- **ADL SCORM**: It is a reference model for standardizing the reusability and interoperability of learning content. It has adopted the IMS Content Packaging and it is the ADL’s most widely known initiative.
2.5.4 SCORM OVERVIEW

The SCORM model is an interrelated set of specifications techniques mainly established in the previous work of the AICC, IMS and IEEE. SCORM specifications establish the levels of accessibility, interoperability, durability and reusability of the Web-based computer-supported learning (CSL) contents and systems (Neto & Brasileiro, 2006).

SCORM divides the world of learning technology into functional components. The key components are LMS and Shareable Content Objects (SCOs). SCOs are a standardized form of reusable learning object while an LMS is (for the purposes of SCORM) any system that keeps learner information, can launch and communicate with SCOs, and can interpret instructions that tell it which SCO comes next (Robson, 2001). Figure 2.7 shows the functional components of learning technology in SCORM view.

![Figure 2.7 Learning functional components in SCORM view (Robson, 2001)](image-url)

SCORM focuses on two important parts. The first part defines a model for packaging learning content, known as content aggregation model. This is shown in Figure 2.7 where three individual SCOs (SCO 1, SCO 2 and SCO 3) are assembled into a package before it is loaded into the LMS. The second part defines how the learning content can communicate with the LMS through API. This is shown in Figure 2.7 where...
the LMS loads and delivers the SCOs to learner’s computer according to instructions. LMS is explained in more detail in Section 2.6.

2.5.4.1 CONTENT AGGREGATION

SCOs are individual units of learning where they can only be grouped together to create packages but cannot be broken down into smaller units. There are three things that must be handled in the content aggregation process. First, the SCOs need to be built into a content organization. Second, provide instructions that define the sequence of delivery of SCOs by a LMS. Third, the SCOs and instructions must be packaged to enable exchange between multiple systems. The instructions in the packages are for the movement between SCOs but not within individual SCOs.

A SCORM package contains an XML document called the manifest file that describes the contents of the package, the content organization and the SCOs’ sequencing information. The manifest file also contains information on where to get the SCOs as the SCOs’ resources can be physically included in the package or referenced externally by the package.

2.5.4.2 COMMUNICATION USING API

SCORM content can use a standardized method based on JavaScript to communicate with any LMS on learner information. The SCORM data model elements define what are the learner information that can be stored and retrieved. In the SCORM model, when a SCO is launched, it initializes communication with the LMS. It tells the LMS that it has started and it also tells the LMS that it has ended when a learner is leaving the SCO.

2.5.4.3 SCORM VERSIONS
SCORM is a series of e-learning standards. The two primary versions of SCORM are version 1.2 and version 2004. SCORM 1.2 was released in 2001 and it was the first version with a real conformance test in the form of a test suite. It uses the IMS Content Packaging specification with full content manifest and support for metadata describing the course. Version 1.2 is no longer maintained by ADL. In 2004 ADL released SCORM 2004, formerly referred to as SCORM Version 1.3. The major change is the introduction of the IMS Simple Sequencing specification (Ritrovato, 2005). There are 4 editions of SCORM 2004. SCORM 2004 4th Edition is the latest version released on March 2009.

SCORM 2004 3rd Edition which was released in November 2006 has been selected as the e-learning standard used in this research. It is a set of specifications concerning the development, packaging and delivery of learning objects. The documentation for this edition includes four books (Neto & Brasileiro, 2006):

- SCORM Overview: Presents the ADL initiative and the summaries of the guidelines of specifications techniques contained in other sections.
- SCORM Content Aggregation Model (CAM): Supplies the specifications to identify and add resources in structuralized CSL contents (that means in learning objects).
- SCORM Run-Time Environment (RTE): Supplies specifications to run the applications, to establish communication, and to control the CSL content.
- SCORM Sequencing and Navigation (SN): Describes how the CSL content, in compliance with the SCORM, can be sequenced through a set of navigation events initiated by the system or by the user. The branching and flow of the content may be described by a predefined set of activities, typically defined at design time and interpreted by an LMS at runtime.
2.5.4.4 SCORM ADVANTAGES

SCORM has been chosen as the e-learning standard used in this project. One of the reasons is its international recognition as a model for developing interoperable online content, as reported in 2005 by the Centre for Learning Innovation (CLI), part of the Department of Education and Training in Australia (CLI Learning Technology Standards Team, 2005). Besides, it is currently the de facto standard for e-learning content.

SCORM is a composite of several specifications developed by international standards organizations, including the IEEE, IMS, AICC and ARIADNE. It uses the IMS Content Packaging and IMS Learning Resource Metadata which allow simple distribution of courses. The standardized manifest file in XML format describes the course structure and allows courses to be shared between LMSs or to be archived in learning repositories. In addition, learning content created by following SCORM standard can be tested for its conformance to SCORM using the Conformance Test Suite software developed by ADL.

SCORM 2004, the latest version of SCORM, addresses the use of intelligent tutoring system (ITS). ITSs are computer software systems that seek to mimic the methods and dialog of natural human tutors, to generate instructional interactions in real time and on demand (Ellis, 2005).

2.6 LEARNING MANAGEMENT SYSTEM

A LMS is a software system that launches online training and then tracks student’s performance on that training. The features and functions generally provided by LMS are administrative functions and learner interface. Administrative functions include course setup, learner registration, course assignment, and reporting of learners’ progress.
by tracking data such as the scores from any tests or quizzes. Learner interface allows learners log in to the LMS using personal identifier and access to e-learning content.

By using the features and functions provided by a LMS as explained above, an online e-tutorial system can be easily created. Once a LMS has been setup successfully, courses can be created by importing content packages, for example SCORM packages if the LMS is SCORM compliant. Next, online tutorials can be provided to learners, either registered or non-registered, depends on the system’s design. For registered learners, their learning progress in the system can be tracked and recorded. As a conclusion, a LMS is a software that can be used to implement e-tutorial system. The e-tutorial systems discussed in Section 2.3.1 are not running on any LMS. However, a few LMSs will be explained below as these LMSs were used in this project to show the interoperability of learning objects between different LMSs.

2.6.1 MOODLE

Moodle is one of the most user-friendly and flexible open source LMS that helps educators create effective online learning communities. Its modular design lets many people develop additional functionality easily.

Moodle runs on UNIX, Linux, Windows or any other systems that support PHP. Features provided by Moodle include forums, quizzes, blogs, chat, glossaries and Wikis. Besides, a lot of new modules or plug-ins contributed by Moodle users for different versions of Moodle can be found in the Moodle website. However, there is no guarantee that those modules or plug-ins are reliable. There are books and manuals which can help users in understanding and learn how to use Moodle. Although Moodle users can also use the informative forum to get support for any problems or questions in using Moodle, but sometimes it can be difficult to get useful information in the forum due to the large amount of posts in the forum. In such situation, users will need to use keywords wisely.
in order to be able to search and retrieve useful information from the forum. The URL of
the Moodle community site is http://moodle.org/.

A Moodle demonstration site is provided in the community site. It has basic
features such as provide categorized courses and a search function. Figure 2.8 shows the
main page of the Moodle demonstration site after a user login to the system as a student.
Students can see a list of course categories and also the courses provided in each
category. Besides, students can also search for courses using keywords.

![Moodle demonstration site main page](image)

**Figure 2.8 Moodle demonstration site main page**

### 2.6.2 DOCEBO

Docebo is a free e-learning (LMS) platform released under Open Source license.
It supports SCORM 1.2 and SCORM 2004. It works under several operating systems,
but in order to use SCORM functions a specific configuration is required. It also
requires a few free technologies like PHP, Apache and MySQL in order to be setup
successfully and works properly. Docebo version 3.5 was used in this project.
A very detailed documentation or manual can be downloaded from the Docebo website. It covers the installation of the Docebo system, user manual for different roles in the system such as the administrator, the teacher, and the student. This manual is quite crucial for new users especially for those who want to set up the system because the system’s setup requires certain technical configuration and hence new users are advised to follow the instructions in the manual in order for the system to run correctly. Users can read the FAQ or search the forum for support but it normally takes few days or more to get response from other users in the forum. The URL for the Docebo website is http://www.docebo.org/doceboCms/.

A Docebo demonstration site can also be found in the Docebo website. Figure 2.9 shows the main page of the Docebo demonstration site after a user login to the system as a student. Students can view the courses provided by the system and select a course to attend. Besides, there is a menu which allows the students to edit their profiles, check the subscribed courses, and also view the messages sent or received in the system.

![Figure 2.9 Docebo demonstration site main page](image_url)
2.6.3 OPEN ENROLLMENT

Open Enrollment LMS is an open source LMS. It is SCORM 2004 3rd Edition certified and it supports online course delivery and tracking. It runs on systems that support JAVA. Features such as individual learning plan, scheduling and course registration, and learning history are provided in this LMS.

Although Open Enrollment LMS supports online course tracking, the information on the learner’s learning activities is less sufficient compared to other LMS such as Moodle. For example, the Open Enrollment LMS can only show whether a SCO has been completed and when did that happen while the Moodle system is able to show those information and also the score gained by the learner and then calculates the average score for all the SCOs that have been completed by the learner. The URL to download this LMS and to get support on it is http://www.pojosoft.org/.

Figure 2.10 shows the course listing page after a user login to the Open Enrollment system as a student. Students can select a course to attend and view the completion status of courses that they have attended.
2.7 RUSTICI SCORM TEST TRACK APPLICATION

Rustici Software’s SCORM TEST TRACK application is the first product to be certified as officially conforming to the newest standards for e-learning. It allows creators of e-learning materials to experience their content exactly as their users will, in a “real” certified LMS. It also allows users to debug content using Test Track’s advanced diagnostic information, to demonstrate content’s compatibility, and to test the SCORM sequencing rules. It can not only be purchased and installed in local computers, the online version of the application can also be accessed through http://www.scorm.com/products/testtrack.aspx.

2.8 CONCLUSION

Studies found that interactive questions and quizzes can maintain a student’s interest in online learning (see Section 2.3) and functions such as categorized menu, discussion forum, navigation buttons and quizzes are the common features provided in an e-tutorial system. Hence, these elements will be taken into consideration in designing the e-tutorial system that will be built in this project.

Learning object is the emerging concept in online education as it can decrease an online education program’s production cost by promoting reusability across different tools or LMSs. Learning objects’ interoperability is important to ensure their reusability. SCORM, the standard to be adopted in this project in developing learning objects basically covers how and what are the descriptive information that should be provided, together with learning content, how learning objects should be packaged before it can be transported between different systems, what are the methods and data model to be used to enable learning objects to communicate with any LMS, and also the sequencing and navigation rules that can be used to control the flow of the content in a content package and make the implementation of remediation learning strategy possible.
The three open source LMSs described in Section 2.6, which are Moodle, Docebo and Open Enrollment, support SCORM 2004 at different levels. These systems can be used to create tutorials by importing the SCORM packages consisting of learning objects and also shows the interoperability of those learning objects.

2.9 SUMMARY

There are many e-learning systems available now but not all of them are very useful and provide quality learning. Learning objects are important elements in e-learning systems. The usage of learning objects is potentially increasing the speed and efficiency of e-learning development. However, standards must be followed in order to ensure the reusability, accessibility, interoperability and durability of the learning objects.

In the next chapter, software development process models will be studied and one of the process models will be chosen to be used in this project.
CHAPTER 3: METHODOLOGY

3.1 INTRODUCTION

Software development process model is important in software engineering. It helps software developers to have common understanding of the activities, resources and deliverables involved in the development process. There are several models that are very well known, such as the waterfall model, V-model, prototyping model and spiral model.

This chapter discusses on the process model selected for this project, i.e. the V-model. Besides, the research methods and techniques used for this project will also be addressed.

3.2 DEVELOPMENT METHODOLOGY

The V-model has been chosen as the system process model in this project. It is chosen because it presents a very high-level view of what is going on during development. It deploys a well-structured method in which each stage can be implemented by the detailed documentation of the previous stage. Testing activities such as test designing start at the beginning of the project well before coding and therefore save a huge amount of project time. Figure 3.1 shows the V-model.
According to German Ministry of Defense (1992) as cited by Pfleeger & Atlee (2005) the V-model is a variation of the waterfall model that demonstrates how the testing activities are related to analysis and design. As shown in Figure 3.1, coding forms the point of the V, with analysis and design on the left, testing and maintenance on the right. The model’s linkage of the left side with the right side of the V implies that if problems are found during verification and validation, then the corresponding left side of the V can be re-executed to fix and improve the requirements, design and code before the testing steps on the right side are reenacted.

The first stage on the left is requirements analysis. In this phase, the requirements of the system are collected by analyzing the needs of users. A requirement is a feature of the system or a description of something the system is capable of doing in order to fulfill the system’s purpose. It concerns about establishing what the system has to perform without determining how the system will be designed and built. Normally a user requirements document which describes the system’s functional, interface, data and performance requirements will be generated. This document will be the guideline for the system designers in the system design phase. In this project, an e-learning system that provides courses built using interoperable learning objects and contains functions such as discussion will be developed.

The second stage is system design, which takes the user requirements document as its initial input. System engineers will figure out the possibilities and techniques by which the user requirements can be implemented. The software specification document which serves as a blueprint for the development phase is generated in this stage. It contains the system organization, menu structures and data structures. Other documentation like screen layout diagrams, entity-relationship diagrams with data dictionary, or system testing document will also be prepared in this phase. Skilled
programmers may develop the system by following the documents with minimal additional input.

The next stage after system design is program design. The overall system design is used to generate the designs of the individual programs involved. System modules or individual programs are designed one by one without any integration. The unit test design is also developed in this stage.

The next stage is coding. This stage will build all programs by using selected programming languages and application development tools following the design specifications. In this project, learning objects that are SCORM compliant will be built using tools such as RELOAD.

The next stage is unit and integration testing. In the V-model of software development, unit testing implies the first stage of dynamic testing process. It involves analysis of the written code with the intention of eliminating errors. It also verifies that the codes are efficient. The testing is done using the unit test design prepared during the program design stage. In integration testing, separate modules will be tested together to expose faults in the interaction between integrated components.

The next stage, system testing, involves a test of the whole system to make sure that the functions and interfaces specified initially have been implemented properly. It is to ensure that the system built meets the requirements and the project objectives. The system test design is derived from the system design documents and is used in this stage.

Acceptance testing is the next stage after system testing. It is to enable the user to test the system in the “real world” and to determine whether to accept the system or not. It also serves the purpose of verifying the system or changes according to the original needs.
The next and also the last stage is operation and maintenance. After the whole system is tested to be running correctly, it will be delivered. However, the system will normally undergo changes once it is delivered. Changes could happen because of some unexpected input values into the system. Hence, maintenance needs to be provided so that if anything goes wrong, or if needs and requirements have changed, immediate action or correction can be carried out to fix it.

3.3 RESEARCH TECHNIQUES

The main research techniques used in this research were:

- **Literature review.** In order to access and analyze information regarding e-learning, learning objects, e-learning standards and LMS, information was collected from the Internet, including articles, white papers, journals and e-books. Other than the Internet, some printed reference books regarding learning objects were referenced because they are also very important to this project. Besides, the SCORM 2004 3rd Edition Documentation Suite that contains 5 books which explain all the SCORM components are used. The information gathered in literature review was used to gain clear understanding of the research topic and helped to identify the requirements.

- **Study of existing systems.** A few existing e-learning systems were analyzed to gain ideas on features provided in the e-learning systems.

- **Discussion.** Useful advice and ideas had been given by the supervisor during meetings. The advice and ideas were used as a guideline to make sure the whole project was on the right track.

- **Forum.** Questions regarding learning objects and LMS were posted on online forums. Useful feedback from other users in the forum helped to clear doubts on
learning objects and the usage of LMS. The information was used during the analysis and design of the P-Learning system.

- Questionnaire. Questionnaires were used to obtain information from the users. The information was analyzed to measure user acceptance of the P-Learning system and the usage of SCORM 2004 sequencing rules in online learning.

3.4 SUMMARY

V-model had been chosen as the process model in this project because of its simplicity and early involvement of testing. Testing is very important in this project in order to create learning objects that are interoperable and examine how they can be reused correctly in different LMSs.

In the next chapter, the functional and non-functional requirements, and also the system requirements for the P-Learning system will be identified.
CHAPTER 4: SYSTEM ANALYSIS

4.1 INTRODUCTION

In order to provide an online learning that offers great value to the learners, determining features or functions to be provided is very important. This chapter discusses the functional and non-functional requirements and hardware and software requirements for the P-Learning system. The requirements are identified carefully to offer interactive, flexible, motivated, self-paced and user-friendly e-tutorial.

4.2 REQUIREMENTS ANALYSIS

Requirements describe activities and features of the system in order to fulfill the system’s purpose. The requirements of the P-Learning system are derived from analysis of information gathered in the literature review (see Chapter 2). Some of the useful information used to help in identifying the requirements were the advantages of using learning objects in e-tutorial system, how to ensure interoperability and reusability of learning objects by following standards, what are the common features of e-tutorial systems and how to use interactive elements such as quizzes and forums to retain learner’s interest in online learning.

Requirements can be categorised into two types:

- Functional requirements
- Non-functional requirements

4.2.1 FUNCTIONAL REQUIREMENTS

Functional requirements describe interaction between the system and its environment. There are three types of users in the P-Learning system and the system’s functional requirements can be categorised into sections based on the user types. The user types are:
• Administrator
• Teacher
• Student

4.2.1.1 ADMINISTRATOR MODULE

Administrator is the type of system’s users with the most control on the functionality and can do anything in the system. Figure 4.1 shows the summary of the main functionalities in the administrator module.

There are four sub-modules in the administrator module.

• Role Management: There are mainly three types of user role. They are administrator, teacher and student. Every user in the system has one of those roles. This module allows the administrator to create, edit and delete a user role and then define the functions that can be used by each user role. This module also allows the administrator to assign a role to users. Any roles assigned in this module will apply to the assigned users throughout the entire system.
• User Management: The administrator can manage all the users in the system. This module allows the administrator to retrieve a list of all the users. The administrator can then get the details of a specific user. Besides, the administrator can also select a group of users and export those user records into downloadable file in certain file format such as Microsoft Excel or plain text. This module also allows the administrator to manually add new user, edit user details or delete a user.

• Edit Profile: The administrator can edit their own personal details. They can also change their password periodically to ensure better security.

• Front Page Settings: This module allows the administrator to set or change some settings on the system’s front page. The settings that can be set are the name and the description of the site, number of courses to be shown in the front page, and the default role for users in the front page.

4.2.1.2 TEACHER MODULE

Users with the role as a teacher can manage courses and also control students’ enrolment to a course. This module allows a teacher to create courses and manage activities for a course. Figure 4.2 shows the summary of the main functionalities in the teacher module.
There are five sub-modules in the teacher module.

- **Role Management**: In this sub-module, a teacher can assign student role to selected users. Any user who has been assigned the student role in this module will be automatically enrolled into all courses throughout the entire system.

- **Course Management**: Course management involves management functions related to a course that can be carried out by a teacher. This module allows the teachers to create, edit and delete courses. After a course has been created, the teacher is allowed to enroll students to the course. The teacher can remove any students from the course at anytime. Besides, the teacher can also view students’ report on their attempts in a course. Students’ performance report can help the teacher to evaluate their understanding on the course. Forum is an activity that can be added to a course by a teacher. It provides a way of communication between the teachers and the students. The teacher can post a question to the forum to start a discussion and let the students to reply to the post.
• Course Category Management: Every course is grouped into a course category. Teachers can create, edit and delete course categories.

• Edit Profile: Teachers can edit their own personal details and change their password.

• Blog Management: Blogging is currently a famous method for self-expression and communicating. Teachers can have their own blog. The blog is non-course specific. The teacher can add a new entry to their blog and edit or delete it. Tagging with keywords can be used so that others can reach their post by searching with the keywords.

4.2.1.3 STUDENT MODULE

This module contains all functions that can be used by the students. The functionalities in this module enable the students to interact actively in the system. Figure 4.3 shows the summary of the main functionalities in the student module.

![Student Module Diagram](image)

There are five sub-modules in the student module.

• Registration: This module enables new user to register to the system.
Course Enrollment: This module allows the students to search for courses provided in the system using keywords and enroll to the courses. However, some courses might require the students to provide a key so that only selected group of students is allowed to take the courses.

Forum Participation: This module enables the students to interact with each other and with the teachers through forum. The students can post their comments and ideas on the forum and view others’ replies. They can also edit and delete their own posts.

Edit Profile: Students can edit their own personal details and change their password.

Blog Management: Students can express their ideas and opinions using blog. They can create posts and view other users’ posts.

4.2.1.4 DESCRIBING FUNCTIONAL REQUIREMENTS USING USE CASE DIAGRAM

Use case diagram is one of the Unified Modeling Language (UML) diagrams. A use case diagram captures the functional aspects of a system (Chitnis et al., 2003A). It provides an overview of the intended functionality of the system. It uses two main types of elements: actors representing the business roles and use cases representing the business processes. Table 4.1 shows the symbols used to draw use case diagrams.

Table 4.1 Use case diagram symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Actors" /></td>
<td>An actor portrays any entity that performs certain roles in a system. An actor in a use case diagram interacts with one or more use cases.</td>
</tr>
<tr>
<td><img src="image" alt="Use case" /></td>
<td>A use case is a visual representation of a distinct functionality in a system. It is shown as an eclipse in a use case diagram.</td>
</tr>
</tbody>
</table>
A system boundary defines the scope of what a system will be. It is shown as a rectangle spanning all the use cases in the system.

The communicates relationship defines how an actor participates in a use case.

All the functionalities provided by the P-Learning system have been represented in several use case diagrams. Figure 4.4 shows the use case diagram for the P-Learning system. The diagram shows that the three actors involved in the system are the administrator, teacher and student. The use cases in the diagram shows that the administrator can manage all roles and users, configure front page settings and edit profile. It also shows that the teacher can manage student role, manage course and course category, edit profile and manage blog while the students can register as users, enroll in courses, participate in forum and also manage their own blog. The system boundary is potentially the entire system. But for large or complex systems, each of the modules may be the system boundary.

Figure 4.4 Use case diagram for the P-Learning system
Figure 4.5 is a use case diagram that shows the discrete processes within the manage all roles function. The administrator can set different permission for each role and assign system roles to any users in the system.

![Use case diagram for the manage all roles function](image)

Figure 4.5 Use case diagram for the manage all roles function

Figure 4.6 is a use case diagram that shows the sub-processes in the manage users process. The administrator can get the information of all the users, add a new user, edit user details, delete user and also download record of selected users.

![Use case diagram for the manage users function](image)

Figure 4.6 Use case diagram for the manage users function
Figure 4.7 shows the processes within the edit profile function. All the users of the system can edit their own personal details and also change their password.

Figure 4.7 Use case diagram for the edit profile function

Figure 4.8 shows the sub-processes in the manage course function. Teachers can view, add, edit and delete courses. They can also manage all the participants of the courses and view their attempt report in the courses. The use cases also show that the teachers can view, add, edit and delete posts in forum.

Figure 4.8 Use case diagram for the manage course function
Figure 4.9 shows the sub-processes in the course enrollment function. The students can search for the courses that they are interested in and then enroll themselves in the selected courses.

![Figure 4.9 Use case diagram for the course enrollment function](image)

Figure 4.9 Use case diagram for the course enrollment function

Figure 4.10 shows the sub-processes in the forum participation function. The students can add, edit or delete their own posts in the forum. They can also view posts created by other participants in the course.

![Figure 4.10 Use case diagram for the forum participation function](image)

Figure 4.10 Use case diagram for the forum participation function

4.2.1.5 COURSE USING SCORM PACKAGES

Other than the requirements described in the previous sections, another requirement that must be met by the P-Learning system is to enable courses to be
created using SCORM content packages. Those packages are in zip file format and consist of multiple SCOs which comply with SCORM 2004 standard.

The import SCORM package module decompresses the zip file and process the manifest file. The physical files in the zip file will be stored into a folder while the package’ organization and sequencing rules information will be stored into database tables.

The course module must be able to play the SCORM contents correctly. The contents will be organized according to the order defined in the manifest file. When the learners go through the course, their progress will be kept track. Next time when the learners access the course again, they can be automatically directed to the content where they stopped previously.

4.2.1.6 REMEDIATION

Another requirement that needs to be met by the system is to support course remediation. Remediation is an instructional strategy. Remediation is a deliberate educational activity designed to correct deficits identified during formal and informal evaluations (National Association of EMS Educators, 2002). It involves the provision of alternative additional instructions to students who have not met a minimum acceptable standard of achievement or required core content and skills. Achievement of learning objectives is enhanced when appropriate remediation is provided including frequent evaluation of students’ task performance and incorrect performance is immediately remediated, based on evaluation results. Pre-test, post-test, mid-quarter and final exam are used to test on objectives to ensure students learn what they need to learn (King et al., 2002).

In the courses used in this research, the learners must progress through the contents in a pre-determined order and the content that will be delivered to the learners
depends on their test results. Pre-tests and post-tests were used to test the learners’ knowledge. In order to provide remediation, a certain level of SCORM 2004 sequencing and navigation rules must be supported.

A few concepts or sequencing rules that need to be supported in order to enable course remediation are:

- **Sequencing control modes:** It defines how contents will be considered for delivery. The contents might be selected randomly by the learners or the contents can be accessed sequentially from the beginning. All these and also many other control modes can be used to set the way how the contents will be shown.

- **Learning objectives:** A learning activity may be loosely described as a meaningful unit of instruction. It may provide a learning resource to the learners or it may be composed of several sub-activities. A learning activity can be associated with one or more objectives. For SCORM sequencing, an objective is a global variable that allows the LMS to share status values between SCOs. Depending on responses to learning activities, objectives may be satisfied or not, leading to different branching options. The objective status information will be used especially in the pre-condition, post-condition or exit-condition rules evaluation.

- **Pre-condition rules:** Activities may have one or more pre-condition sequencing rules associated with them. The sequencing rules have the structure of ‘If [condition set] Then [action]’. The [condition set] defines a set of conditions which will be evaluated against the tracking information for the activity. If the evaluation result is true, then the [action] is applied. Pre-condition rules associated with an activity will be evaluated right before the activity is delivered.
• Post-condition rules: Post-condition rules have the same structure as the pre-condition rules. The main difference between them is that the post-condition rules will be evaluated right after the activity is completed and before the next activity is delivered.

• Exit-condition rules: Exit condition rules also have the same structure as the pre-condition rules. The conditions will be evaluated when the users exit the current activity.

The sequencing rules that have been discussed above are just a subset of the whole SCORM 2004 sequencing and navigation rules. The P-Learning system can support these rules and is able to provide remediation option.

4.2.2 NON-FUNCTIONAL REQUIREMENTS

Non-functional requirements are essential definitions of system properties and constraints under which a system must operate. Although these requirements are relatively subjective as compared to functional requirements, they are still very important to ensure the success of the system.

The objectives of this project are to create an e-tutorial system using interoperable learning objects developed based on the SCORM standard, to enable the Moodle SCORM module to support SCORM 2004 Sequencing and Navigation rules, and to evaluate learners’ satisfaction on the usage of those navigation rules in online learning. Hence, interoperability and reusability are crucial non-functional requirements for the P-Learning system. Learning objects need to be used between different LMSs and also to be reused in courses creation as this can reduce the development cost of learning contents. In order to ensure the interoperability and reusability of learning objects, SCORM standard has to be followed. Besides, system’s reliability and user friendliness are the factors that might affect learners’ satisfaction on the P-Learning
system while system’s maintainability is important to ensure the quality of the system in terms of error correction and system enhancement. All the non-functional requirements mentioned above will ensure that the objectives of this project are more achievable.

- Reusability: Learning objects used in the course are reusable. They can be reused to create different courses in different contexts.
- Interoperability: Learning objects developed with a tool or on a platform can be used in another tool or platform. They are reusable between different standard-compliant LMSs.
- Comply with SCORM standard: Learning objects developed should be SCORM 2004 conformant. Metadata, content packaging, manifest file and data elements were used according to the standard.
- Reliability: System’s reliability is important to ensure that unnecessary failure or downtime is minimized. Testing was carried out to detect errors and to ensure that the system works properly.
- Maintainability: System should be managed in an easy manner. Future enhancement can be done and new features can be added without affecting currently working modules.
- User-friendly: System should have a user-friendly interface so that it is easy to use and understand. This is important to retain learners’ interest in online learning.

4.3 SYSTEM REQUIREMENTS

In order to develop and deploy the P-Learning system, several system hardware and software requirements must be met.
4.3.1 HARDWARE REQUIREMENTS

The hardware requirements are shown in Table 4.2.

Table 4.2 Hardware requirements

<table>
<thead>
<tr>
<th>Processor</th>
<th>Intel Pentium 3 (or equivalent), 800Mhz or higher.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk Space</td>
<td>Minimum 160MB.</td>
</tr>
<tr>
<td>Memory</td>
<td>Minimum 512MB. 1GB for better performance.</td>
</tr>
<tr>
<td>Other</td>
<td>Standard computer peripherals such as computer</td>
</tr>
<tr>
<td></td>
<td>monitor, mouse and keyboard.</td>
</tr>
</tbody>
</table>

4.3.2 SOFTWARE REQUIREMENTS

Table 4.3 below shows the software requirements for the system.

Table 4.3 Software requirements

<table>
<thead>
<tr>
<th>Web Server</th>
<th>Apache.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database Server</td>
<td>MySQL (version 4.1.12 or later).</td>
</tr>
<tr>
<td>Operating System</td>
<td>Microsoft Windows XP.</td>
</tr>
<tr>
<td>Scripting Language</td>
<td>PHP.</td>
</tr>
<tr>
<td>Web Browser</td>
<td>IE 6.0 or above, Mozilla Firefox 3.0 or above.</td>
</tr>
</tbody>
</table>

4.4 APPLICATIONS USED

Few applications have been used to help the development of the P-Learning system and to show the learning objects’ interoperability. These applications were:

- Moodle: It is the LMS chosen to create the P-Learning system.
- RELOAD: The RELOAD editor is a content package and metadata editor. It takes Web pages, images and flash animations and package them.
- Docebo and Open Enrollment: These two LMSs were used to show learning objects’ interoperability.
- Zend Development Environment: It is a complete PHP development environment for coding, debugging, analyzing and deploying PHP applications.

4.5 SUMMARY

Requirement analysis is a very important phase in ensuring the success of a system. Functional and non-functional requirements that have been identified were used and checked throughout the development of the system.

In the next chapter, the requirements are used to design the P-Learning system. System architecture, process flow, data flow and database schema are determined and designed.
CHAPTER 5: SYSTEM DESIGN

5.1 INTRODUCTION

Based on the user requirements and the detailed analysis of the desired system, the P-Learning system was designed. It was a phase where requirements for the system were translated into the system characteristics.

This chapter discusses the system architecture used and also shows the important entities in the system and the process flow by using flow chart, UML class diagram and sequence diagram. Besides, the database design and user interface design are specified.

5.2 SYSTEM ARCHITECTURE

The P-Learning system uses the client-server architecture. The relationship between client and server is a command or control relationship where the client initiates a request and the server responds accordingly.

As mentioned in the previous chapter, SCORM has been chosen as the e-learning standard used in this project. It uses a Web-based infrastructure as the basis for its technical implementation. Figure 5.1 illustrates the connection between the learner, teacher, Web browser, authoring tools and LMS used in the P-Learning system. The SCORM package in the figure is adopted from Munindar (2004).
Figure 5.1 P-Learning system architecture

The teachers use authoring tools such as RELOAD or Macromedia FLASH to develop learning content. Learning content is developed according to the SCORM standard. SCORM provides a specification for construction and exchange of learning objects, which are called SCOs (see section 2.5.4). Each SCO contains multiple assets such as Web pages and GIF files. SCORM uses the IMS Packaging Specification as a
foundation for the packaging and organization of learning objects while Metadata is used to describe the package and its content. SCOs are organized into a predefined structure and packaged into a zip file with all the physical files, manifest file and metadata inside. Besides, sequencing rules are incorporated into the package based on the IMS Simple Sequencing Specification. In Figure 5.1, each small circle with a number inside indicates a SCO that has been arranged in a predefined order.

The SCORM package created can be used to create courses in the LMS. It will be imported into the LMS and all the information in the manifest file will be stored into database. The learners access the P-Learning system through a Web browser. When the learners view a course, the course contents will be retrieved and SCOs will be launched in the Web browser. JavaScript functions in a SCO will be called in order to communicate with the system through the API. The learners’ progress throughout the course will be kept track and stored into database. The flow of the course contents to be shown depends on the content organization, sequencing rules and the learners’ performance in the course.

5.3 SYSTEM ENTITIES AND PROCESS FLOW

As mentioned in the system’s requirement analysis stage, the P-Learning system consists of three main modules, which are administrator module, teacher module and student module. Administrator, teacher and student are the main entities in the system and there are a lot more other entities in the system. These entities are closely connected and interact with each other to provide system functionalities.

5.3.1 DESCRIBING THE SYSTEM USING CLASS DIAGRAM

Class diagram is one of the Unified Modeling Language (UML) diagrams and it is a pictorial representation of the detailed system design. A class diagram consists of a
group of classes reflecting important entities in the system, and the relationships between these classes. Table 5.1 shows the symbols (Chitnis et al., 2003B) used in the class diagrams in the following section.

Table 5.1 Class diagram symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>A class represents an entity of a given system. Methods provide an encapsulated implementation of certain functionality of a given entity. Attributes are the properties of a class.</td>
</tr>
<tr>
<td>Association Relation</td>
<td>When two classes are connected to each other in any way, an association relation is established.</td>
</tr>
<tr>
<td>Directed Association Relation</td>
<td>Association between classes is bidirectional by default. However, the flow of the association can be defined by using directed association. The arrowhead identifies the container-contained relationship.</td>
</tr>
<tr>
<td>Aggregation Relation</td>
<td>When a class is formed as a collection of other classes, it is called an aggregation relationship between these classes. It is also called a “has a” relationship.</td>
</tr>
<tr>
<td>Composition Relation</td>
<td>Composition is a variation of the aggregation relationship. Composition connotes that a strong life cycle is associated between the classes.</td>
</tr>
<tr>
<td>Generalization/Inheritance Relation</td>
<td>Also called an “is a” relationship, because the child class is a type of the parent class. The child classes “inherit” the common functionality defined in the parent class.</td>
</tr>
<tr>
<td>Multiplicity of association</td>
<td>The multiplicity of an association end is the number of possible instances of the class associated with a single instance of the other end. Multiplicities are single numbers or ranges of numbers. In the example, there can be only one instance of Class 2 for each instance of Class 1, but an instance of Class 2 can have any number of instances of Class 1.</td>
</tr>
</tbody>
</table>
Figure 5.2 depicts the main classes identified in the P-Learning system and the relationship between those classes. Administrator, teacher and student are the three important entities and part of their attributes and methods are the same. Those common attributes and functionality between classes can be defined in a common parent class. This parent class is called the user class. The attributes and methods of the main classes will be shown later in this chapter.

Figure 5.2 Class diagram for P-Learning system

Figure 5.3 shows the attributes and methods in those classes and the generalization relationship has been shown using the triangle symbol. The administrator, teacher and student classes inherit the identical attributes and methods of the user class, and then add new functionality of their own.

Figure 5.3 also shows the three classes related to role assignments, which are the role, role_capabilities, and role_assignment classes. The administrator can manage all the roles in the system while the teacher can manage the student role. The attributes in the role class describe the basic information regarding each role while the attributes in
the role_capabilities class describe all the functionalities that can be performed by each role. The role_assignment class contains the attributes and methods used to keep track the role assigned to each user in the system.

Figure 5.3 Generalization relationship and role related classes

Figure 5.4 shows the classes related to course and blog and also the relationship between those classes. The blog class consists of the attributes and methods used to provide the blog functionality. The course entity is one of the important entities in the system. The course class contains the attributes which describe the details of a course and it also contains the methods which provide the functionalities related to a course such as view course details and search courses. The relationship between the course
class and the course_categories class depicts that a course belongs to a course category while a course category might contain a few courses.

Figure 5.4 Course related classes and blog class

The Scorm class is also an important entity because it is the main content in a course. The Scorm class contains attributes that describe the details of a SCORM package and the class’ methods provide functions needed to handle SCORM packages. The Scorm_Scoes class depicts a SCO entity that is closely related to the Scorm class.
because SCOs are the contents in a SCORM package. A composition relationship exists between those two classes because a SCO cannot exist before a SCORM package exists.

The relationship between the course class and the forum class represents that a course can contain zero or more forums but a forum should only belong to a course. A forum can contain discussions and a forum discussion contains zero or more forum posts. The Forum, Forum_Discussion and Forum_Posts classes are closely related to each other and have composition relationship because a forum post can only exist if the discussion exists while a discussion can only exist if the forum exists.

5.3.2 DESCRIBING THE SYSTEM USING SEQUENCE DIAGRAM

UML sequence diagrams are used to represent or model the flow of messages, events and actions between the objects or components of a system (Grgec and Muzar, 2007). Time is represented in the vertical direction showing the sequence of interactions of the header elements, which are displayed horizontally at the top of the diagram. UML sequence diagrams provide a dynamic view of the system behavior. Table 5.2 shows the symbols and notations in sequence diagram.

<table>
<thead>
<tr>
<th>Symbol and Notation</th>
<th>Represents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object</td>
<td>Represents an object in the system or one of its components.</td>
</tr>
<tr>
<td>Call Message</td>
<td>A call (procedure) message between header elements.</td>
</tr>
<tr>
<td>Return Message</td>
<td>A return message between header elements.</td>
</tr>
</tbody>
</table>

The UML sequence diagram can be used to flesh out the details of one or more use cases by illustrating visually how the system will behave in a particular scenario.
Figure 5.5 details how a user role is managed by the administrator. The administrator initiates the process by defining the basic details of a user role. Besides, the administrator will select the set of functionalities that can be used by the specific user role. The selected role capabilities will then be sent from the role object to the role_capabilities object to accomplish the process. An acknowledgement message will be returned to the administrator.

After the user roles have been defined, the administrator can send a message to the role object to get the list of all the user roles available in the system. Next, the administrator can assign system role such as the teacher role to a selected group of users. Message will be returned to the administrator to inform the success or failure of the action.

![Sequence diagram for manage user role](image)

Figure 5.5 Sequence diagram for manage user role

Figure 5.6 shows how objects interact in the process of creating new course with SCORM package and viewing report. The teacher object creates a new course by sending course details to the course object. After the course has been created successfully, SCORM package will be uploaded and imported into the system. The package will be extracted and all the information and files will be sent to the scorm
object. As a result, a message will be sent to the teacher object regarding the status of the action.

The next portion of the sequence diagram shows the process of viewing students’ attempts report in the course. Firstly, the teacher object will send a view course request to the course object. Once the course is found, a message will be sent to the scorm object to retrieve the SCORM content in that course and the following action is to get the tracking information for that particular SCORM content. The tracking information retrieved will be sent to the teacher object as students’ report.

![Sequence diagram for add course and view SCORM report](image)

Figure 5.6 Sequence diagram for add course and view SCORM report

Figure 5.7 shows the actions involved in the course management by the teachers. The teachers can view all participants in a course and enroll new students into the course. The process starts with the teacher object sends a request of view course to the course object. Next, a request to view all the participants in that course will be sent to the student object. List of all the students who are participating in the course will be retrieved. Based on the list, the teachers can enroll new students into the course. The teacher object needs to select the new students and send the enroll students message to the student object. An acknowledgement message will be returned to the teacher object.
Other than enroll students into a course, the teachers can also manage forum in a course. At first, the teacher object needs to send a view course request to the course object. Next, the get course forum message will be sent to the forum object. If forum does exist, a get discussion request will be sent to the forum_discussion object via the getForumDiscussion call. The process will be followed by the get forum posts request sent to the forum_posts object. At the end of the process, the forum posts will be returned to the teacher object as the result of invoking all those messages.

![Sequence diagram for course management](image)

Figure 5.7 Sequence diagram for course management

Figure 5.8 shows the flow of actions involved when students enroll and participate in a course. The student object initiates the process by searching courses using keyword. List of courses that are matched with the keyword will be returned to the student object. Next, the student can enroll to the course via the enrollCourse call to the course object. Once the enrollment process is completed successfully, the student object may send the view course request message to the course object and then followed by the view SCORM content message to the scorm object.
Figure 5.8 Sequence diagram for student’ enrollment in a course

Figure 5.9 shows the flow of actions involved for the students to participate in a forum of a course. As shown in the sequence diagram, the process starts with a view course request message sent from the student object to the course object. Next, getCourseForum and getForumDiscussions calls are invoked to the forum object and the forum discussion object respectively. The getForumPosts call will then be invoked to get all the posts for the forum. An add new forum post message can be sent to the forum_posts object in order to create new post in the forum.

Figure 5.9 Sequence diagram for student’ participation in forum
5.3.3 SCORM CONTENT DESIGN

SCORM packages were used to create courses in the P-Learning system. One of the SCORM packages used in the system is the Java_Tutorial_1. This SCORM package consists of multiple SCOs. Before we discuss about the SCOs in the package, the content of the course has to be identified. Figure 5.10 depicts the main topics that were included in the Java tutorial.

![Course structure diagram](image)

Each topic shown in Figure 5.10 was included into lessons. In order to provide course remediation, pre-tests and post-tests were added into the tutorial. Pre-tests were used to evaluate students’ knowledge on each topic before they start reading the content of those topics while post-tests were used to evaluate students’ knowledge on each topic after they have read the content of those topics. Besides, there is a quiz at the end of the tutorial to let students to test their understanding on the tutorial. Figure 5.11 shows the detailed course structure diagram with pre-tests and post-tests assessment.
After the course contents have been identified, SCOs can be designed. The tutorial contents need to be divided into individual SCOs with proper level of granularity to ensure its quality and reusability. In this Java tutorial, each lesson, pre-test and post-test has been designed as individual SCOs.

SCORM prescribes functionality that occurs outside of the SCO itself. With the inclusion of the sequencing functionality in SCORM 2004, content creators have the capability to prescribe the manner in which learners receive individual pieces of content from the LMS. These individual pieces of tracked content are SCOs. The LMS controls the movement of the learner from SCO to SCO with inter-SCO sequencing. The sequencing rules that can be supported in the P-Learning system in order to provide course remediation (see section 4.2.1.6) have to be included into the Java tutorial SCORM package. Figure 5.12 is a content structure diagram which shows the tree structure that specifies all the SCOs with their assets, the organization of the SCOs, and also the rules and behavior set in the Java tutorial. In Figure 5.12, light grey boxes represent SCOs. There are a total of 13 SCOs in the Java tutorial. The SCOs that contain
pre-test and post-test are basically consisting of a single HTML page while SCO-13 which contains the quiz consists of an HTML page and a flash file.
Figure 5.12 SCOs organization with sequencing structure diagram
SCO-5, SCO-7, SCO-9 and SCO-11 in Figure 5.12 are the SCOs that contain lessons of the Java tutorial. Figure 5.13 shows the collection of assets which compose the SCO-5, SCO-7, SCO-9 and SCO-11.

Figure 5.13 Collections of assets in SCOs

A few sequencing control modes have been used in this tutorial. Flow control mode is set at the root aggregation. Hence, the contents in the tutorial can only be accessed sequentially from the beginning. However, choice control mode is set for the remediation part. The lessons in the remediation part of the tutorial will be available after the students have completed all the post-tests. When the remediation part has been enabled, the students are free to select any of the four lessons in the remediation part.

Multiple learning objectives have been used for remediation purpose. Each SCO can set or read multiple objectives, and a single objective can be set by or read by multiple SCOs. These objectives are stored in the P-Learning system and will be referenced to make sequencing decisions. In Figure 5.12, it can be seen that the first four objectives are set by the pre-test SCOs. Based upon the student’s response to the pre-test item, the score will be stored and the status of the objective associated with that item is
set to passed or failed. The score will be calculated by dividing the number of correct answers with the total number of questions. The objective’s status depends on the score and the minimum satisfaction criteria. If the score is equal or higher than the minimum satisfaction value, then the objective can be considered as satisfied and the status is set to passed. For example, the minimum satisfaction value set for OBJ-1 is 0.8 and there are a total of 5 questions in the pre-test of SCO-1. If a student has answered 4 questions correctly, the score will be calculated as 0.8 (4 divided by 5). As a result, the OBJ-1 has been satisfied and the status is set to passed.

The dotted boxes in Figure 5.12 explain the pre and post-condition rules set for the SCOs. After the students have completed all the pre-tests, they will proceed with Module 1. There is a pre-condition set for SCO-5 which defines that the SCO will be skipped if OBJ-1 is satisfied. Hence, OBJ-1 will be referenced before the students can access Lesson 1 in SCO-5. If previously the students have passed the pre-test in SCO-1, SCO-5 will not be shown and the students will be automatically directed to SCO-6 which contains a post-test. The students’ performance in the post-test will be stored and OBJ-6 will be set. The post-test SCO works like the pre-test SCO except the minimum satisfaction value is set to 0.6, which is a bit different from the value set in the pre-test SCO. Post-condition rules were set for all the post-test SCOs to ensure that the students complete the post-tests. The students can only continue to the next module after they have submitted the answers for the post-tests of the current module.

Module 2, Module 3 and Module 4 work the same like Module 1. The students will continue through the other modules until Module 4 has been completed. The students will then reach the remediation part. Which lessons that the students are required to re-take depend on the pre-condition and the objectives that will be referenced. For example, a student needs to re-take Lesson 1 in SCO-5 if OBJ-6 has not been satisfied. However, the lessons in the remediation part will become available to the
students once they have completed all the post-tests. This is to provide an option for the students to re-take the lessons even though they have achieved good results in the post-tests, which is evaluated as the students do not need to re-take any lessons.

The students will proceed to the quiz contained in SCO-13 after walking through the remediation part of the Java tutorial. There is no learning objective associated with this SCO because the quiz is simply provided for the student to assess their understanding on the contents provided in the tutorial and also to test their mastery of knowledge in Java.

All the steps explained here can be shown in a flowchart. Table 5.3 shows the symbols used in a flowchart.

Table 5.3 Flowchart symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Represents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminator</td>
<td>Shows the start and stop points in a process. When used as a Start symbol, it depicts a trigger action that sets the process flow into motion.</td>
</tr>
<tr>
<td>Process</td>
<td>Shows a process or action step.</td>
</tr>
<tr>
<td>Decision</td>
<td>Indicates a question or branch in the process flow.</td>
</tr>
<tr>
<td>Off-Page Connector</td>
<td>Shows continuation of a process flowchart onto another page.</td>
</tr>
</tbody>
</table>

Figure 5.14 is the flowchart that shows the sequence of the course content that will be shown to the students based on their performance and the rules.
5.4 DATABASE DESIGN

Database design provides a data model that supports transaction required on the data. It represents the data and the relationships between data required by all major application areas and user groups.

5.4.1 ENTITY-RELATIONSHIP MODEL

Entity-Relationship (ER) model gives the conceptual model of the world to be represented in the database. ER Model is based on a perception of a real world that consists of collection of basic objects called entities and relationships among these objects (Esakkirajan, 2007). The model visually represents these concepts by the Entity-Relationship diagram. The basic concepts of the Entity-Relationship model include
entity types, relationship types, and attributes. Table 5.4 shows the symbols and notations used in an entity-relationship model.

Table 5.4 Entity-Relationship Model symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Represents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entity Type</td>
<td>An object or concept that is identified as having an independent existence.</td>
</tr>
<tr>
<td>Relationship Type</td>
<td>A meaningful association among entity types.</td>
</tr>
<tr>
<td>Disjoint Specialization</td>
<td>Specialization is the process of maximizing the differences between members of an entity by identifying their distinguishing characteristics. Disjoint specialization means apply constraints to a specialization. This constraint specifies that if the subclasses of a specialization are disjoint, then an entity can be a member of only one of the subclasses of the specialization.</td>
</tr>
<tr>
<td>Cardinality</td>
<td>Cardinality specifies how many instances of an entity relate to one instance of another entity (m and n=0,1,2,3…).</td>
</tr>
</tbody>
</table>

Figure 5.15 shows the Entity-Relationship model for the P-Learning system.
Figure 5.15 Entity-Relationship Model for P-Learning System
5.4.2 DATA DICTIONARY

The attributes of few main entities are identified and listed in the tables below.

The tables that will be shown are the user, role, role_assignments, course_categories, course, forum, scorm and scorm_scoes table.

5.4.2.1 USER TABLE

The user table is used to store the information of each user.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>bigint</td>
<td>Identification no.</td>
</tr>
<tr>
<td>auth</td>
<td>varchar</td>
<td>Authorization method.</td>
</tr>
<tr>
<td>confirmed</td>
<td>tinyint</td>
<td>Confirmation.</td>
</tr>
<tr>
<td>policyagreed</td>
<td>tinyint</td>
<td>Policy agreement.</td>
</tr>
<tr>
<td>deleted</td>
<td>tinyint</td>
<td>Indicates record is deleted.</td>
</tr>
<tr>
<td>mnethostid</td>
<td>bigint</td>
<td>Moodle network host id.</td>
</tr>
<tr>
<td>username</td>
<td>varchar</td>
<td>Username of the user.</td>
</tr>
<tr>
<td>password</td>
<td>varchar</td>
<td>Password of the user.</td>
</tr>
<tr>
<td>idnumber</td>
<td>varchar</td>
<td>Id number assigned.</td>
</tr>
<tr>
<td>firstname</td>
<td>varchar</td>
<td>First name of the user.</td>
</tr>
<tr>
<td>lastname</td>
<td>varchar</td>
<td>Last name of the user.</td>
</tr>
<tr>
<td>email</td>
<td>varchar</td>
<td>Email address.</td>
</tr>
<tr>
<td>emailstop</td>
<td>tinyint</td>
<td>Email disabled flag.</td>
</tr>
<tr>
<td>icq</td>
<td>varchar</td>
<td>Icq contact.</td>
</tr>
<tr>
<td>skype</td>
<td>varchar</td>
<td>Skype contact.</td>
</tr>
<tr>
<td>yahoo</td>
<td>varchar</td>
<td>Yahoo contact.</td>
</tr>
<tr>
<td>aim</td>
<td>varchar</td>
<td>Aim contact.</td>
</tr>
<tr>
<td>msn</td>
<td>varchar</td>
<td>Msn contact.</td>
</tr>
<tr>
<td>phone1</td>
<td>varchar</td>
<td>Phone contact 1.</td>
</tr>
<tr>
<td>phone2</td>
<td>varchar</td>
<td>Phone contact 2.</td>
</tr>
<tr>
<td>institution</td>
<td>varchar</td>
<td>Institution name.</td>
</tr>
<tr>
<td>department</td>
<td>varchar</td>
<td>Department name.</td>
</tr>
<tr>
<td>address</td>
<td>varchar</td>
<td>Address.</td>
</tr>
<tr>
<td>city</td>
<td>varchar</td>
<td>City.</td>
</tr>
<tr>
<td>country</td>
<td>varchar</td>
<td>Country.</td>
</tr>
<tr>
<td>lang</td>
<td>varchar</td>
<td>Language.</td>
</tr>
<tr>
<td>theme</td>
<td>varchar</td>
<td>Theme.</td>
</tr>
<tr>
<td>timezone</td>
<td>varchar</td>
<td>Time zone.</td>
</tr>
<tr>
<td>firstaccess</td>
<td>bigint</td>
<td>Time when user first access the system.</td>
</tr>
<tr>
<td>lastaccess</td>
<td>bigint</td>
<td>Time when user last access the system.</td>
</tr>
<tr>
<td>lastlogin</td>
<td>bigint</td>
<td>Last login.</td>
</tr>
<tr>
<td>currentlogin</td>
<td>bigint</td>
<td>Current login.</td>
</tr>
<tr>
<td>lastip</td>
<td>varchar</td>
<td>Last access ip.</td>
</tr>
<tr>
<td>secret</td>
<td>varchar</td>
<td>User secret settings.</td>
</tr>
<tr>
<td>Field Name</td>
<td>Data Type</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td>picture</td>
<td>tinyint</td>
<td>User picture.</td>
</tr>
<tr>
<td>url</td>
<td>varchar</td>
<td>URL.</td>
</tr>
<tr>
<td>description</td>
<td>text</td>
<td>Description of the user.</td>
</tr>
<tr>
<td>mailformat</td>
<td>tinyint</td>
<td>Email format.</td>
</tr>
<tr>
<td>maildigest</td>
<td>tinyint</td>
<td>Set mail to be in digest form.</td>
</tr>
<tr>
<td>maildisplay</td>
<td>tinyint</td>
<td>Display of email address.</td>
</tr>
<tr>
<td>htmleditor</td>
<td>tinyint</td>
<td>Indicates use of html editor.</td>
</tr>
<tr>
<td>ajax</td>
<td>tinyint</td>
<td>Indicates AJAX is allowed.</td>
</tr>
<tr>
<td>autosubscribe</td>
<td>tinyint</td>
<td>Forum auto subscription.</td>
</tr>
<tr>
<td>trackforums</td>
<td>tinyint</td>
<td>Forum tracking.</td>
</tr>
<tr>
<td>timemodified</td>
<td>bigint</td>
<td>Time when the record is last modified.</td>
</tr>
<tr>
<td>trustbitmask</td>
<td>bigint</td>
<td>Bit mask.</td>
</tr>
<tr>
<td>imagealt</td>
<td>varchar</td>
<td>Alternative image.</td>
</tr>
<tr>
<td>screenreader</td>
<td>tinyint</td>
<td>Indicates use of screen reader.</td>
</tr>
</tbody>
</table>

### 5.4.2.2 ROLE TABLE

The role table is used to store the information of each type of role.

Table 5.6 Fields in Role table

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>bigint</td>
<td>Identification no.</td>
</tr>
<tr>
<td>name</td>
<td>varchar</td>
<td>Role name.</td>
</tr>
<tr>
<td>shortname</td>
<td>varchar</td>
<td>Short name for the role.</td>
</tr>
<tr>
<td>description</td>
<td>text</td>
<td>Description for the role type.</td>
</tr>
<tr>
<td>sortorder</td>
<td>bigint</td>
<td>Order of the role type.</td>
</tr>
</tbody>
</table>

### 5.4.2.3 ROLE_ASSIGNMENTS TABLE

This table is used to store the information about the role assigned to each user.

Table 5.7 Fields in Role Assignments table

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>bigint</td>
<td>Identification no.</td>
</tr>
<tr>
<td>roleid</td>
<td>bigint</td>
<td>Role type identification no.</td>
</tr>
<tr>
<td>contextid</td>
<td>bigint</td>
<td>Context id that indicates module and access level.</td>
</tr>
<tr>
<td>userid</td>
<td>bigint</td>
<td>User identification no.</td>
</tr>
<tr>
<td>hidden</td>
<td>tinyint</td>
<td>Visibility setting.</td>
</tr>
<tr>
<td>timemodified</td>
<td>bigint</td>
<td>Time when the role is modified.</td>
</tr>
<tr>
<td>modifierid</td>
<td>bigint</td>
<td>Id of the user who modify the record.</td>
</tr>
<tr>
<td>enrol</td>
<td>varchar</td>
<td>Method of role assignment, either manual or using Moodle mechanism to connect to other Moodle sites.</td>
</tr>
<tr>
<td>sortorder</td>
<td>bigint</td>
<td>Sort order.</td>
</tr>
</tbody>
</table>
5.4.2.4 COURSE_CATEGORIES TABLE

This table is used to store the records of all course categories.

Table 5.8 Fields in Course_Categories table

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>bigint</td>
<td>Identification no.</td>
</tr>
<tr>
<td>name</td>
<td>varchar</td>
<td>Name of the category.</td>
</tr>
<tr>
<td>description</td>
<td>text</td>
<td>Description of the category.</td>
</tr>
<tr>
<td>parent</td>
<td>bigint</td>
<td>Parent category of the category.</td>
</tr>
<tr>
<td>sortorder</td>
<td>bigint</td>
<td>Sort order.</td>
</tr>
<tr>
<td>coursecount</td>
<td>bigint</td>
<td>Number of course belongs to the category.</td>
</tr>
<tr>
<td>visible</td>
<td>tinyint</td>
<td>Category visibility flag.</td>
</tr>
<tr>
<td>timemodified</td>
<td>bigint</td>
<td>Time when the record is last modified.</td>
</tr>
<tr>
<td>depth</td>
<td>bigint</td>
<td>Level of the category.</td>
</tr>
<tr>
<td>path</td>
<td>varchar</td>
<td>Path to the category.</td>
</tr>
<tr>
<td>theme</td>
<td>varchar</td>
<td>Theme of the category.</td>
</tr>
</tbody>
</table>

5.4.2.5 COURSE TABLE

This table is used to store all information about the courses.

Table 5.9 Fields in Course table

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>bigint</td>
<td>Identification no.</td>
</tr>
<tr>
<td>category</td>
<td>bigint</td>
<td>Course category.</td>
</tr>
<tr>
<td>sortorder</td>
<td>bigint</td>
<td>Sort order of the course.</td>
</tr>
<tr>
<td>password</td>
<td>varchar</td>
<td>Enrollment key.</td>
</tr>
<tr>
<td>fullname</td>
<td>varchar</td>
<td>Full name of the course.</td>
</tr>
<tr>
<td>shortname</td>
<td>varchar</td>
<td>Short name of the course.</td>
</tr>
<tr>
<td>idnumber</td>
<td>varchar</td>
<td>Id number assigned.</td>
</tr>
<tr>
<td>summary</td>
<td>text</td>
<td>Summary of the course.</td>
</tr>
<tr>
<td>format</td>
<td>varchar</td>
<td>Format of the course.</td>
</tr>
<tr>
<td>showgrades</td>
<td>tinyint</td>
<td>Show grades flag.</td>
</tr>
<tr>
<td>modinfo</td>
<td>longtext</td>
<td>Course module information.</td>
</tr>
<tr>
<td>newsitems</td>
<td>mediumint</td>
<td>Number of news items.</td>
</tr>
<tr>
<td>guest</td>
<td>tinyint</td>
<td>Indicates guest is allowed for course.</td>
</tr>
<tr>
<td>startdate</td>
<td>bigint</td>
<td>Start date of the course.</td>
</tr>
<tr>
<td>enrolperiod</td>
<td>bigint</td>
<td>Enroll period of the course.</td>
</tr>
<tr>
<td>numsections</td>
<td>mediumint</td>
<td>Number of sections in the course.</td>
</tr>
<tr>
<td>marker</td>
<td>bigint</td>
<td>Indicates marker is allowed.</td>
</tr>
<tr>
<td>maxbytes</td>
<td>bigint</td>
<td>Maximum size for file upload.</td>
</tr>
<tr>
<td>showreports</td>
<td>smallint</td>
<td>Show reports flag.</td>
</tr>
<tr>
<td>visible</td>
<td>tinyint</td>
<td>Course visibility flag.</td>
</tr>
<tr>
<td>hiddensections</td>
<td>tinyint</td>
<td>Hidden sections.</td>
</tr>
<tr>
<td>groupmode</td>
<td>smallint</td>
<td>Type of group.</td>
</tr>
<tr>
<td>groupmodeforce</td>
<td>smallint</td>
<td>Force usage in group mode.</td>
</tr>
<tr>
<td>defaultgroupingid</td>
<td>bigint</td>
<td>Default grouping id.</td>
</tr>
<tr>
<td>Field</td>
<td>Data Type</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>lang</td>
<td>varchar</td>
<td>Language.</td>
</tr>
<tr>
<td>theme</td>
<td>varchar</td>
<td>Theme.</td>
</tr>
<tr>
<td>cost</td>
<td>varchar</td>
<td>Cost.</td>
</tr>
<tr>
<td>currency</td>
<td>varchar</td>
<td>Currency.</td>
</tr>
<tr>
<td>timecreated</td>
<td>bigint</td>
<td>Time when the record is created.</td>
</tr>
<tr>
<td>timemodified</td>
<td>bigint</td>
<td>Time when the record is last modified.</td>
</tr>
<tr>
<td>metacourse</td>
<td>tinyint</td>
<td>Meta course flag.</td>
</tr>
<tr>
<td>requested</td>
<td>tinyint</td>
<td>Course requested flag.</td>
</tr>
<tr>
<td>restrictmodules</td>
<td>tinyint</td>
<td>Restricted modules.</td>
</tr>
<tr>
<td>expirynotify</td>
<td>tinyint</td>
<td>Notification of expired course.</td>
</tr>
<tr>
<td>expirythreshold</td>
<td>bigint</td>
<td>Threshold for course expiration.</td>
</tr>
<tr>
<td>notifystudents</td>
<td>tinyint</td>
<td>Email notification to students for course expiration.</td>
</tr>
<tr>
<td>enrollable</td>
<td>tinyint</td>
<td>Flag to show whether the course can be enrolled.</td>
</tr>
<tr>
<td>enrolstartdate</td>
<td>bigint</td>
<td>Enrollment start date.</td>
</tr>
<tr>
<td>enrolenddate</td>
<td>bigint</td>
<td>Enrollment end date.</td>
</tr>
<tr>
<td>enrol</td>
<td>varchar</td>
<td>Enrollment.</td>
</tr>
<tr>
<td>defaultrole</td>
<td>bigint</td>
<td>Course default role.</td>
</tr>
</tbody>
</table>

### 5.4.2.6 FORUM TABLE

This table is used to store information of forums.

Table 5.10 Fields in Forum table

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>bigint</td>
<td>Identification no.</td>
</tr>
<tr>
<td>course</td>
<td>bigint</td>
<td>Course identification no.</td>
</tr>
<tr>
<td>type</td>
<td>enum</td>
<td>Type of the forum.</td>
</tr>
<tr>
<td>name</td>
<td>varchar</td>
<td>Name of the forum.</td>
</tr>
<tr>
<td>intro</td>
<td>text</td>
<td>Introduction for the forum.</td>
</tr>
<tr>
<td>assessed</td>
<td>bigint</td>
<td>Flag indicates forum post can be rated.</td>
</tr>
<tr>
<td>assesstimestart</td>
<td>bigint</td>
<td>Period start time when post submitted can be rated.</td>
</tr>
<tr>
<td>assesstimefinish</td>
<td>bigint</td>
<td>Period end time when post submitted can be rated.</td>
</tr>
<tr>
<td>scale</td>
<td>bigint</td>
<td>Rating scale.</td>
</tr>
<tr>
<td>maxbytes</td>
<td>bigint</td>
<td>Attachment maximum file size.</td>
</tr>
<tr>
<td>forcesubscribe</td>
<td>tinyint</td>
<td>Flag indicates force subscription.</td>
</tr>
<tr>
<td>trackingtype</td>
<td>tinyint</td>
<td>Tracking type.</td>
</tr>
<tr>
<td>rssstype</td>
<td>tinyint</td>
<td>Flag indicates RSS type.</td>
</tr>
<tr>
<td>rssarticles</td>
<td>tinyint</td>
<td>No of RSS articles.</td>
</tr>
<tr>
<td>timemodified</td>
<td>bigint</td>
<td>Time when record is last modified.</td>
</tr>
<tr>
<td>warnafter</td>
<td>bigint</td>
<td>Notify if number of post exceeds this number.</td>
</tr>
<tr>
<td>blockafter</td>
<td>bigint</td>
<td>Block post if number of post exceeds this number.</td>
</tr>
<tr>
<td>blockperiod</td>
<td>bigint</td>
<td>Block post period.</td>
</tr>
</tbody>
</table>
5.4.2.7 SCORM TABLE

This table is used to store information of SCORM content.

Table 5.11 Fields in Scorm table

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>bigint</td>
<td>Identification no.</td>
</tr>
<tr>
<td>course</td>
<td>bigint</td>
<td>Course identification no.</td>
</tr>
<tr>
<td>name</td>
<td>varchar</td>
<td>Name of the SCORM content.</td>
</tr>
<tr>
<td>reference</td>
<td>varchar</td>
<td>Imsmanifest file name.</td>
</tr>
<tr>
<td>summary</td>
<td>text</td>
<td>SCORM content summary.</td>
</tr>
<tr>
<td>version</td>
<td>varchar</td>
<td>SCORM version number.</td>
</tr>
<tr>
<td>maxgrade</td>
<td>double</td>
<td>Maximum grade to be assigned.</td>
</tr>
<tr>
<td>grademethod</td>
<td>tinyint</td>
<td>Grading method.</td>
</tr>
<tr>
<td>maxattempt</td>
<td>bigint</td>
<td>Maximum number of attempt allowed.</td>
</tr>
<tr>
<td>updatefreq</td>
<td>tinyint</td>
<td>Auto update frequency.</td>
</tr>
<tr>
<td>md5hash</td>
<td>varchar</td>
<td>MD5 hash hexadecimal number.</td>
</tr>
<tr>
<td>launch</td>
<td>bigint</td>
<td>Id of first learning object to be launched.</td>
</tr>
<tr>
<td>skipview</td>
<td>tinyint</td>
<td>Flag indicates skip content structure page.</td>
</tr>
<tr>
<td>hidebrowse</td>
<td>tinyint</td>
<td>Flag indicates disable preview mode.</td>
</tr>
<tr>
<td>hidetoc</td>
<td>tinyint</td>
<td>Flag indicates hide table of content.</td>
</tr>
<tr>
<td>hidenav</td>
<td>tinyint</td>
<td>Flag indicates hide navigation buttons.</td>
</tr>
<tr>
<td>auto</td>
<td>tinyint</td>
<td>Flag indicates learning object to be launched automatically.</td>
</tr>
<tr>
<td>popup</td>
<td>tinyint</td>
<td>Flag indicates content to be displayed in a popup window.</td>
</tr>
<tr>
<td>options</td>
<td>varchar</td>
<td>Window settings.</td>
</tr>
<tr>
<td>width</td>
<td>bigint</td>
<td>Learning objects frame/window width.</td>
</tr>
<tr>
<td>height</td>
<td>bigint</td>
<td>Learning objects frame/window height.</td>
</tr>
<tr>
<td>timemodified</td>
<td>bigint</td>
<td>Time modified.</td>
</tr>
</tbody>
</table>

5.4.2.8 SCORM_SCOES TABLE

This table is used to store information of learning objects in SCORM content.

Table 5.12 Fields in Scorm_Scoes table

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>bigint</td>
<td>Identification no.</td>
</tr>
<tr>
<td>scorm</td>
<td>bigint</td>
<td>SCORM identification no.</td>
</tr>
<tr>
<td>manifest</td>
<td>varchar</td>
<td>Manifest name.</td>
</tr>
<tr>
<td>organization</td>
<td>varchar</td>
<td>Organization name.</td>
</tr>
<tr>
<td>parent</td>
<td>varchar</td>
<td>Parent learning object identifier.</td>
</tr>
<tr>
<td>identifier</td>
<td>varchar</td>
<td>Learning object identifier.</td>
</tr>
<tr>
<td>launch</td>
<td>varchar</td>
<td>Name of the file to be launched.</td>
</tr>
<tr>
<td>scormtype</td>
<td>varchar</td>
<td>Content type, either sco or asset.</td>
</tr>
<tr>
<td>title</td>
<td>varchar</td>
<td>Learning object title.</td>
</tr>
</tbody>
</table>
Other tables used in the P-Learning system are shown in Appendix A.

5.5 USER INTERFACE DESIGN

User interface can be tricky things to design because different people have different styles of perceiving, understanding and working. A good user interface design can help users gain rapid access to the content of the system without losing their comprehension as they move through information. Such design should make the system to be simple and easy to use.

Constantine and Lockwood (1999) describe a collection of principles for improving the quality of user interface design. These principles are:

- The structure principle. The design should organize the user interface purposefully, in meaningful and useful ways based on clear, consistent models that are apparent and recognizable to users, putting related things together and separating unrelated things, differentiating dissimilar things and making similar things resemble one another.

- The simplicity principle. The design should make simple and common tasks easy to do.

- The visibility principle. The design should keep all needed options and materials for a given task visible without distracting the user with extraneous or redundant information.

- The feedback principle. The design should keep users informed of actions, changes of state, and errors that are relevant and of interest to the users through clear language familiar to them.

- The tolerance principle. The design should be flexible and tolerant, reducing the cost of mistakes and misuse by allowing undoing and redoing, while also preventing errors wherever possible.
The reuse principle. The design should reuse internal and external components and behaviors, thus reducing the need for users to rethink and remember.

5.5.1 SYSTEM SCREEN SHOTS

Below are a few screen shots of the P-Learning system. Figure 5.16 shows the default page of the system. In the default page, different parts such as the calendar and courses provided are grouped and shown in different pane, this helps to improve the visibility and simplicity of the system’s components. Besides, new added courses are displayed in the default page to keep users informed of the new courses available.

![P-Learning default page](image)

Figure 5.16 P-Learning default page

Figure 5.17 shows the student main page after a student login to the system. Courses that a student has already joined will be shown in the center. A search textbox and a view all courses button are located under the courses to allow the students to search for courses easily and view all courses. This helps the students to get to the
required functions easily. Besides, there is no redundant information in the page to distract the students’ attention to the courses.

Figure 5.17 Student main page

Figure 5.18 shows the page when a teacher views a course in the system. The site administration block on the left hand side of the page allows the teacher to perform all actions related to the course. There is also a block on the right hand side which shows the information on recent activities and upcoming events. These two blocks are placed separately in order to group related functionalities together and differentiating unrelated functionalities.
5.6 SUMMARY

System design is a stage where the requirements are translated into a solution. This chapter explains the system architecture, process flow, data flow, database structure and the user interface design of the P-Learning system.

In the next chapter, the system and all the components are built based on the system design. It is a stage which involves a lot of coding in order to implement the design.
CHAPTER 6: SYSTEM DEVELOPMENT

6.1 INTRODUCTION

Development phase involves converting design specifications into executable programs. This chapter discusses the creation of interoperable learning objects and how they were placed together and assembled into SCORM packages and later be imported into a LMS (Moodle) to create useful tutorials. The phase also involves the modification of the SCORM module in the Moodle system to be able to support a certain level of SCORM sequencing and navigation rules. Besides, another two LMS, Docebo and Open Enrollment were installed and tutorials were created by importing the SCORM packages from the first LMS (Moodle) in order to show interoperability of the learning objects.

6.2 DEVELOPMENT ENVIRONMENT

Development environment is the set of processes and tools used to create the system and it has certain impact on the development of a system. For example, using suitable hardware and software will help to speed up the system development and determine the success of the project.

6.2.1 HARDWARE USED

The hardware used to develop the system was a computer with the specifications as below:

- Intel Core2 Duo 2.16GHz Processor
- 250GB Hard Disk
- 3GB RAM
6.2.2 SOFTWARE USED

Various programs and tools were used to create learning objects and modification of Moodle SCORM module. Below is the list of tools used during the development of the system:

Table 6.1: Summary of tools used

<table>
<thead>
<tr>
<th>Tools</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft Windows XP</td>
<td>Operating system.</td>
</tr>
<tr>
<td>Apache</td>
<td>Web server.</td>
</tr>
<tr>
<td>MySQL</td>
<td>Database server.</td>
</tr>
<tr>
<td>PHP, JavaScript, XML, HTML</td>
<td>Scripting and markup languages.</td>
</tr>
<tr>
<td>Internet Explorer v7.0, Mozilla Firefox v3.0</td>
<td>Web browsers.</td>
</tr>
<tr>
<td>Zend Studio v5.5</td>
<td>PHP Integrated Development Environment.</td>
</tr>
<tr>
<td>Macromedia Flash 8</td>
<td>Flash authoring tool.</td>
</tr>
<tr>
<td>phpMyAdmin</td>
<td>MySQL administration tool.</td>
</tr>
<tr>
<td>RELOAD Editor</td>
<td>Content package and Metadata editor.</td>
</tr>
<tr>
<td>Moodle, Docebo, Open Enrollment</td>
<td>LMSs.</td>
</tr>
<tr>
<td>Microsoft Paint</td>
<td>Painting program.</td>
</tr>
</tbody>
</table>

Other than the tools mentioned above, Microsoft Word and Microsoft Visio were used in the report writing.

6.3 SYSTEM DEVELOPMENT

The main processes in developing the P-Learning system were the creation of interoperable learning objects, modification of SCORM module in Moodle, and also installation of multiple LMS in order to show learning objects’ interoperability.

6.3.1 CREATE LEARNING OBJECTS

Learning contents in the tutorials consist of HTML pages, jpg image files, CSS(Cascading Style Sheets) that define how to display HTML elements, flash files and js files which contain JavaScript. The Java_Tutorial_1 course provided in the P-Learning system contains a tutorial that teaches the core techniques and principles to
create a solid foundation for developing program using Java. The learners will be able to learn the syntax, patterns and styles of Java programming language. The tutorial mainly consists of pre-tests, lessons, post-tests and quizzes. These learning contents were created as individual SCOs with the standard JavaScript functions to allow communication between the SCOs and the LMS. For the pre-tests and post-tests, the JavaScript functions used to get the test scores were encrypted so that the learner will not be able to get the test answers and other information easily by viewing the source code.

Those SCOs were then organized and assembled into a package with metadata that describe the elements in the package in an XML manifest file. Sequencing rules have been added into the manifest file to describe the intended sequencing behavior that a learner will experience as they work with the SCOs. These sequencing rules will make sure that the remediation learning strategy is implemented in the tutorial. RELOAD Editor was used to organize the SCOs, adding the sequencing rules and to create the SCORM package in zip file format. An example of a manifest file that was used in the Java tutorial is shown in Appendix B.

The Java tutorial also has a flash file which contains a simple quiz. The External Interface method is used to allow Flash to call JavaScript functions in a js file in order to communicate with the LMS. Macromedia Flash 8 was the main authoring tool used to create the quiz flash file.

Another tutorial named Java_Tutorial_2 was created. It has exactly the same contents and organization as Java_Tutorial_1 but the pre-condition and learning objective settings between the two tutorials are different. There is no pre-condition and learning objective set in the Java_Tutorial_2. Hence, although the learners' test results were stored into the database tables, these data will not be referenced in any part of the tutorial. Besides, all the lessons in the tutorial will be shown to the learners regardless of
their performance in the tests. These two Java tutorials were used to allow the learners to experience the differences between a tutorial with remediation strategy supported by the sequencing rules and a tutorial without the remediation strategy. A survey was conducted to compare the users’ preference to the two tutorials. The results of the survey is presented in Section 7.7.

6.3.2 MODIFY SCORM MODULE

The P-Learning system is developed on Moodle version 1.9.2+. SCORM 2004 is supported in this version to the extent that SCORM 2004 packages can be uploaded but will not be played according to the sequencing and navigation rules. Hence, in order to implement the sequencing rules in the tutorials to support remediation learning strategy, the SCORM module of Moodle had been modified. PHP codes have been added and modified so that all the sequencing rules information such as the pre-conditions and objectives data are stored correctly into the database tables.

When a learner views the tutorial, sequencing rules information is retrieved from the database tables and stored into PHP session variables. The learner’s progress in the tutorial is stored and the sequencing rules are checked while the learner goes through the tutorial in order to determine which SCO should be presented next and which SCO should be skipped.

6.3.3 LMS INSTALLATION

Three LMSs were installed. Those LMS were Moodle, Docebo and Open Enrollment. Moodle is the LMS that was used to provide the P-Learning tutorial system while the other two LMSs were used to show the interoperability of the learning objects among different LMSs by importing and playing the same SCORM packages that were used in Moodle.
6.3.3.1 MOODLE INSTALLATION

Before Moodle can be installed, Apache v2.2.11, MySQL v5.0.18 and PHP 5 were installed. A number of PHP settings were checked to make sure Moodle works correctly. For example the safe mode need to be set to off. A database named moodle was created to hold all the tables needed and a directory name moodledata was also created for the purpose of storing uploaded files.

As mentioned in Section 6.3.2, the SCORM module was modified once Moodle has been installed. After the SCORM module has been modified successfully to support the sequencing and navigation rules, SCORM packages can be imported into Moodle to create the tutorial. The first step is to create a new course in SCORM format. The second step is to import the SCORM package which contains the tutorial into the course. The zipped file needs to be extracted and the manifest file must be selected in order to allow the metadata, resources and sequencing information to be processed and stored into database tables. When these were done, the tutorial was ready and learners will be able to enroll to the course to view the tutorial.

6.3.3.2 DOCEBO INSTALLATION

The Docebo LMS was installed on Windows platform. PHP is the main programming language used in Docebo. Similar to the Moodle installation, Apache, MySQL and PHP must be installed before Docebo can be installed. In order to use SCORM components, the domxml library had been enabled in the php.ini file. A database named docebo was created using phpMyAdmin.

After the system was successfully installed, the SCORM packages were imported into the system and courses were created using the contents in the packages. However, Docebo does not fully support SCORM 2004 yet and thus, although the
tutorial contents could be shown, most of the sequencing and navigation rules were not implemented correctly.

6.3.3.3 OPEN ENROLLMENT INSTALLATION

The Open Enrollment LMS was installed on Linux platform and the programming language used is Java. The required pre-installed software such as JDK 1.5, Tomcat and MySQL were installed.

A lms.war file and a database directory can be found in the downloaded installation zip file. A database name lmsdb was created and tables, constraints and reference data were created by using the db scripts in the database directory. After the database has been successfully created, the lms.war file was placed into the Tomcat Web application directory and the whole LMS project directory was created after Tomcat had started.

In order to create courses, SCORM packages were imported into the system. When the courses are ready, students can be registered to the course. Open Enrollment system supports SCORM 2004 and hence the tutorials can be carried out in the predetermined order. Explanation on how the tutorials were tested will be given in the next chapter.

6.4 USER INTERFACE DEVELOPMENT

To create images to be used in the tutorials, Microsoft Paint was used. For the Moodle user interface, a very simple theme was selected and a logo of the P-Learning system was created. When learners view a tutorial, they will see a table of contents which shows a list of learning contents displayed in a given order. This helps the learners to understand the scope and the whole structure and contents provided in the tutorial. Navigation buttons such as the ‘Previous’ and ‘Continue’ buttons are placed on
top of the table of contents. These buttons can be used by the learners to navigate through the content in addition to clicking on the content link to access the content directly.

6.5 CODING APPROACH AND STYLE

Moodle is built in a very modular fashion. New functions can be created merely by inserting them into a file in the directory of the specific module. Hence, all the functions needed to support the implementation of sequencing and navigation rules were placed in the files in the SCORM module directory.

Coding styles is an important attribute of writing source code and it determines the readability and maintainability of a program. An easy to read source code makes the system easier to maintain and enhance. The elements of coding style include the use of comments, variables and methods naming, and code indentation.

- **Use of comments**
  The comments written in the code help the users of the program to understand the code easily. The comments provide a clear guide during the maintenance or enhancement of the system.

- **Variables and methods naming**
  A standard or meaningful variables and methods naming can help the users of the program to understand the code easily. Using meaningful methods naming helps the user to get a brief idea on the purpose of a method before going into details.

- **Code indentation**
  Indentation assists in identifying control flow and blocks of code. It makes the code more readable and structured.
6.6 SUMMARY

This chapter discusses the development of the system. It describes the tools, steps, methods and techniques that were used to develop the system. The use of good coding style ensures that the system is readable and maintainable.

In the next chapter, tests that were carried out will be explained. SCOs and SCORM packages will be tested using the ADL SCORM 2004 Conformance Test Suite to assess their conformance with the SCORM 2004 standard. Tutorials created in Moodle using SCORM packages will be tested to ensure the sequencing behavior follows what is being specified in the manifest file. In addition, the P-Learning system will be fully deployed and maintenance tasks will be described as well.
CHAPTER 7: SYSTEM TESTING, DEPLOYMENT AND MAINTENANCE

7.1 INTRODUCTION

Testing is performed to ensure that the programs are executed correctly and to detect the existence of errors. It provides a method to correct errors and for testing system reliability. Testing is a verification and validation process. Verification ensures the system implements a specific function correctly, whereas validation ensures the system has been built traceable to user requirements.

System will be delivered after it has been tested. System deployment is the process whereby software is installed into an operational environment (Bidgoli, 2004, p.399). After the system has been setup, the system operation is monitored for continued performance in accordance with user requirements and it will be assessed to determine how the system can be made more efficient.

This chapter discusses various types of testing that were carried out before the P-Learning system was deployed. A series of tests were used to test SCO’s interoperability and their conformance to SCORM 2004 standard. The P-Learning system was tested to ensure that all the modules were working properly and the system requirements had been fulfilled. This chapter also discusses the deployment of the P-Learning system and the activities that have been carried out to keep the system works properly. Besides, the analysis of the survey data collected from questionnaire will be discussed.

7.2 TESTING STRATEGY AND TECHNIQUE

Software testing strategy is an essential process that comprises part of the software development lifecycle. A test strategy basically defines which types of testing to do, the order in which to perform them and the sequence of execution to make the testing more effective (Brown, 2003).
The testing strategy adopted in this project is the bottom-up testing. Testing starts with the fundamental components and works upwards. Some of the important components in this project that must be tested include the import SCORM package, record learning progress data, and the implementation of sequencing and navigation rules. Besides, the SCOs were tested for their interoperability and their conformance to SCORM 2004 standard. After these components have been tested, they were integrated. Tests were carried out to ensure that the components work well with each other. The advantages of using this type of testing strategy are the test conditions are easy to create and the observation of test result is easier.

There are two common testing techniques known as white-box testing and black box testing. White-box testing is a test method where tester views the internal behavior and structure of the program. It is usually undertaken by someone who has knowledge of the development language used. Black-box testing is a test method where the tester views the program as a black box, which means the test is completely unconcerned about the internal behavior and structure of the program. Data is entered as an input and only the results of the output are known. The primary focus is on the selection of data inputs to test against the functional specifications.

Both testing techniques were used in the testing of the P-Learning system. White-box testing was used mostly in unit testing while black-box testing was used in system testing. Test cases were created based on prioritized requirements. Well-designed test cases ensure requirements are being met and useful to uncovering defects. Test cases used in this project are shown in Appendix C.

7.3 P-LEARNING SYSTEM TESTING

Testing that was carried out in this project can be categorized into three major parts. The first part was to test the SCOs and SCORM packages to assess their
conformance to the SCORM 2004 standard. The second part was to test whether the
SCOs were interoperable between different LMSs and the last part was to test the
SCORM module in the P-Learning system and also to test the system as a whole.

7.3.1 SCORM CONFORMANCE TESTING

The purpose of the SCORM conformance test was to ensure that the SCOs and
the content packages used to create the tutorials were created and packaged according to
the SCORM standard. The ADL SCORM 2004 3rd Edition Conformance Test Suite
Version 1.0.2 was used to perform testing to determine their conformance to the
SCORM 2004 3rd Edition standard. However, the use of this software does not imply

The Conformance Test Suite can be used to assess the conformance to SCORM
by providing several testing components and the components that were used in this
project were as follows:

- Manifest Utility Test
- SCO RTE Conformance Utility Test
- Content Package Conformance Test

The Conformance Test Suite provides a common framework for all of the
conformance tests and each test produces a log of each test action and the corresponding
outcome. The test suite runs within a Web browser on one local computer while all the
software is loaded on the machine and requires no HTTP Web server to run.

7.3.1.1 MANIFEST UTILITY TEST

The Manifest Utility Test verifies that the IMS Manifest file is conformant with
the rules specified in the SCORM 2004 3rd Edition Content Package Application
Profiles. Some of the aspects of the IMS Manifest that are being verified in the test include:

- It is named imsmanifest.xml and it is well-formed.
- It is located at the root of the Content Packages.
- It validates against the IMS Content Packaging XML Schema Definition (XSD) Version 1.1.4.
- It validates against the SCORM 2004 3rd Edition Content Packaging Extensions XML XSD Version 1.0.
- It implements all mandatory elements correctly.
- If the IMS Manifest contains IMS Simple Sequencing Information, verifies that the sequencing information is valid according to the IMS Simple Sequencing XML Schema Definition (XSD).

To run the Manifest Utility Test, some brief information such as the Manifest identifier name and version number has to be provided. The IMS Manifest can be tested in the form of a Package Interchange File (PIF) which is a zip file, or an uncompressed Package (non-PIF). After the file has been selected and some settings are set, the test can be started and the results will be shown. Besides, the logs will be created and automatically saved in a folder.

The content packages used to create Java_Tutorial_1 and Java_Tutorial_2 had run through and passed this Manifest Utility Test. The results are shown in Appendix D.

7.3.1.2 SCO RTE CONFORMANCE UTILITY TEST

The SCO RTE Conformance Utility Test verifies that the test subject SCO is conformant with the SCORM 2004 3rd Edition Conformance Requirements. This test will verify that the test subject:
• Can be launched by a known conformant LMS.

• Supports the Run-Time Environment Application Program Interface (API) functions defined in SCORM 2004 3rd Edition.

• Can successfully invoke, at a minimum, the Initialize(“”) and Terminate(“”) API methods.

In addition to verification of the above requirements, this test will also audit which Run-Time Environment Data Model elements the SCO makes use of in the content implementation, and verify that data elements are used in the correct manner with regard to the data type requirements associated with the data model elements.

The first thing to do when running a SCO test is to provide the SCO title, version and developer information. Next, the SCO that will be tested is selected. Initialization values such as learner name and objective data can be entered. When the information provided is sufficient, the SCO can be launched. The Conformance Test Suite will wait for a call to Initialize(“”) and then wait for calls to any of the API functions. The SCO will run as how it is designed. The results will be shown when the test has been completed. Logs will be created and saved in a folder.

All the SCOs used to create the Java_Tutorial_1 and Java_Tutorial_2 had run through this SCO RTE Conformance Utility Test. The results for the PreTest1 SCO, Lesson1 SCO and the Module PostTest1 SCO are shown in Appendix D.

7.3.1.3 CONTENT PACKAGE CONFORMANCE TEST

A content package is required to support various aspects of the SCORM Run-Time Environment and the SCORM Content Aggregation Model. The purpose of the Content Package Conformance Test is to verify that a content package implements the conformance requirements defined for the following conformance categories:
• Content Package Content Aggregation Model Version 1.0 (CP CAM 1.0)
• Content Package Run-Time Environment Version 1.0 (CP RTE 1.0)

The requirements defined in the CP CAM 1.0 and CP RTE 1.0 include:
• The content package shall contain a manifest named imsmanifest.xml.
• The imsmanifest.xml file shall be placed at the root of the content package.
• The imsmanifest.xml instance shall be well-formed.
• The imsmanifest.xml instance shall validate against the IMS Content Packaging XML Schema Definition (XSD).
• If the content package manifest contains sequencing information as defined by IMS Simple Sequencing Version 1.0, then those extension elements and attributes shall validate against the IMS Simple Sequencing XSD Version 1.0.
• If the content package is placed into a Package Interchange File (PIF), then the PIF shall be conformant to RFC 1951 with archive format PKZIP Version 2.04g with .zip extension.
• The content package shall contain at least one SCO or Asset (SCORM resources).
• All learning resources identified as SCOs shall be SCORM 2004 3rd Edition conformant.

To run the Content Package Conformance Test, information such as the Content Package name, version number and developer have to be provided. The test type and the SCORM Application Profile type need to be set. Next, the Content Package to be tested will be selected. Once the test has started, the Conformance Test Suite will test the IMS Manifest and metadata for schema validation. Any SCOs referenced by the IMS
Manifest will also be tested. When the test is complete, results will be shown and the log file will be created and saved in a folder.

Both the content package for Java_Tutorial_1 and Java_Tutorial_2 had been tested using this Content Package Conformance Test. The test result for Java_Tutorial_1 and Java_Tutorial_2 are shown in Appendix D.

7.3.2 SCO INTEROPERABILITY TESTING

In order to test learning object’s interoperability, SCOs used to create Java_Tutorial_1 were imported into Open Enrollment LMS and also Docebo LMS.

7.3.2.1 TEST SCOS IN OPEN ENROLLMENT

The content package used to create the Java tutorial was mainly consist of multiple SCOs which contain the pretests, lessons, posttests and quiz. Each of these individual SCOs was imported into the Open Enrollment LMS. For example, the SCO which contains the Java quiz was imported into the system and it works exactly the same as how it works in the Moodle system. Figure 7.1 shows the screenshot where the quiz SCO is launched.
Figure 7.1: Quiz SCO launched in Open Enrollment LMS

Figure 7.2 depicts the page which shows the information of the course that contains the Quiz SCO. After each individual SCO has been tested in the Open Enrollment LMS, the content package which consists of these SCOs was imported into the system. This is to test whether the tutorial created by using the SCORM content package will work the same as in the Moodle system. Since Open Enrollment LMS supports SCORM 2004 Sequencing and Navigation rules, the Java tutorial created works according to the rules defined in the manifest file. The tutorial’s content to be shown depends on the Java tests result.

As a result of the above tests, the SCOs are proven to be interoperable between Moodle and Open Enrollment LMS.
7.3.2.2 TEST SCOS IN DOCEBO

All the SCOs used to create the Java tutorial were imported into the Docebo LMS. Each individual SCO contains a pretest, a lesson, a posttest or a quiz. For example, the SCO that contains the first pretest in the Java tutorial was imported into Docebo. Figure 7.3 shows the screenshot where the PreTest SCO was launched.
The learner’s progress was stored in the system. After each individual SCO has been tested, the content package which consists of all these SCOs was imported into the system. Although the content package was successfully imported and the tutorial can be viewed in the system, but most of the sequencing rules defined in the package were not successfully implemented because of limited support of SCORM 2004 in the Docebo system. However, the results still show that the SCOs created are interoperable between Moodle and Docebo LMS. Figure 7.4 depicts the page which shows the information of the course that contains the PreTest SCO.

![Figure 7.4: Pre-test SCO course details page](image)

**7.3.3 P-LEARNING TESTING**

The P-Learning system is developed on Moodle system. Moodle is an open source system which was only released after a series of testing and so it is free from major defects. Hence, most of the tests were focused on the SCORM module developed in this project. The SCORM module has been tested separately and was later being integrated together with other modules in Moodle. After the integration, the system as a whole was tested again. The SCORM module contains functions that can be checked.
and tested carefully. These functions may call other sub functions and tests were carried out to ensure all possible paths were tested.

7.3.3.1 UNIT TESTING

Unit testing concentrates on the smallest components of the system for testing. Every individual component is tested independently. It verifies that the component functions properly and errors in coding and logical mistakes can be detected.

The first step of the testing process was to examine the program code by reading through it, trying to spot algorithm or syntax faults. Next, the code was compared with specifications and designs to make sure that all the relevant cases have been considered. Finally, the components were tested to ensure that the desired output was produced for every possible input.

A few important aspects that were tested in the SCORM module include:

- **Import SCORM content packages**
  To make sure that when content package was imported into the system, the zip file was imported and extracted into a folder and all the information in the imsmanifest.xml file was stored correctly into the database tables.

- **Store SCO’s runtime data**
  To make sure that the learner’s progress data in the SCOs was stored into the database tables and SCOs were able to retrieve certain information from the database.

- **Evaluate sequencing and navigation rules**
  To ensure that the sequencing and navigation rules defined in the imsmanifest.xml file have been implemented throughout the tutorial. Rustici Software’s SCORM Test Track application has been used to evaluate the tutorial content and to test the SCORM sequencing rules. The sequencing rules behavior
in the tutorials created in Moodle should be the same as when it was run in the SCORM Test Track application.

- Learner’s attempt report

To make sure that the learner’s attempt report was shown correctly.

### 7.3.3.2 INTEGRATION TESTING

Integration testing is the process of verifying that the system components work together as described in the system and program design specification. After the SCORM module has been tested to show it works correctly and meets the objectives and requirements, it was combined with other Moodle modules. Other Moodle modules that were involved include the login module, course category module and the course module. Testing has been carried out to ensure that all these modules interact with each other correctly.

### 7.3.3.3 SYSTEM TESTING

After integration testing, the system was tested as a whole for functionality and fitness of use. It verifies that the system satisfies all of its functional and quality attributes, and operational requirements in simulated or real hardware environment. It also verifies that certain nonfunctional characteristics are present, such as scalability, usability, security and reliability.

- Acceptance Testing

Acceptance testing is a user-run test that demonstrates the application’s ability to meet the original business objectives and system requirements (Lewis, 2000). Questionnaires survey was conducted to collect feedback from users. The data was used to determine whether the system satisfies its acceptance criteria and
enable users to determine whether to accept the system or not. Analysis of the survey results is presented in the next section.

- **Usability Testing**
  It focuses on how well users can understand, use and navigate through the system. Feedback collected through questionnaires allows improvements to be made so that the system can be closely aligned with user requirements.

- **Security Testing**
  It determines that the system protects data and maintains functionality as intended. Security concepts such as authorization, availability and confidentiality were covered. Login and enrollment key features were tested to ensure authorization and availability while encryption was useful to provide confidentiality.

- **Reliability Testing**
  Reliability refers to the ability of a system or component to perform its required functions under stated conditions for a specified period of time. Multiple test cases were used in the testing process in order to obtain data to measure the system’s reliability.

### 7.4 ANALYSIS OF THE TESTING

#### 7.4.1 ANALYSIS OF LEARNING OBJECTS AND P-LEARNING SYSTEM

From the testing process that has been carried out, the test results are summarized as below:

- **E-Tutorial created using learning object technology**
  Generally, the main objective of the project has been achieved. Learning objects that conform to standard have been created and were used to create online tutorials.
• Learning objects conform to standard
  Learning objects created are conforming to SCORM 2004 standard. All the SCOs have passed the tests in ADL Conformance Test Suite.

• Learning objects’ interoperability
  SCOs have been created using tools such as Macromedia Dreamweaver and Macromedia Flash. These SCOs can be used not only in P-Learning system that was built on Moodle, they can also be used in Open Enrollment and Docebo LMS without any modification. Besides, they can also be put together to create a larger learning module.

• SCORM sequencing and navigation rules support
  Tutorials were created by importing SCORM content package that contains sequencing and navigation rules. These rules have been implemented correctly in P-Learning system and this has been proven because the sequencing behavior shown in P-Learning and Rustici Software’s SCORM Test Track application are the same.

7.4.2 ANALYSIS OF SURVEY

There were eighteen users participated in the survey on the usage of SCORM 2004 Sequencing and Navigation rules in online learning. Although this small sample size limits the applicability of the results, it still gives us a brief idea on how users felt about the usage of those rules in online learning, what are the factors that might affect their preferences on the usage of those rules, and also how they felt about the content of tutorials provided in the P-Learning system that have been created by using interoperable learning objects. This information can be helpful in designing and developing other learning objects.
The survey had been carried out for about 10 weeks. Sequencing rules was implemented in the Java_Tutorial_1 to provide remediation learning strategy while the Java_Tutorial_2 has no sequencing rules implemented. Among the 18 users participated in the survey, 9 of the users were asked to complete Java_Tutorial_1 before Java_Tutorial_2 while the other 9 users were asked to complete Java_Tutorial_2 before Java_Tutorial_1. This is to ensure that the participants can experience both tutorials before they complete the questionnaire survey.

7.4.2.1 RESPONDENTS’ BACKGROUND

A total of eighteen users completed both Java_Tutorial_1 and Java_Tutorial_2 and were included in the data analysis after completing a questionnaire survey. Among the users, 8 of the users are male and 10 of the users are female. The users’ prior knowledge in Java programming language is self-reported. A majority of the users (72%) do not have prior knowledge in Java programming language before taking the Java tutorials in P-Learning system. Although all the users think that the Internet is an important source of learning, there are still 7 users (39%) do not have any online learning experience before taking the Java tutorials. Table 7.1 shows the survey data regarding users’ learning experience and opinion on online learning.

Table 7.1 Users’ learning experience and opinion on online learning

<table>
<thead>
<tr>
<th>Question</th>
<th>User Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior knowledge</td>
<td></td>
</tr>
<tr>
<td>Have prior knowledge in Java programming language.</td>
<td>5</td>
</tr>
<tr>
<td>Do not have prior knowledge in Java programming language.</td>
<td>13</td>
</tr>
<tr>
<td>Online learning experience</td>
<td></td>
</tr>
<tr>
<td>Have online learning experience before taking the Java tutorials.</td>
<td>11</td>
</tr>
<tr>
<td>Do not have online learning experience before taking the Java tutorials.</td>
<td>7</td>
</tr>
<tr>
<td>Internet as source of learning</td>
<td></td>
</tr>
<tr>
<td>Think the Internet is an important source of learning.</td>
<td>18</td>
</tr>
<tr>
<td>Do not think the Internet is an important source of learning.</td>
<td>0</td>
</tr>
</tbody>
</table>
7.4.2.2 LAYOUT, DESIGN, AND CONTENT OF TUTORIALS

A summary of responses to selected questions of the survey from the eighteen users are shown in Table 7.2, which shows the users’ responses to questions regarding the layout, design content, and organization of the Java tutorials.

Table 7.2 Users responses to questions regarding layout, design and content of tutorials

<table>
<thead>
<tr>
<th>Layout, design and content of Java tutorials</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I liked the layout of the materials.</td>
<td>0</td>
<td>2</td>
<td>8</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>There was too much text.</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>It gives a broad enough coverage of the subject.</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Content was covered in sufficient depth.</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>The content has been arranged in a logical manner.</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>I have been able to understand the learning material given.</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>The tests were accurate and fair.</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>The difficulty level is appropriate.</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>I will be able to use what I learned in the tutorials.</td>
<td>0</td>
<td>2</td>
<td>10</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

The data in Table 7.2 shows that 8 users (44%) had neutral opinion about the layout of the materials while 8 users (44%) liked the layout of the materials. There were 7 users (39%) felt that there was too much text in the tutorials but 5 users (28%) felt the opposite.

One of the best practices in the design and content in online tutorials addressed by Dewald (1999) is to teach concepts and not just mechanics. It shows that it is important for the users to understand the concepts. Thus, the introduction and explanation of concepts used in Java programming were included in the Java tutorials to help users in learning Java programming. As a result, many users (61%) agreed that the
tutorials gave broad enough coverage of the subject and more than half of the users (56%) agreed that the content was covered in sufficient depth.

Unstructured content is one of the factors that may de-motivate learners. The logical flow of chunks of information is very important for making the content effective (Shivkumar, 2006). There were 11 users (61%) felt the tutorial content has been arranged in a logical manner while others had neutral opinion. Besides, most users (61%) were able to understand the learning material given.

Half of the users (50%) agreed that the tests in the tutorials were accurate and fair while others have neutral opinion. Besides, 50% of the users also agreed that the difficulty level of the tutorial is appropriate while others have neutral opinion. 33% of the users agreed that they will be able to use what they learned in the tutorials yet 11% of the users felt that they will not be able to use what they learned.

The data in Table 7.2 is also shown in Figure 7.5 and Figure 7.6 using bar chart.

![Survey Questions](image)

Figure 7.5 Users responses to questions regarding layout, design and content of tutorials
Part I
Users’ online learning experience may affect their perception on the tutorials provided in the P-Learning system. Figure 7.7 shows the opinion on the arrangement of content in the Java tutorials from two types of users, which were grouped according to their online learning experience.

Figure 7.7 Users’ opinion on the arrangement of content in Java tutorials
The data in Table 7.2 already shows that there were 10 users agreed that the tutorials content has been arranged in a logical manner, 1 user strongly agreed on that while 7 users had neutral opinion. Among the 18 users, 11 users have online learning experience. Within the group of users with online learning experience, 8 users (72.7%) agreed, 1 user (9.1%) strongly agreed and 2 users (18.2%) had neutral opinion that the tutorials content has been arranged in a logical manner. On the other hand, for the group of users without online learning experience, 2 users (28.6%) agreed that the content was in a logical manner while others (71.4%) had neutral opinion. The statistics show that the users who have online learning experience were more comfortable with the arrangement of content in the tutorials compared to the users without online learning experience.

The correlation coefficient, denoted by \( r \), is a measure of the strength and direction of the linear relationship between two variables. It takes on values ranging between +1 and -1 (Ratner, 2003). Table 7.3 shows the numeric representations of survey data related to users’ online learning experience and logical arrangement of content in Java tutorials. Table 7.4 shows how the survey data from the 18 users were used, by following the numeric representations, to calculate the correlation coefficient between the users’ online learning experience and their opinion on the logical arrangement of content in the Java tutorials.

Table 7.3 Numeric representations of survey data related to users’ online learning experience and logical arrangement of content

<table>
<thead>
<tr>
<th>Survey data</th>
<th>Representation in numeric numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users’ online learning experience</td>
<td></td>
</tr>
<tr>
<td>Have online learning experience before taking the Java tutorials.</td>
<td>1</td>
</tr>
<tr>
<td>Do not have online learning experience before taking the Java tutorials.</td>
<td>0</td>
</tr>
<tr>
<td>Users’ opinion on the statement of the Java tutorials content has been arranged in a logical manner</td>
<td></td>
</tr>
<tr>
<td>Strongly disagree.</td>
<td>1</td>
</tr>
<tr>
<td>Disagree.</td>
<td>2</td>
</tr>
<tr>
<td>Neutral.</td>
<td>3</td>
</tr>
<tr>
<td>Agree.</td>
<td>4</td>
</tr>
<tr>
<td>Strongly agree.</td>
<td>5</td>
</tr>
</tbody>
</table>
Table 7.4 Correlation coefficient between users’ online learning experience and their opinion on the logical arrangement of content in the Java tutorials

<table>
<thead>
<tr>
<th>Online learning experience</th>
<th>Opinion on arrangement of content in logical manner</th>
<th>Online learning experience</th>
<th>Opinion on arrangement of content in logical manner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>

Correlation coefficient: 0.526

The calculated correlation coefficient value is 0.526. This value indicates a moderate correlation between users’ online learning experience and their opinion on the logical arrangement of content in the Java tutorials.

Apart from online learning experience, the 18 users were also grouped based on whether they have prior knowledge on Java programming language. Figure 7.8 shows the opinion on the difficulty level of the tutorials from the two groups of users.

![Java tutorials difficulty level is appropriate](image)

Users with prior knowledge in Java programming language

Users without prior knowledge in Java programming language

Figure 7.8 Users’ opinion on the difficulty level of the Java tutorials
There was no user who disagreed that the difficulty level of the tutorials was appropriate. Among all the 18 users, 2 users were strongly agreed and 7 users agreed that the difficulty level of the tutorials was appropriate. 9 other users had neutral opinion. In the group of 5 users who have prior knowledge in Java programming, 3 users (60%) agreed that the difficulty level was appropriate and 2 users (20%) had neutral opinion. For the group of users without prior knowledge in Java programming, 2 users (15.4%) strongly agreed that the difficulty level was appropriate, 4 users (30.8%) agreed while others had neutral opinion. The statistics shows that no matter the users have prior knowledge in Java programming or not, 50% of the users felt that the difficulty level of the Java tutorials was appropriate. This also means that the tutorials were suitable for both beginners and non-beginners.

Correlation coefficient had also been used to measure the strength of relationship between the users’ prior knowledge in Java programming and their opinion on the difficulty level of the Java tutorials. Table 7.5 shows the numeric representations of survey data related to users’ prior knowledge in Java programming and their opinion on difficulty level of the Java tutorials. Table 7.6 shows how the survey data were used, by following the numeric representations, to calculate the correlation coefficient between the users’ prior knowledge in Java programming and their opinion on the appropriateness of difficulty level of the Java tutorials.

Table 7.5 Numeric representations of survey data related to users’ prior knowledge in Java programming and the difficulty level of Java tutorials

<table>
<thead>
<tr>
<th>Survey data</th>
<th>Representation in numeric numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users’ prior knowledge in Java programming</td>
<td>Have prior knowledge in Java programming language.</td>
</tr>
<tr>
<td></td>
<td>Do not have prior knowledge in Java programming language.</td>
</tr>
<tr>
<td>Users’ opinion on the statement of the difficulty level of Java tutorials is appropriate</td>
<td>Strongly disagree.</td>
</tr>
<tr>
<td></td>
<td>Disagree.</td>
</tr>
<tr>
<td></td>
<td>Neutral.</td>
</tr>
<tr>
<td></td>
<td>Agree.</td>
</tr>
<tr>
<td></td>
<td>Strongly agree.</td>
</tr>
</tbody>
</table>
Table 7.6 Correlation coefficient between users’ prior knowledge in Java programming and their opinion on the appropriate difficulty level of the Java tutorials

<table>
<thead>
<tr>
<th>Prior knowledge in Java programming</th>
<th>Opinion on the appropriate difficulty level of Java tutorials</th>
<th>Prior knowledge in Java programming</th>
<th>Opinion on the appropriate difficulty level of Java tutorials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>5</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

Correlation coefficient: -0.010

The calculated correlation coefficient value is -0.010. This value indicates a very weak to negligible correlation between users’ prior knowledge in Java programming and their opinion on the appropriateness of difficulty level of the Java tutorials.

Besides the difficulty level of the Java tutorials, the comparison between the two groups of users (with or without prior knowledge in Java programming language) was made by analyzing their opinion on the coverage of the subject in the tutorials. Figure 7.9 shows the opinion on the coverage in terms of breadth of the subject in the Java tutorials from the two groups of users while Figure 7.10 shows their opinion on the depth of the content in the Java tutorials.
Java tutorials give broad enough coverage of the subject

Figure 7.9 Users’ opinion on the coverage in terms of breadth of subject in the Java tutorials

Java tutorials content was covered in sufficient depth

Figure 7.10 Users’ opinion on the depth of content in the Java tutorials

Overall, for the statement of the Java tutorials gave broad enough coverage on the subject, 2 users were strongly agreed, 9 users agreed, 1 user disagreed and 6 users had neutral opinion. Figure 7.9 shows that in the group of users with prior knowledge on Java programming, 4 users (80%) agreed that the Java tutorials give broad enough coverage of the subject while only 1 user (20%) disagreed. On the other hand, in the group of 13 users who did not have prior knowledge, 2 users (15.3%) were strongly agreed, 5 users (38.5%) agreed and 6 users (46.2%) had neutral opinion. There were
about half of the users in this group had neutral opinion and that is probably because they did not know how complicated the Java tutorials can be and what other topics should be included in the tutorials. Anyway, 80% of the users who have prior knowledge agreed that the tutorials gave broad enough coverage on the subject and this indicates the Java tutorials have covered at least the basics topics for users to learn Java programming.

There was 1 user strongly agreed that the content in the Java tutorials was covered in sufficient depth, 9 users agreed and 8 users had neutral opinion. The only 1 user who had strongly agreed on that was a user who did not have prior knowledge on Java programming. Among the 9 users who agreed that the content was covered in sufficient depth, 5 users were without prior knowledge. Another 4 users were with prior knowledge and that covers 80% of the group of users who have prior knowledge. The 4 users who have prior knowledge and agreed that the content was covered in sufficient depth are the same 4 users who agreed that the Java tutorials gave broad enough coverage on the subject. This shows that the 4 users (80%) in the group of 5 users who have prior knowledge felt that the Java tutorials were covered sufficiently in terms of breadth and depth.

Table 7.7 shows the numeric representations of survey data related to users’ prior knowledge in Java programming and the coverage in terms of breadth of subject in the Java tutorials. Table 7.8 shows the data used to calculate the correlation coefficient between the users’ prior knowledge in Java programming and their opinion on the broad coverage of subject in the Java tutorials.
Table 7.7 Numeric representations of survey data related to users’ prior knowledge in Java programming and the coverage in terms of breadth of subject in the Java tutorials

<table>
<thead>
<tr>
<th>Survey data</th>
<th>Representation in numeric numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users’ prior knowledge in Java programming</td>
<td>Have prior knowledge in Java programming language. 1</td>
</tr>
<tr>
<td></td>
<td>Do not have prior knowledge in Java programming language. 0</td>
</tr>
<tr>
<td>Users’ opinion on the statement of the Java tutorials give broad enough coverage of the subject</td>
<td>Strongly disagree. 1</td>
</tr>
<tr>
<td></td>
<td>Disagree. 2</td>
</tr>
<tr>
<td></td>
<td>Neutral. 3</td>
</tr>
<tr>
<td></td>
<td>Agree. 4</td>
</tr>
<tr>
<td></td>
<td>Strongly agree. 5</td>
</tr>
</tbody>
</table>

Table 7.8 Correlation coefficient between users’ prior knowledge in Java programming and their opinion on the broad coverage of subject in the Java tutorials

<table>
<thead>
<tr>
<th>Prior knowledge in Java programming</th>
<th>Opinion on the broad coverage of subject in tutorials</th>
<th>Prior knowledge in Java programming</th>
<th>Opinion on the broad coverage of subject in tutorials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>5</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

Correlation coefficient: -0.055

The calculated correlation coefficient value is -0.055 and it indicates a very weak to negligible correlation between users’ prior knowledge in Java programming and their opinion on the broad coverage of subject in the Java tutorials. It can be concluded that users’ opinion on the broad coverage of subject in tutorials is not dependent upon their prior knowledge in Java programming.

Table 7.9 shows the numeric representations of survey data related to users’ prior knowledge in Java programming and the sufficient depth of content in the Java tutorials. Table 7.10 shows the data used to calculate the correlation between the users’ prior knowledge in Java programming and their opinion on the sufficient depth of content in the Java tutorials.
Table 7.9 Numeric representations of survey data related to users’ prior knowledge in Java programming and the sufficient depth of content in the Java tutorials

<table>
<thead>
<tr>
<th>Survey data</th>
<th>Representation in numeric numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users’ prior knowledge in Java programming</td>
<td></td>
</tr>
<tr>
<td>Have prior knowledge in Java programming language.</td>
<td>1</td>
</tr>
<tr>
<td>Do not have prior knowledge in Java programming language.</td>
<td>0</td>
</tr>
<tr>
<td>Users’ opinion on the statement of the Java tutorials content was covered in sufficient depth</td>
<td></td>
</tr>
<tr>
<td>Strongly disagree.</td>
<td>1</td>
</tr>
<tr>
<td>Disagree.</td>
<td>2</td>
</tr>
<tr>
<td>Neutral.</td>
<td>3</td>
</tr>
<tr>
<td>Agree.</td>
<td>4</td>
</tr>
<tr>
<td>Strongly agree.</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 7.10 Correlation coefficient between users’ prior knowledge in Java programming and their opinion on the sufficient depth of content in the Java tutorials

<table>
<thead>
<tr>
<th>Prior knowledge in Java programming</th>
<th>Opinion on the sufficient depth of content in tutorials</th>
<th>Prior knowledge in Java programming</th>
<th>Opinion on the sufficient depth of content in tutorials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>5</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

Correlation coefficient: 0.198

The calculated correlation coefficient value is 0.198 and it indicates a weak correlation between users’ prior knowledge in Java programming and their opinion on the sufficient depth of content in the Java tutorials.

7.4.2.3 IMPLEMENTATION OF SEQUENCING RULES

Other than questions regarding the layout, design and content of the Java tutorials, the survey also consists of questions regarding the implementation of sequencing rules. The data collected were used to evaluate users’ preference and feedback towards the use of sequencing rules in providing remediation in learning. Table 7.11 shows the users’ responses to questions regarding the implementation of
sequencing rules in Java_Tutorial_1. The data in Table 7.11 is also shown in Figure 7.11 and Figure 7.12 in bar charts.

Table 7.11 Users responses to questions regarding implementation of sequencing rules

<table>
<thead>
<tr>
<th>Implementation of sequencing rules in Java_Tutorial_1</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The tutorial is in good organization where it starts with the easiest content and followed by the harder content.</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>The tests in the tutorial help me to evaluate my knowledge in each main topic before taking the lessons.</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>The way the tutorial is conducted in Java_Tutorial_1 helps me to be more focus on the topics that I’m not very good at.</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>I like the way of how the tutorial is conducted where the flow of content to be shown depends on the test results.</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>The organization and the flow of content in Java_Tutorial_1 is more time efficient than in Java_Tutorial_2.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>I prefer the way the tutorial is conducted in Java_Tutorial_1 compared to Java_Tutorial_2.</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>I prefer the way the tutorial is conducted in Java_Tutorial_2 compared to Java_Tutorial_1.</td>
<td>0</td>
<td>13</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I do not have any preference between the way the tutorial is conducted in Java_Tutorial_1 and Java_Tutorial_2.</td>
<td>1</td>
<td>4</td>
<td>9</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>
Part I

Survey Questions

Figure 7.11 Users responses to questions regarding implementation of sequencing rules
Part I

Part II

Survey Questions

Figure 7.12 Users responses to questions regarding implementation of sequencing rules
Part II
The survey questions in Table 7.11 are focused on Java_Tutorial_1. The data in Table 7.11 shows that 8 users (44%) had neutral opinion about the organization of the tutorial while 11 users (61%) agreed that the tutorial was in good organization.

Pre-tests and post-tests were used to provide course remediation by implementing sequencing rules. Pre-tests were provided before each main topic. There were 14 users (78%) felt that the tests help to evaluate their knowledge before taking the lessons. Among the 14 users, there were 2 users who strongly agreed that the pre-tests were helpful. The pre-tests and post-tests results were used to determine the lessons to be shown to the users. There were 12 users (67%) liked the flow of content which depends on the tests results while other users (33%) had neutral opinion. The lessons associated with those tests will only be shown to the users if they did not obtain good results in the tests. This helps the users to be more focused on lessons that they are not very good at. The survey shows that there were more than half of the users (56%) felt that the way the tutorial is conducted in Java_Tutorial_1 makes them more focused in learning. Only 1 user (5%) disagreed that the way the tutorial is conducted helps the user to be more focused during the learning process. The organization and the flow of content may determine the time users spend in a tutorial. There were 15 users (83%) felt that Java_Tutorial_1, which implements the sequencing rules, is more time efficient than Java_Tutorial_2, which does not implement sequencing rules.

Basically the data that has been discussed so far shows that most of the users were satisfied with the way the tutorial was conducted in Java_Tutorial_1. There were 11 users (61%) preferred the way the tutorial was conducted in Java_Tutorial_1 compared to Java_Tutorial_2. There were 5 users (28%) had neutral opinion while 2 users (11%) did not preferred Java_Tutorial_1 compared to Java_Tutorial_2. However, there were 13 users (72%) disagreed that they prefer the way the tutorial was conducted in Java_Tutorial_2 compared to Java_Tutorial_1. Those 13 users are the addition of the
11 users who agreed that they prefer Java_Tutorial_1 compared to Java_Tutorial_2 and 2 other users who disagreed that they prefer Java_Tutorial_1 compared to Java_Tutorial_2. That means the 2 users did not prefer any of the 2 Java tutorials.

However, there were a total of 4 users (22.2%) who actually strongly agreed and agreed that they did not have any preference between the way both tutorials were conducted. Besides, there were 9 users (50%) had neutral opinion on that. Among those 9 users, there were 4 users who already had neutral opinion when they were asked whether they prefer the way the tutorial is conducted in Java_Tutorial_1 compared to Java_Tutorial_2, and vice versa, while the other 5 users were those who agreed that they prefer Java_Tutorial_1 compared to Java_Tutorial_2.

All these information can be retrieved from Table 7.12, which shows the differences of users’ response on the 3 questions regarding their preference towards the 2 Java tutorials. Each color line with arrow head indicates the response from a single group of users with the number at the end of the line is the number of users in that group. For example, the red color line with the number 1 at the end of the line means there were 1 user who agreed that he/she prefers the way the tutorial is conducted in Java_Tutorial_1 compared to Java_Tutorial_2, and then also disagreed that he/she prefers Java_Tutorial_2 compared to Java_Tutorial_1, and at last strongly disagreed that he/she does not have any preference between the way the tutorial is conducted in Java_Tutorial_1 and Java_Tutorial_2.
Table 7.12 Differences of users’ response on questions regarding their preference towards the Java tutorials

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prefer Java_Tutorial_1 compared to Java_Tutorial_2</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td>4</td>
<td>5</td>
<td>4</td>
<td>1</td>
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</table>

As mentioned earlier, users’ online learning experience may influence their perception on the tutorials. Figure 7.13 shows opinion on the use of tests in the tutorials to help users to evaluate their knowledge before taking lessons.

In the group of users with online learning experience, 18.2% of the users strongly agreed that the tests were useful in helping them in their knowledge evaluation while 63.6% of the users agreed on that. Only 18.2% of the users had neutral opinion and that means more than 80% of the users who have online learning experience liked...
the use of tests in tutorials. Besides, there were also more than 70% of the users without online learning experience agreed that the use of tests in tutorials helps them to evaluate their knowledge before taking lessons.

Among the 18 users participated in the survey, 9 of the users had completed Java_Tutorial_1 before Java_Tutorial_2 while the other 9 users had completed Java_Tutorial_2 before Java_Tutorial_1. Figure 7.14 shows the opinion from these 2 groups of users on whether the way the tutorial was conducted in Java_Tutorial_1 helps them to be more focused on the topics in the tutorial.

![Figure 7.14 Users’ opinion on the way Java_Tutorial_1 is conducted helps them focus on topics](image)

For the group of users who completed Java_Tutorial_1 before Java_Tutorial_2, 4 of them (44.5%) agreed that the way the tutorial was conducted in Java_Tutorial_1 helped them to be more focused on the topics in the tutorial, while 1 of them (11%) strongly agreed and 4 of them (44.5%) had neutral opinion. On the other hand, for the group of users who have completed Java_Tutorial_2 first, 4 of them (44.5%) agreed that the way the tutorial was conducted in Java_Tutorial_1 helped them to be more focused, while 3 of them (33.3%) had neutral opinion, 1 of them (11.1%) strongly agreed and 1 of them (11.1%) disagreed. Both pie charts in Figure 7.14 were quite similar and this
shows that the sequence in which the 2 tutorials were taken was not a factor affecting the users’ perception on whether the way the tutorial was conducted in Java_Tutorial_1 helped them to be more focused.

The flow of content in Java_Tutorial_1 depends on the test results. Figure 7.15 shows the preference of those 2 groups of users on the way Java_Tutorial_1 was conducted where the flow of content depends on test results.

![Pie chart](https://example.com/image.png)

**Figure 7.15 Users’ preference on the flow of content in Java_Tutorial_1 that depends on test results**

There were a total of 11 users who agreed that they liked the way of how Java_Tutorial_1 was conducted where the flow of content to be shown depends on the test results. Among the 11 users, 7 users have completed Java_Tutorial_1 before Java_Tutorial_2 while the other 4 users have completed Java_Tutorial_2 first. Most of the users who have completed Java_Tutorial_1 first liked the flow of content that depends on test results as they represent 77.8% of the users in that group. In addition, 1 user (11.1%) in that group strongly agreed that he/she liked the way the tutorial was conducted.

Figure 7.16 shows users’ opinion on comparison of time efficiency between Java_Tutorial_1 and Java_Tutorial_2. In the group of users who had completed
Java_Tutorial_1 before Java_Tutorial_2, 77.8% of them agreed that the organization and flow of content in Java_Tutorial_1 is more time efficient than in Java_Tutorial_2, while 22.2% of the users strongly agreed on that. Overall, all the users in that group felt that Java_Tutorial_1 was more time efficient than Java_Tutorial_2. However, in the group of users who had completed Java_Tutorial_2 before Java_Tutorial_1, only 55.6% of the users agreed that the organization and flow of content in Java_Tutorial_1 is more time efficient than in Java_Tutorial_2 and 11.1% of the users strongly agreed on that. This figure is relatively small compared to the group of users who completed Java_Tutorial_1 first. In addition, there was 1 user (11.1%) in the group who disagreed that Java_Tutorial_1 was more time efficient.

Besides the sequence in which the tutorials were taken, the users’ opinion on time efficiency between Java_Tutorial_1 and Java_Tutorial_2 can be analyzed based on users’ prior knowledge in Java programming. Figure 7.17 shows users’ opinion on time efficiency between Java_Tutorial_1 and Java_Tutorial_2 based on their prior knowledge in Java programming.
In the group of users with prior knowledge, 3 users (60%) agreed that the organization and flow of content in Java_Tutorial_1 is more time efficient than in Java_Tutorial_2, while 1 user (20%) strongly agreed on that and 1 user (20%) had neutral opinion. On the other hand, in the group of 13 users who did not have prior knowledge, 2 users (15.4%) were strongly agreed, 9 users (69.2%) agreed, 1 user (7.7%) disagreed and 1 user (7.7%) had neutral opinion.

The statistics shows that no matter the users have prior knowledge in Java programming or not, there were at least 80% of users in each group felt that the organization and flow of content in Java_Tutorial_1 is more time efficient than Java_Tutorial_2 which does not implement sequencing rules and remediation strategy. This indicates that the implementation of sequencing rules has positive impact on the users’ learning in terms of time spent in a tutorial, no matter the users are beginners or non-beginners.

![Figure 7.17 Users’ opinion on comparison of time efficiency between tutorials based on users’ prior knowledge in Java programming](image)

**Figure 7.17 Users’ opinion on comparison of time efficiency between tutorials based on users’ prior knowledge in Java programming**

### 7.4.2.4 USERS’ EXPECTATION AND IMPACT ON THEIR KNOWLEDGE LEVEL

There are also a few questions of the survey that were used to collect users’ feedback on the tutorials provided in the P-Learning system. The effect on users’
knowledge in Java after completing the Java tutorials is self-reported data. Figure 7.18 is the bar chart that shows users’ responses on how the tutorials meet their expectations. Figure 7.19 is the bar chart that shows users’ responses on how the tutorials affect their knowledge in Java.

Figure 7.18 shows that there were 3 users (17%) felt that the Java tutorials have exceeded their expectations, 11 users (61%) felt that their expectations have been met, 2 users (11%) felt that their expectations were barely met while another 2 users (11%) do not have any expectation on the tutorials. Figure 7.19 shows that all the users (100%) felt that their knowledge in Java has increased moderately after completing the Java tutorials.

Based on all the survey data that has been analyzed, users’ feedback on the Java tutorials provided in the P-Learning system can be summarized as follows. The tutorials
content was sufficient and users were able to understand the tutorials. Most users liked the usage of tests for their knowledge evaluation. Besides, users felt comfortable with the use of pre-tests, post-tests and sequencing rules in providing remediation in tutorial. They liked the way the tutorial is conducted where the flow of content depends on test results and that helps to make their learning more focused. In addition, the organization and use of tests and sequencing rules make the learning more time efficient. Thus, the use of sequencing rules to provide course remediation has a positive impact on online learning.

7.5 SYSTEM DEVELOPMENT

The deployment of P-Learning system is very straightforward. It is a new clean installation. It is not built to replace any existing system and hence no data needs to be back-up before the deployment. However, the production server information and a few required software tools were checked to make sure that they support the system well. Once the P-Learning system has been setup in the real production server, a simple testing was carried out. This is to ensure that the system has been setup and works properly.

Other than just setting up the system, another important thing in system deployment is preparing the installation scripts and release notes. The installation scripts provide the information on how to setup the system. This enables the system to be deployed in another place or another time easily by another person. Release notes contain some information on the system includes the system version number, features and the required software or tools to support the system. This information is crucial when user wants to maintain or upgrade the system. The installation scripts and release notes are include in Appendix E.
7.6 SYSTEM OPERATION AND MAINTENANCE

The system operation is ongoing. The system is monitored for continued performance in accordance with user requirements, and needed system modifications are incorporated. The operational system is periodically assessed to determine how the system can be made more efficient and effective. This important aspect of SDLC is called maintenance (White, 2007). Maintenance starts when a system is released to the user and it encompasses all activities that keep the system operational. It covers the correction of errors, the enhancement, deletion or addition of functions, the improvement of performance, or the adaptation to changes of data input.

The maintenance effort in this project can be grouped into two main categories:

- Corrective Maintenance
- Perfective Maintenance

7.6.1 CORRECTIVE MAINTENANCE

Corrective maintenance includes all the changes made to remove actual faults in the system. The system has been monitored for a while after it has been deployed. When an error was found, checking was carried out immediately to identify the cause. Changes were made to correct it and the updated files were uploaded to the server. Next, the corrected component was tested to make sure that it works properly.

7.6.2 PERFECTIVE MAINTENANCE

Perfective maintenance refers to enhancements made to improve software performance, maintainability, or understandability. It is generally performed as a result of new or changing requirements, or in an attempt to augment or fine tune the software. Optimization of code to make it run faster or to use storage more efficiently is included in the perfective maintenance category (Belzer et al., 1990).
7.7 SUMMARY

This chapter discusses the testing that has been carried out in this project. The testing results have shown that the system fulfils the requirements and works as expected. It also explains how the system was deployed and the activities that were carried out in providing system maintenance.

In the next chapter, the project objectives will be reviewed. System strengths and limitations will be discussed. Besides, future enhancement will be identified to make the system becomes better.
CHAPTER 8: CONCLUSION

8.1 INTRODUCTION

All the activities defined in the software development process model selected in this project, the V-model, have been completed. This chapter discusses the objectives that have been met in this project, the strengths and limitations of the P-Learning system, the future enhancement that can make the system becomes better, and also the lessons learnt in developing the P-Learning system using learning objects.

8.2 PROJECT OVERVIEW

The scope of this project is to develop an e-tutorial system using interoperable learning objects and to evaluate learners’ satisfaction on the usage of SCORM 2004 Sequencing and Navigation rules in online learning. Learning objects were created based on SCORM 2004 3rd Edition standard. The study of the learning objects interoperability was focus on the interoperability between LMSs. Results show that the interoperable learning objects created according to SCORM standard could be used in various SCORM-compliant LMSs. Three LMSs that were used in this project were Moodle, Docebo and Open Enrollment.

Learners’ satisfaction and the effectiveness of the use of SCORM 2004 Sequencing and Navigation rules were taken into consideration in choosing learning strategies and designing learning contents for online learning. Two tutorials on Java programming language were created by using interoperable learning objects created according to SCORM 2004 3rd Edition. Sequencing rules were incorporated into Java_Tutorial_1 to support remediation learning strategy while Java_Tutorial_2 did not use any sequencing rules. Questionnaires were used to collect survey data from a group of 18 learners that have completed both Java tutorials. The results show that the learners
are comfortable with the use of sequencing rules. In addition, the results also show that the use of sequencing rules has a positive impact on online learning.

8.3 REVIEW OF PROJECT OBJECTIVES

A few objectives of this project have been identified from the early stage of this research. Those objectives were reviewed to ensure that they have been met.

- Interoperable learning objects were developed according to SCORM 2004 3rd Edition standard. The learning objects created have passed the tests in ADL Conformance Test Suite. The learning objects are also interoperable between three LMSs.

- An e-tutorial system using interoperable learning objects was developed. The P-Learning system provides tutorials on Java. The tutorials consist of multiple Shareable Content Objects (SCOs).

- Technologies required to develop interoperable learning objects such as Metadata, Content Aggregation Model and Run-Time Environment specifications have been identified.

- Course remediation is supported as shown in Java_Tutorial_1 by using SCORM 2004 Sequencing and Navigation rules.

- Survey data has been collected from the learners. Analyzed data show that the learners felt comfortable with the use of SCORM 2004 Sequencing and Navigation rules in online learning.

The review conforms that the five objectives specified in Section 1.4 have all been met.

8.4 SYSTEM STRENGTHS
Moodle has been chosen to create the P-Learning system because of its growing adoption and as a widely-used open source LMS. However, as of January 2009, Moodle version 1.9.4 still does not support SCORM 2004 Sequencing and Navigation.

The P-Learning system has been developed with a certain level of SCORM 2004 Sequencing and Navigation support. This enables course creators or teachers to create courses with learning objects which have been associated with sequencing and navigation rules. The course creators will be able to provide different learning paths to the learners and make their learning more time efficient and more effective. Besides, the learners are comfortable with the application of remediation in online course learning and the use of sequencing rules to implement remediation strategy has positive impact on online learning.

Moodle is built in modular design. The support for part of SCORM 2004 Sequencing and Navigation in the P-Learning system can be integrated easily into other versions of Moodle. This allows other Moodle users who are interested in providing remediation option to be able to experience and enhance it.

The learning objects created in this project are reusable. They can be reused in contexts other than they were originally designed and they can be incorporated into other applications without much additional effort. Besides, these learning objects are interoperable. The interoperability between learning objects and standard-compliant LMSs had been shown through the use of the learning objects in different LMSs such as Docebo and Open Enrollment. The reusability and interoperability of these learning objects show the benefits of using learning objects in terms of saving learning objects creators and course creators’ effort, increasing time efficiency and also reducing cost.

8.5 SYSTEM LIMITATIONS
There are some limitations in the P-Learning system due to some undesirable reasons:

- **No tracking of most visited tutorials**
  The amount of tutorials provided will grow as more course creators participate in the system. When there are a lot of tutorials, new users of the system might feel confused and difficult on choosing tutorials to enroll. A list of most visited tutorials may give the new users an idea on which tutorials to be chosen.

- **Lack of video and audio learning resources**
  Video and audio are interactive learning resources. Different learners may have different preferences over the way how the learning content is presented. The use of video and audio learning resources can provide an extra option for the learners.

- **Learning content not downloadable**
  Downloadable learning content provides extra convenient to the learners. The learners may access the learning content anytime without internet connection and are able to keep the content for further reference.

### 8.6 FUTURE ENHANCEMENT

Some of the future enhancements that can be considered to be included in the system are:

- **Use of AJAX**
  The existing system needs to reload the whole page when a new page or new content needs to be loaded. This will slow down the learning process. AJAX is a technique for building web pages that are more interactive and dynamic (Tate et al., 2008). AJAX can be used to replace the page reload method for it only reloads changed content so that the learners can save some time without wasting
time for the whole content to be reloaded. As a result, the P-Learning system will be more responsive.

- Support more sequencing and navigation rules

The current P-Learning system can support only certain sequencing and navigation rules. Support for other rules such as the rollup rules and limit conditions can be added into the system to enable users to use SCORM packages which are implementing those rules. This also allows course creator to create courses with more combinations of sequencing and navigation rules.

- Use more multimedia content in courses

The use of plain text and graphics might be a bit boring for certain learners. More multimedia content such as video or audio can be added into the course content in order to make the courses become more attractive and interesting.

- Keep learners’ performance history

Personalised learning means learning that recognizes diversity, difference and individuality in the ways that learning is developed, delivered and supported (Beetham & Sharpe, 2007). Learners’ performance history can be kept in the P-Learning system for further assessment and to be used in course and teaching strategies planning.

8.7 LESSONS LEARNT

The use of learning objects is important to online education. However, there are a few issues that need to be handled wisely in order to maximize the advantages of learning objects.

The granularity of learning objects is one of the factors that will affect their reusability. The size of the learning objects, how broad should a topic be covered in a learning object, how to ensure the learning objects be easily reused in other contexts, all
these factors need to be taken into consideration while designing the learning objects. Besides, the learning objects’ creators should avoid using user interface that is too fancy such as using multiple colors and decorative purpose animation, so that the learning objects can be reused or reassembled with other learning objects easily without spending much effort in standardizing the layout of the whole learning content.

The creation of learning objects may be time consuming after they were designed. Individual SCO needs to be created using web pages, images, video, audio etc. JavaScript needs to be added to enable the communication between SCOs and LMS. If a bigger SCO consists of multiple smaller size SCOs, those smaller SCOs have to be organized into a structure. Sequencing and navigation rules could be added to define the flow of learning contents based on learner’s information. Next, metadata has to be created and learning objects can be packaged as a SCORM package before it can be transported between different systems. All these steps in developing a SCORM package can be aided by using tools. There are a lot of open source and commercial tools available that can help to accomplish the tasks easily, for example the RELOAD Editor, eXe authoring application, MOS Solo and Lectora Pro Suite. Hence, learning objects creators should utilizes these tools in order to produce quality standard-compliant learning packages in a timely manner.

SCORM is the e-learning standard that has been chosen in this project. The documentation for SCORM 2004 3rd Edition contains details on what is SCORM standard and all the specifications to be followed to create SCORM compliant learning contents. The documentation has provided great guidelines on the development process of the learning objects used in this project. Besides, SCORM is a good option to be chosen as the standard to use in creating learning objects. Among 10 LMSs, which are Moodle, Docebo, Dokeos, Claroline, Ilias, ATutor, OLAT, Open Enrollment, eFront and dotLRN, all of them are claimed to be SCORM-compliant while 6 of them are yet to be
able to support AICC standard. Although this does not mean that SCORM is always the better standard over AICC, but it indicates higher possibility to reuse learning objects created under SCORM standard in different LMSs.

8.8 SUMMARY

The project objectives have been reviewed and all of the objectives have been met. System strengths, system limitations and future enhancements for the P-Learning system were identified. This project has successfully shown the advantages of building e-learning (e-tutorial in the context of this project) systems using standard-compliant learning objects which promotes reusability and interoperability. The inclusion of sequencing and navigation rules on the other hand allows e-learning systems to be tailored according to learners’ personal preference or ability. These factors enable the building of better e-learning systems in terms of reusability, interoperability, as well as customization and personalization.
REFERENCES


APPENDIX A: DATABASE TABLES NOT LISTED IN CHAPTER 5

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TABLE: SCORM_SCOES_DATA

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<tr>
<td>conditioncombination</td>
<td>varchar</td>
<td>Rule’s condition combination setting.</td>
</tr>
<tr>
<td>ruletype</td>
<td>tinyint</td>
<td>Type of the rule condition.</td>
</tr>
<tr>
<td>action</td>
<td>varchar</td>
<td>Action to be performed if condition is met.</td>
</tr>
</tbody>
</table>

### POST TABLE

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>bigint</td>
<td>Identification no.</td>
</tr>
<tr>
<td>module</td>
<td>varchar</td>
<td>Name of the module, for example: Blog.</td>
</tr>
<tr>
<td>userid</td>
<td>bigint</td>
<td>User identification no.</td>
</tr>
<tr>
<td>courseid</td>
<td>bigint</td>
<td>Course identification no.</td>
</tr>
<tr>
<td>groupid</td>
<td>bigint</td>
<td>User group identification no.</td>
</tr>
<tr>
<td>moduleid</td>
<td>bigint</td>
<td>Module identification no.</td>
</tr>
<tr>
<td>coursemoduleid</td>
<td>bigint</td>
<td>Course module identification no.</td>
</tr>
<tr>
<td>subject</td>
<td>varchar</td>
<td>Subject of the post.</td>
</tr>
<tr>
<td>summary</td>
<td>longtext</td>
<td>Summary of the post.</td>
</tr>
<tr>
<td>content</td>
<td>longtext</td>
<td>Content of the post.</td>
</tr>
<tr>
<td>uniqueshash</td>
<td>varchar</td>
<td>Unique hash code.</td>
</tr>
<tr>
<td>rating</td>
<td>bigint</td>
<td>Rating of the post.</td>
</tr>
<tr>
<td>format</td>
<td>bigint</td>
<td>Format of the post.</td>
</tr>
<tr>
<td>attachment</td>
<td>varchar</td>
<td>Attachment of the post.</td>
</tr>
<tr>
<td>publishstate</td>
<td>enum</td>
<td>Publish state of the post (draft/site/public).</td>
</tr>
<tr>
<td>lastmodified</td>
<td>bigint</td>
<td>Time when the record is last modified.</td>
</tr>
<tr>
<td>created</td>
<td>bigint</td>
<td>Time when the record is created.</td>
</tr>
<tr>
<td>usermodified</td>
<td>bigint</td>
<td>User who modified the record.</td>
</tr>
</tbody>
</table>
APPENDIX B: SCORM PACKAGE XML MANIFEST FILE

XML ELEMENTS INTRODUCTION

Basic structure of a manifest file:

```xml
<manifest>
  <metadata>
    <organizations>
      <resources>
        ...
      </resources>
    </organizations>
  </metadata>
</manifest>
```

- The manifest element declares the manifest, its unique identifier and XML references to the schema files defining its format.
- The metadata element defines the content package’s schema and version. Learning object metadata can be included into this portion as children of the metadata element.
- The organization element defines the content package’s organization. A content package can have multiple organizations. An organization needs to declare its unique identifier, title and also defines all the items. Each item has an identifier, title, and might contain sequencing rules, as shown below:

```xml
<organization identifier="">
  <title>
  </title>
  <item identifier="">
    <title>
    </title>
    <mss:sequencing>
      <imss:sequencing>
    </mss:sequencing>
  </item>
</organization>
```

- The resources element defines the resources or files that comprise the learning objects used in the content package.
MANIFEST FILE FOR JAVA_TUTORIAL_1

<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE manifest PUBLIC "-//OASIS//DTD MDM V1.0//EN" "http://www.openarchives.org/mdm/1.0/manifest.dtd"/>
<manifest xmlns="http://www.imsglobal.org/xsd/imscp_v1p1" xmlns:imsmd="http://www.imsglobal.org/xsd/imsmd_v1p1"
        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xsi:schemaLocation="http://www.imsglobal.org/xsd/imsmd_v1p1 http://www.imsglobal.org/xsd/imsmd_v1p1.xsd"
        xmlns:ims="http://www.imsglobal.org/xsd/imsns_v1p0"
        xmlns:imsmd="http://www.imsglobal.org/xsd/imsmd_v1p1"
        xmlns:imsmd="http://www.imsglobal.org/xsd/imsmd_v1p1" idref="MF_Java">
    <imsmd:title>
        <imsmd:string language="en-US">Java Tutorial</imsmd:string>
    </imsmd:metadata>
    </manifest>
MANIFEST FILE FOR JAVA_TUTORIAL_2

<?xml version="1.0" encoding="UTF-8"?>
PUBLIC "-//IIE//IMM LOM 2003//EN" "http://www.imsglobal.org/xsd/lom/lomv1p3.dtd"
PUBLIC "-//IIE//IMM LOM 2003//EN" "http://www.imsglobal.org/xsd/lom/lomv1p3.dtd"
PUBLIC "-//IIE//IMM LOM 2003//EN" "http://www.imsglobal.org/xsd/lom/lomv1p3.dtd"
PUBLIC "-//IIE//IMM LOM 2003//EN" "http://www.imsglobal.org/xsd/lom/lomv1p3.dtd"
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PUBLIC "-//IIE//IMM LOM 2003//EN" "http://www.imsglobal.org/xsd/lom/lomv1p3.dtd"
PUBLIC "-//IIE//IMM LOM 2003//EN" "http://www.imsglobal.org/xsd/lom/lomv1p
APPENDIX C: TEST CASES

TEST CASE 1:

Name: Run manifest utility test for Java_Tutorial_1 and Java_Tutorial_2.

Description: To check whether the Java tutorials’ IMS Manifest file are conformant to SCORM 2004 3rd Edition.

Pre-conditions: Tutorials were created according to SCORM 2004 3rd Edition standard.

Scenario:

<table>
<thead>
<tr>
<th>Step No</th>
<th>Description</th>
<th>Data</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Successful Or Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Run manifest utility test for Java_Tutorial_1.</td>
<td>Java_Tutorial_1 zip file is selected.</td>
<td>The IMS Manifest file is conformant to standard.</td>
<td>The IMS Manifest file was conformant to standard.</td>
<td>Successful</td>
</tr>
<tr>
<td>2.</td>
<td>Run manifest utility test for Java_Tutorial_2.</td>
<td>Java_Tutorial_2 zip file is selected.</td>
<td>The IMS Manifest file is conformant to standard.</td>
<td>The IMS Manifest file was conformant to standard.</td>
<td>Successful</td>
</tr>
</tbody>
</table>

TEST CASE 2:

Name: Run SCO RTE conformance utility test for all SCOs.

Description: To check whether the SCOs used in the Java tutorials are conformant to SCORM 2004 3rd Edition.

Pre-conditions: SCOs were created according to SCORM 2004 3rd Edition standard.

Scenario:

<table>
<thead>
<tr>
<th>Step No</th>
<th>Description</th>
<th>Data</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Successful Or Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Run SCO RTE conformance utility test for all the pre-tests SCOs.</td>
<td>Pre-test SCOs’ file is selected.</td>
<td>The pre-tests SCOs are SCO RTE 1.0 conformant.</td>
<td>The SCOs were SCO RTE 1.0 conformant.</td>
<td>Successful</td>
</tr>
<tr>
<td>2.</td>
<td>Run SCO RTE conformance utility test for all the lessons SCOs.</td>
<td>Lesson SCOs’ file is selected.</td>
<td>The lessons SCOs are SCO RTE 1.0 conformant.</td>
<td>The SCOs were SCO RTE 1.0 conformant.</td>
<td>Successful</td>
</tr>
</tbody>
</table>
3. Run SCO RTE conformance utility test for all the post-tests SCOs.

<table>
<thead>
<tr>
<th>Step No.</th>
<th>Description</th>
<th>Data</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Successful Or Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Run content package conformance test for Java_Tutorial_1.</td>
<td>Java_Tutorial_1 zip file is selected.</td>
<td>The content package is conformant to standard.</td>
<td>The content package was conformant to standard.</td>
<td>Successful.</td>
</tr>
<tr>
<td>2</td>
<td>Run content package conformance test for Java_Tutorial_2.</td>
<td>Java_Tutorial_2 zip file is selected.</td>
<td>The content package is conformant to standard.</td>
<td>The content package was conformant to standard.</td>
<td>Successful.</td>
</tr>
</tbody>
</table>

**TEST CASE 3:**

Name: Run content package conformance test for Java_Tutorial_1 and Java_Tutorial_2.

Description: To check whether the Java tutorials’ content package are conformant to SCORM 2004 3rd Edition.

Pre-conditions: Content packages were created according to SCORM 2004 3rd Edition standard.

Scenario:

<table>
<thead>
<tr>
<th>Step No.</th>
<th>Description</th>
<th>Data</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Successful Or Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Run content package conformance test for Java_Tutorial_1.</td>
<td>Java_Tutorial_1 zip file is selected.</td>
<td>The content package is conformant to standard.</td>
<td>The content package was conformant to standard.</td>
<td>Successful.</td>
</tr>
<tr>
<td>2</td>
<td>Run content package conformance test for Java_Tutorial_2.</td>
<td>Java_Tutorial_2 zip file is selected.</td>
<td>The content package is conformant to standard.</td>
<td>The content package was conformant to standard.</td>
<td>Successful.</td>
</tr>
</tbody>
</table>

**TEST CASE 4:**

Name: Test SCOs that were used to create the Java tutorials in different LMSs.

Description: To check whether the SCOs are interoperable between LMS.

Pre-conditions: SCOs were created according to SCORM 2004 3rd Edition standard.

Scenario:

<table>
<thead>
<tr>
<th>Step No.</th>
<th>Description</th>
<th>Data</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Successful Or Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Import SCOs into Open Enrollment LMS.</td>
<td>SCOs' files.</td>
<td>SCOs work the same way as in P-Learning system.</td>
<td>SCOs worked the same way as in P-Learning system.</td>
<td>Successful.</td>
</tr>
</tbody>
</table>
2. Import SCOs into Docebo LMS.

SCOs’ files.

SCOs work the same way as in P-Learning system.

SCOs worked the same way as in P-Learning system.

<table>
<thead>
<tr>
<th>Step No</th>
<th>Description</th>
<th>Data</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Successful Or Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Select and upload SCORM content package.</td>
<td>File selected is Java_t1.zip.</td>
<td>Java_t1.zip will be uploaded into moodledata folder.</td>
<td>Java_t1.zip was uploaded into moodledata folder.</td>
<td>Successful</td>
</tr>
<tr>
<td>2</td>
<td>Extract zip file and select the imsmanifest.xml file to get all information on the package.</td>
<td>Imsmanifest.xml file in the extracted folder is selected.</td>
<td>Resources, content organization and sequencing rules information will be stored into database tables.</td>
<td>Information was stored correctly in database tables.</td>
<td>Successful</td>
</tr>
<tr>
<td>3</td>
<td>View course content structure.</td>
<td>Select and view Java_Tutorial_1 course.</td>
<td>Content organization can be viewed in course information page.</td>
<td>Content was in correct organization as defined in the imsmanifest file.</td>
<td>Successful</td>
</tr>
</tbody>
</table>

**TEST CASE 5:**

Name: Import SCORM content package.

Description: To check whether the SCORM content package can be imported correctly.

Pre-conditions: Course has been created and packaged according to SCORM 2004 3rd Edition standard.

Scenario:

**TEST CASE 6:**

Name: Test Java_Tutorial_1 sequencing control flow.

Description: To check whether the tutorial runs according to the sequencing control flow mode defined in imsmanifest.xml file.
Pre-conditions: Sequencing control flow is set to True for the whole organization.

Scenario:

<table>
<thead>
<tr>
<th>Step No</th>
<th>Description</th>
<th>Data</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Successful Or Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Start tutorial.</td>
<td>Sequencing control flow is set to true while choice is set to false.</td>
<td>Continue navigation button will be available and content cannot be selected freely.</td>
<td>Navigation button was shown. Contents cannot be simply chosen to access it.</td>
<td>Successful</td>
</tr>
<tr>
<td>2.</td>
<td>Click Continue button.</td>
<td>-</td>
<td>Pre-test in Module 1 will be shown.</td>
<td>Pre-test in Module 1 was shown.</td>
<td>Successful</td>
</tr>
</tbody>
</table>

TEST CASE 7:

Name: Test Java_Tutorial_1 sequencing control choice and choice exit.

Description: To check whether the tutorial runs according to the sequencing control choice and choice exit mode defined in imsmanifest.xml file.

Pre-conditions: Sequencing control choice and choice exit are set to True for the remediation section. Post-test in all Modules have been completed.

Scenario:

<table>
<thead>
<tr>
<th>Step No</th>
<th>Description</th>
<th>Data</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Successful Or Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Run through the tutorial until the remediation section.</td>
<td>-</td>
<td>All four lessons in the remediation section will be clickable and can be chosen.</td>
<td>All lessons in the remediation section were clickable.</td>
<td>Successful</td>
</tr>
<tr>
<td>2.</td>
<td>Click on one of the lessons, for example the Lesson 3.</td>
<td>-</td>
<td>Content of Lesson 3 will be shown.</td>
<td>Content of Lesson 3 was shown.</td>
<td>Successful</td>
</tr>
</tbody>
</table>

TEST CASE 8:

Name: Test Java_Tutorial_1 pre-condition sequencing rules in Module 1 section.

Description: To check whether the tutorial runs according to the pre-condition
sequencing rules defined in imsmanifest.xml file. Lesson 1 will not be shown if more than 3 questions in Pre-test Module 1 have been answered correctly.

Pre-conditions: Pre-condition rule is set for Lesson 1 in Module 1. All questions in Pre-test Module 1 have been answered correctly.

Scenario:

<table>
<thead>
<tr>
<th>Step No</th>
<th>Description</th>
<th>Data</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Successful Or Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Run through the tutorial until the Pre-test Module 4 and submit the answers.</td>
<td>Answers for all questions in pre-test.</td>
<td>Submit Answers button will be disabled after the answers are submitted and score is stored.</td>
<td>Score has been calculated and stored. Submit Answers button was disabled.</td>
<td>Successful</td>
</tr>
<tr>
<td>2.</td>
<td>Click on the Continue navigation button.</td>
<td>-</td>
<td>Post-test 1 in Module 1 will be shown.</td>
<td>Lesson 1 in Module 1 was skipped. Post-test 1 was shown.</td>
<td>Successful</td>
</tr>
</tbody>
</table>

**TEST CASE 9:**

Name: Test Java_Tutorial_1 pre-condition sequencing rules in remediation section.

Description: To check whether the tutorial runs according to the pre-condition sequencing rules defined in imsmanifest.xml file. Lessons in remediation section are not clickable until post-test in all modules has been completed.

Pre-conditions: Pre-condition rule is set for the whole remediation section. Post-test in Module 1, 2 and 3 have been completed.

Scenario:

<table>
<thead>
<tr>
<th>Step No</th>
<th>Description</th>
<th>Data</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Successful Or Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Run through the tutorial until the Post-test in Module 4.</td>
<td>-</td>
<td>The whole remediation section should not be clickable.</td>
<td>Remediation section was not clickable.</td>
<td>Successful</td>
</tr>
</tbody>
</table>
2. Submit Post-test.
   Submit Answers for questions in Post-test.
   Submit Answers button will be disabled after the answers are submitted and score is stored.
   Score has been calculated and stored. Submit Answers button was disabled.
   Successful.

3. Click on the Continue navigation button.
   All lessons in remediation section will be clickable.
   Lessons in remediation section were clickable.
   Successful.

TEST CASE 10:

Name: Test Java_Tutorial_1 pre-condition sequencing rules in the quiz section.

Description: To check whether the tutorial runs according to the pre-condition sequencing rules defined in imsmanifest.xml file. Quiz can only be attempted once and it will be disabled after it has been completed.

Pre-conditions: Pre-condition rule is set for the Quiz.

Scenario:

<table>
<thead>
<tr>
<th>Step No</th>
<th>Description</th>
<th>Data</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Successful Or Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Complete and submit the quiz.</td>
<td>Answers for all questions in the quiz.</td>
<td>Score will be calculated.</td>
<td>Score has been calculated.</td>
<td>Successful</td>
</tr>
<tr>
<td>2.</td>
<td>Click on any lesson in the remediation section.</td>
<td>-</td>
<td>Quiz will be disabled.</td>
<td>Quiz was disabled.</td>
<td>Successful</td>
</tr>
</tbody>
</table>

TEST CASE 11:

Name: Test Java_Tutorial_1 post-condition sequencing rule for Post-test 1 in Module 1.

Description: To check whether the tutorial runs according to the post-condition sequencing rules defined in imsmanifest.xml file. Post-test 1 in Module 1 must be completed before continue to the next module.

Pre-conditions: Post-condition rule is set for the Pre-test 1 in Module 1.

Scenario:
<table>
<thead>
<tr>
<th>Step No</th>
<th>Description</th>
<th>Data</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Successful Or Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Run through the tutorial until the Post-test 1 in Module 1.</td>
<td>-</td>
<td>Post-test 1 will be shown.</td>
<td>Post-test 1 was shown.</td>
<td>Successful</td>
</tr>
<tr>
<td>2.</td>
<td>Click on the Continue navigation button without submission of answers for the Post-test 1.</td>
<td>-</td>
<td>Post-test 1 will be shown again.</td>
<td>Post-test 1 was shown.</td>
<td>Successful</td>
</tr>
<tr>
<td>3.</td>
<td>Submit answers in Post-test 1.</td>
<td>Answers for questions in Post-test 1.</td>
<td>Submit Answers button will be disabled after the answers are submitted and score is stored.</td>
<td>Score has been calculated and stored. Submit Answers button was disabled.</td>
<td>Successful</td>
</tr>
<tr>
<td>4.</td>
<td>Click on the Continue navigation button.</td>
<td>-</td>
<td>Either Lesson 2 or Post-test 2 in Module 2 will be shown, depends on the result of Pre-test 2.</td>
<td>Post-test 2 was shown if more than 2 questions has been answered correctly in Pre-test 2, otherwise Lesson 2 was shown.</td>
<td>Successful</td>
</tr>
</tbody>
</table>

**TEST CASE 12:**

Name: Test Java_Tutorial_2 sequencing control flow and sequencing control choice.

Description: To check whether the tutorial runs according to the sequencing control settings defined in imsmanifest.xml file. Make sure the results in pre-tests will not affect the lessons to be shown since there is no pre-condition rule set in the Java_Tutorial_2.

Pre-conditions: For the whole organization, sequencing control flow is set to True and sequencing control choice is set to False. No pre-condition rule is set.

Scenario:
<table>
<thead>
<tr>
<th>Step No</th>
<th>Description</th>
<th>Data</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Successful Or Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Start tutorial.</td>
<td>Sequencing control flow is set to true while choice is set to false.</td>
<td>Continue navigation button will be available and content cannot be selected freely.</td>
<td>Navigation button was shown. Contents cannot be simply chosen to access it.</td>
<td>Successful</td>
</tr>
<tr>
<td>2.</td>
<td>Complete the Pre-test Module 1. All questions are answered correctly.</td>
<td>Correct answers for all questions in pre-test.</td>
<td>Score for Pre-test Module 1 will be stored.</td>
<td>Score has been calculated and stored.</td>
<td>Successful</td>
</tr>
<tr>
<td>3.</td>
<td>Run through the tutorial until the Pre-test Module 4 and submit the answers.</td>
<td>Answers for all questions in pre-test.</td>
<td>Submit Answers button will be disabled after the answers are submitted and score is stored.</td>
<td>Score has been calculated and stored. Submit Answers button was disabled.</td>
<td>Successful</td>
</tr>
<tr>
<td>4.</td>
<td>Click on the Continue navigation button.</td>
<td>-</td>
<td>Lesson 1 in Module 1 will be shown.</td>
<td>Lesson 1 in Module 1 was shown.</td>
<td>Successful</td>
</tr>
</tbody>
</table>

**TEST CASE 13:**

Name: Check correctness of the report for learner’s attempt in Java_Tutorial_1.

Description: To check whether the score of all the tests has been stored correctly.

Pre-conditions: Each SCO has JavaScript functions which enable communication with the P-Learning system.

Scenario:

<table>
<thead>
<tr>
<th>Step No</th>
<th>Description</th>
<th>Data</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Successful Or Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Learner completes all the tests in Java_Tutorial_1.</td>
<td>Answers for questions in all the tests.</td>
<td>Answers are submitted and score is stored.</td>
<td>Score has been calculated and stored.</td>
<td>Successful</td>
</tr>
<tr>
<td>2.</td>
<td>Login into the system using a teacher user account.</td>
<td>A teacher’s login username and password.</td>
<td>Login is successful and system’s main page will be shown.</td>
<td>Login was successful and system’s main page was shown.</td>
<td>Successful</td>
</tr>
<tr>
<td></td>
<td>Select Java_Tutorial_1 and click on the view reports link.</td>
<td>A list of attempts by all the learners will be shown.</td>
<td>List of attempts by the learners was shown.</td>
<td>Successful</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>----------------------------------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Click on the attempt link of a learner.</th>
<th>-</th>
<th>Details such as status and score for all the lessons and tests in Java_Tutorial_1 will be shown.</th>
<th>Details for all the lessons and tests in Java_Tutorial_1 were shown.</th>
<th>Successful</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
APPENDIX D: TEST RESULT FOR SCORM 2004 3rd EDITION
CONFORMANCE TEST SUITE

MANIFEST UTILITY TEST

1. Manifest Utility Test Result for Java_Tutorial_1

Advanced Distributed Learning (ADL)
Shareable Content Object Reference Model (SCORM ©) 2004 3rd Edition
Conformance Test Suite Version 1.0.2
Self Test Log

Test Environment Information:
Operating System: Windows XP - SP 3
Java Run-Time Environment: 1.6.0_07
Web Browser: Internet Explorer 7.05

Test Subject Information:
Date: Sunday, January 18, 2009 10:36:11 AM
Manifest Product: Java_Tutorial_1
Manifest Version: 1.0
Manifest Vendor/Developer: yc

- The Manifest Utility test has initiated.
- It may take a few moments to begin logging messages, please be patient.

Manifest Test Conformance Summary
- Testing against the SCORM Content Aggregation Content Package Application Profile
  - The IMS Manifest is Well-formed
  - The IMS Manifest is valid against the Controlling Documents
  - The IMS Manifest is valid against the SCORM Application Profile
  - The IMS Manifest does not contain extensions
    Click here to view detailed CP test log

SCORM 2004 3rd Edition Conformance Statement:
- The IMS Manifest is Manifest CAM 1.0 Conformant
  Successful outcome of this test does not constitute ADL Certification.

2. Manifest Utility Test Result for Java_Tutorial_2

Advanced Distributed Learning (ADL)
Shareable Content Object Reference Model (SCORM ©) 2004 3rd Edition
Conformance Test Suite Version 1.0.2
Self Test Log

Test Environment Information:
Operating System: Windows XP - SP 3
Java Run-Time Environment: 1.6.0_07
Web Browser: Internet Explorer 7.05

Test Subject Information:
Date: Sunday, January 18, 2009 1:27:29 PM
Manifest Product: Java_Tutorial_2
Manifest Version: 1.0
Manifest Vendor/Developer: yc

- The Manifest Utility test has initiated.
- It may take a few moments to begin logging messages, please be patient.

Manifest Test Conformance Summary
- Testing against the SCORM Content Aggregation Content Package Application Profile
  - The IMS Manifest is Well-formed
  - The IMS Manifest is valid against the Controlling Documents
  - The IMS Manifest is valid against the SCORM Application Profile
  - The IMS Manifest does not contain extensions
    Click here to view detailed CP test log

SCORM 2004 3rd Edition Conformance Statement:
- The IMS Manifest is Manifest CAM 1.0 Conformant
  Successful outcome of this test does not constitute ADL Certification.
SCO RTE CONFORMANCE UTILITY TEST

1. SCO RTE Conformance Utility Test Result for SCO-1 Pre-Test in Java_Tutorial_1

Advanced Distributed Learning (ADL)
Shareable Content Object Reference Model (SCORM ®) 2004 3rd Edition
Conformance Test Suite Version 1.3.2
Self Test Log

Test Environment Information:
Operating System: Windows XP - SP 3
Java Run-Time Environment: 1.6.0.07
Web Browser: Internet Explorer 7.05

Test Subject Information:
Date: Sunday, January 18, 2009 2:19:33 PM
SCO Product: SCO_PreTest1
SCO Version: 1.0
SCO Publisher/Developer: yc

- Launching the Shareable Content Object
- This process may take a few minutes, please be patient ...
- Attempting to Launch SCO 0:\Study\Java_Tutorial_1\test1\PreTest1.htm

The SCO Testing Summary Results

- The Features Supported:
  - API Support
  - Found an LMS provided API Instance
- The Session Methods supported:
  - Initialize()
  - Terminate()
- The Data Transfer Methods supported:
  - GetValue()
  - SetValue()
- The Support Methods supported:
  - GetTestError()
- Data Model Support
  - SCORM Run-Time Environment Data Model
    - cmi.mode
    - cmi.score.scaled
    - cmi.completion_status
    - cmi.exit

Click here to view detailed SCO test log

SCORM 2004 3rd Edition Conformance Statement:

The SCO is SCORM 2004 3rd Edition Conformant, as tested in accordance with the SCORM 2004 3rd Edition
Conformance Test Suite Version 1.0.2

The SCO is SCO RTE 1.0 Conformant

Successful outcome of this test does not constitute ADL Certification.
2. SCO RTE Conformance Utility Test Result for SCO-5 Lesson 1 in Java_Tutorial_1

| Advanced Distributed Learning (ADL) |
| Shared Content Object Reference Model (SCORM) 2004 3rd Edition |
| Conformance Test Suite Version 1.0.2 |
| Self Test Log |

**Test Environment Information:**
- Operating System: Windows XP - SP 3
- Java Run-Time Environment: 1.6.0_07
- Web Browser: Internet Explorer 7.05

**Test Subject Information:**
- Date: Sunday, January 18, 2009 2:10:01 PM
- SCO Product: SCO Lesson1
- SCO Version: 1.0
- SCO Vendor/Developer: yc

<table>
<thead>
<tr>
<th>The SCO Testing Summary Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Launch the SCORM Component" /></td>
</tr>
<tr>
<td><img src="image" alt="This process may take a few minutes, please be patient..." /></td>
</tr>
<tr>
<td><img src="image" alt="Attempting to launch SCO" /></td>
</tr>
<tr>
<td><img src="image" alt="D:/Share/Java_Tutorial/SCO1/j progwarnfunc.html" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The Features Supported:</th>
</tr>
</thead>
<tbody>
<tr>
<td>API Support</td>
</tr>
<tr>
<td><img src="image" alt="Found an LMS provided API instance" /></td>
</tr>
<tr>
<td>The Session Methods supported:</td>
</tr>
<tr>
<td><img src="image" alt="Initialize()" /></td>
</tr>
<tr>
<td><img src="image" alt="Terminate()" /></td>
</tr>
<tr>
<td>The Data Transfer Methods supported:</td>
</tr>
<tr>
<td><img src="image" alt="SetValue()" /></td>
</tr>
<tr>
<td>The Support Methods supported:</td>
</tr>
<tr>
<td><img src="image" alt="None Supported" /></td>
</tr>
<tr>
<td>Data Model Support</td>
</tr>
<tr>
<td><img src="image" alt="SCORM Run-Time Environment Data Model" /></td>
</tr>
<tr>
<td><img src="image" alt="cml.completion_status" /></td>
</tr>
</tbody>
</table>

[Click here to view detailed SCO test log](image)

**SCORM 2004 3rd Edition Conformance Statement:**
- The SCO is SCORM 2004 3rd Edition Conformant, as tested in accordance with the SCORM 2004 3rd Edition Conformance Test Suite Version 1.0.2
- The SCO is SCO RTE 1.0 Conformant

- Successful outcome of this test does not constitute ADL Certification.
Advanced Distributed Learning (ADL)
Shareable Content Object Reference Model (SCORM ©) 2004 3rd Edition
Conformance Test Suite Version 1.3.2

Self Test Log

Test Environment Information:
Operating System: Windows XP - SP 3
Java Run-Time Environment: 1.6.0_07
Web Browser: Internet Explorer 7.05

Test Subject Information:
Date: Sunday, January 18, 2009 2:16:25 PM
SCO Product: SCO_PostTest1
SCO Version: 1.0
SCO Vendor/Developer: yc

Launching the Shareable Content Object
This process may take a few minutes, please be patient ...
Attempting to Launch SCO D:\Study\Java_11\ModuleTest1\ModuleTest1.htm

The SCO Testing Summary Results

- The Features Supported:
  - API Support
  - Found an LMS provided API Instance
  - The Session Methods supported:
    - Initialize()
    - Terminator()
  - The Data Transfer Methods supported:
    - GetValue()
    - SetValue()
  - The Support Methods supported:
    - GetTestError()
  - Data Model Support
    - SCORM Run-Time Environment Data Model
      - cmi.mode
      - cmi.score.scaled
      - cmi.completion_status
      - cmi.exit

Click here to view detailed SCO test log

SCORM 2004 3rd Edition Conformance Statement:
- The SCO is SCORM 2004 3rd edition Conformant, as tested in accordance with the SCORM 2004 3rd Edition
Conformance Test Suite Version 1.0.2
- The SCO is SCO RTE 1.0 Conformant

Successful outcome of this test does not constitute ADL Certification.
CONTENT PACKAGE CONFORMANCE TEST

1. Content Package Conformance Test Result for Java_Tutorial_1

Advanced Distributed Learning (ADL)
Shareable Content Object Reference Model (SCORM @) 2004 3rd Edition
Conformance Test Suite Version 1.0.2
Self Test Log

Test Environment Information:
Operating System: Windows XP - SP 3
Java Run-Time Environment: 1.6.0_07
Web Browser: Internet Explorer 7.05

Test Subject Information:
Date: Sunday, January 10, 2009 4:57:29 PM
Content Package Product: Java_Tutorial_1
Content Package Version: 1.0
Content Package Vendor/Developer: yc

Content Package Test Conformance Summary
☑ Testing against the SCORM Content Aggregation Content Package Application Profile
☑ The IMS Manifest is Well-formed
☑ Controlling Document(s) Required For XML Parsing Found at Root of the Content Package
☑ The IMS Manifest is valid against the Controlling Documents
☑ The IMS Manifest is valid against the SCORM Application Profile
☑ The IMS Manifest does not contain extensions
  Click here to view detailed CP test log

Metadata Testing
Testing the Metadata XML Instance against the SCORM Metadata Profile Requirements

Metadata Test Conformance Summary
☑ Testing the Metadata XML Instance (inline) that exists for the IMS Manifest element identifier of MF_Java
☑ The Metadata XML Instance is Well-formed
☑ The Metadata XML Instance is valid against the Controlling Documents
  Click here to view detailed MD test log MF_Java

SCO Testing
Testing Shareable Content Objects referenced from within the IMS Manifest of the Content Package

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 10, 2009 4:58:39 PM
SCO: C:\ADL\SCORM_2004_3rd EdCTS_V1.0.2_ST\PackageImport\Test1\PreTest1.htm
☑ Launching the Shareable Content Object
☑ This process may take a few minutes, please be patient...
☑ Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd EdCTS_V1.0.2_ST\PackageImport\Test1\PreTest1.htm

The SCO Testing Summary Results

☑ The Features Supported:
  ☑ API Support
  ☑ Found an IMS provided API Instance
  ☑ The Session Methods supported:
    ☑ Initialize()
    ☑ Terminate()
  ☑ The Data Transfer Methods supported:
    ☑ GetValue()
    ☑ SetValue()  ☑ GetLastError()
  ☑ The Support Methods supported:
    ☑ GetValue()

☑ Data Model Support
☑ SCORM Run Time Environment Data Model
  cmi.mode
  cmi.score.scaled
  cmi.completion_status
  cmi.exit
  Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 10, 2009 4:59:09 PM
SCO: C:\ADL\SCORM_2004_3rd EdCTS_V1.0.2_ST\PackageImport\Test2\PreTest2.htm
☑ Launching the Shareable Content Object
☑ This process may take a few minutes, please be patient...
☑ Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd EdCTS_V1.0.2_ST\PackageImport\Test2\PreTest2.htm
The SCO Testing Summary Results

The Features Supported:
- API Support
- Found an LMS provided API Instance
- The Session Methods supported:
  - Initialize()
  - Terminate()
- The Data Transfer Methods supported:
  - GetValue()
  - SetValue()
- The Support Methods supported:
  - GetLastError()
- Data Model Support
  - SCORM Run-Time Environment Data Model
  - cmi.mode
  - cmi.score.scaled
  - cmi.completion_status
  - cmi.exit

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 18, 2009 4:59:55 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\Test3\PreTest3.htm

Launching the Shareable Content Object
This process may take a few minutes, please be patient ...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\Test3\PreTest3.htm

The SCO Testing Summary Results

The Features Supported:
- API Support
- Found an LMS provided API Instance
- The Session Methods supported:
  - Initialize()
  - Terminate()
- The Data Transfer Methods supported:
  - GetValue()
  - SetValue()
- The Support Methods supported:
  - GetLastError()
- Data Model Support
  - SCORM Run-Time Environment Data Model
  - cmi.mode
  - cmi.score.scaled
  - cmi.completion_status
  - cmi.exit

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 18, 2009 5:00:24 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\Test4\PreTest4.htm

Launching the Shareable Content Object
This process may take a few minutes, please be patient ...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\Test4\PreTest4.htm

The SCO Testing Summary Results

The Features Supported:
- API Support
- Found an LMS provided API Instance
- The Session Methods supported:
  - Initialize()
  - Terminate()
- The Data Transfer Methods supported:
  - GetValue()
  - SetValue()
- The Support Methods supported:
  - GetLastError()
- Data Model Support
  - SCORM Run-Time Environment Data Model
  - cmi.mode
  - cmi.score.scaled
  - cmi.completion_status
  - cmi.exit

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 18, 2009 5:00:52 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO1\j_programwarnfunc.html

Launching the Shareable Content Object
This process may take a few minutes, please be patient ...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO1\j_programwarnfunc.html
The SCO Testing Summary Results

The Features Supported:
- API Support
  ✓ Found an LMS provided API Instance
- The Session Methods supported:
  ✓ Initialize()
  ✓ Terminate()
- The Data Transfer Methods supported:
  ✓ GetValue()
  ✓ SetValue()
- The Support Methods supported:
  ✓ GetLastError()
- Data Model Support
  ✓ SCORM Run-Time Environment Data Model
  ✓ cmi.completion_status

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 10, 2009 5:01:49 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\ModuleTest2\ModuleTest2.htm

Launching the Shareable Content Object
This process may take a few minutes, please be patient ...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\ModuleTest2\ModuleTest2.htm

The SCO Testing Summary Results

The Features Supported:
- API Support
  ✓ Found an LMS provided API Instance
- The Session Methods supported:
  ✓ Initialize()
  ✓ Terminate()
- The Data Transfer Methods supported:
  ✓ GetValue()
  ✓ SetValue()
- The Support Methods supported:
  ✓ GetLastError()
- Data Model Support
  ✓ SCORM Run-Time Environment Data Model
  ✓ cmi.mode
  ✓ cmi.score.scaled
  ✓ cmi.completion_status
  ✓ cmi.exit

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 10, 2009 5:01:33 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO2\1_decisionloop.html

Launching the Shareable Content Object
This process may take a few minutes, please be patient ...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO2\1_decisionloop.html

The SCO Testing Summary Results

The Features Supported:
- API Support
  ✓ Found an LMS provided API Instance
- The Session Methods supported:
  ✓ Initialize()
  ✓ Terminate()
- The Data Transfer Methods supported:
  ✓ GetValue()
  ✓ SetValue()
- The Support Methods supported:
  ✓ None Supported
  ✓ Data Model Support
  ✓ SCORM Run-Time Environment Data Model
  ✓ cmi.completion_status

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 10, 2009 5:01:46 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\ModuleTest2\ModuleTest2.htm

Launching the Shareable Content Object
This process may take a few minutes, please be patient ...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\ModuleTest2\ModuleTest2.htm

The SCO Testing Summary Results

The Features Supported:
- API Support
  ✓ Found an LMS provided API Instance
- The Session Methods supported:
  ✓ Initialize()
  ✓ Terminate()
- The Data Transfer Methods supported:
  ✓ GetValue()
  ✓ SetValue()
- The Support Methods supported:
  ✓ None Supported
  ✓ Data Model Support
  ✓ SCORM Run-Time Environment Data Model
  ✓ cmi.completion_status

Click here to view detailed SCO test log
The Features Supported:
  API Support
  ✅ Found an LMS provided API Instance
  The Session Methods supported:
    ✅ Initialize()
    ✅ Terminate()
  The Data Transfer Methods supported:
    ✅ GetValue()
    ✅ SetValue()
  The Support Methods supported:
    ✅ GetLastError()
    Data Model Support
    ✅ SCORM Run-Time Environment Data Model
      cmi.mode
      cmi.score.scaled
      cmi.completion_status
      cmi.exit
  Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
  Date: Sunday, January 10, 2009 5:02:11 PM
  SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO3\l_onarray.html

  Launching the Shareable Content Object
  This process may take a few minutes, please be patient ...
  Attempting to launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO3\l_onarray.html

The SCO Testing Summary Results

The Features Supported:
  API Support
  ✅ Found an LMS provided API Instance
  The Session Methods supported:
    ✅ Initialize()
    ✅ Terminate()
  The Data Transfer Methods supported:
    ✅ GetValue()
    ✅ SetValue()
  The Support Methods supported:
    Data Model Support
    ✅ SCORM Run-Time Environment Data Model
    cmi.completion_status
  Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
  Date: Sunday, January 10, 2009 5:02:22 PM
  SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\ModuleTest3\ModuleTest3.htm

  Launching the Shareable Content Object
  This process may take a few minutes, please be patient ...
  Attempting to launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\ModuleTest3\ModuleTest3.htm

The SCO Testing Summary Results

The Features Supported:
  API Support
  ✅ Found an LMS provided API Instance
  The Session Methods supported:
    ✅ Initialize()
    ✅ Terminate()
  The Data Transfer Methods supported:
    ✅ GetValue()
    ✅ SetValue()
  The Support Methods supported:
    Data Model Support
    ✅ SCORM Run-Time Environment Data Model
    cmi.mode
    cmi.score.scaled
    cmi.completion status
    cmi.exit
  Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
  Date: Sunday, January 10, 2009 5:03:00 PM
  SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO4\l_oopinherihrance.html

  Launching the Shareable Content Object
  This process may take a few minutes, please be patient ...
  Attempting to launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO4\l_oopinherihrance.html

The SCO Testing Summary Results
The Features Supported:
- API Support
  - Found an LMS provided API Instance
- The Session Methods supported:
  - Initialize()
  - Terminate()
- The Data Transfer Methods supported:
  - SetValue()
- The Support Methods supported:
  - None Supported
- Data Model Support
  - SCORM Run-Time Environment Data Model
  - cmi.completion_status

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 10, 2009 5:04:02 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO3\j_ieonarray.html
- Launching the Sharable Content Object
- This process may take a few minutes, please be patient...
- Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO3\j_ieonarray.html

The SCO Testing Summary Results

The Features Supported:
- API Support
  - Found an LMS provided API Instance
- The Session Methods supported:
  - Initialize()
  - Terminate()
- The Data Transfer Methods supported:
  - SetValue()
- The Support Methods supported:
  - None Supported
- Data Model Support
  - SCORM Run-Time Environment Data Model
  - cmi.completion_status

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 10, 2009 5:04:11 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO4\\_oopinheriitance.html
- Launching the Sharable Content Object
- This process may take a few minutes, please be patient...
- Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO4\\_oopinheriitance.html

The SCO Testing Summary Results

The Features Supported:
- API Support
  - Found an LMS provided API Instance
- The Session Methods supported:
  - Initialize()
  - Terminate()
- The Data Transfer Methods supported:
  - SetValue()
- The Support Methods supported:
  - None Supported
- Data Model Support
  - SCORM Run-Time Environment Data Model
  - cmi.completion_status

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 10, 2009 5:04:10 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\Flash\Java_Exam.html
- Launching the Sharable Content Object
- This process may take a few minutes, please be patient...
- Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\Flash\Java_Exam.html

The SCO Testing Summary Results

The Features Supported:
- API Support
  - Found an LMS provided API Instance
- The Session Methods supported:
  - Initialize()
  - Terminate()
## Content Package Conformance Test Result for Java_Tutorial_2

**Advanced Distributed Learning (ADL)***

**Shareable Content Object Reference Model (SCORM ®) 2004 3rd Edition**

**Conformance Test Suite Version 1.0.2**

---

### Test Environment Information:
- Operating System: Windows XP - SP 3
- Java Run-Time Environment: 1.6.0_07
- Web Browser: Internet Explorer 7.05

### Test Subject Information:
- Date: Sunday, January 11, 2009 11:17:56 PM
- Content Package Product: Java_Tutorial_2
- Content Package Version: 1.0
- Content Package Vendor/Developer: yc

---

**Content Package Test Conformance Summary**
- Testing against the SCORM Content Aggregation Content Package Application Profile
  - The IMS Manifest is Well-formed
  - Controlling Document(s) Required for XML Parsing Found at Root of the Content Package
  - The IMS Manifest is valid against the Controlling Documents
  - The IMS Manifest is valid against the SCORM Application Profile
  - The IMS Manifest does not contain extensions

---

**Metadata Testing**

**Testing the Metadata XML Instance against the SCORM Metadata Profile Requirements**

**Metadata Test Conformance Summary**
- Testing the Metadata XML Instance (Inline) that exists for the IMS Manifest element identifier of MF_Java
  - The Metadata XML Instance is Well-formed
  - The Metadata XML Instance is valid against the Controlling Documents

---

**SCO Testing**

**Testing Sharable Content Objects referenced from within the IMS Manifest of the Content Package**

---

**The SCO Testing Summary Results**
- The Features Supported:
  - API Support
  - Found an LMS provided API Instance
- The Session Methods supported:
Initialize()
Terminate()
The Data Transfer Methods supported:
GetValue()
SetValue()
The Support Methods supported:
GetLastError()
Data Model Support
SCORM Run-Time Environment Data Model
cmi.mode
cmi.score.scaled
cmi.completion_status
cmi.exit

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 11, 2009 11:22:06 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\Test2\PreTest2.htm

Launching the Shareable Content Object
This process may take a few minutes, please be patient...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\Test2\PreTest2.htm

The SCO Testing Summary Results

The Features Supported:
API Support
✓ Found an LMS provided API Instance
The Session Methods supported:
✓ Initialize()
✓ Terminate()
The Data Transfer Methods supported:
✓ GetValue()
✓ SetValue()
The Support Methods supported:
✓ GetLastError()
Data Model Support
SCORM Run-Time Environment Data Model
cmi.mode
cmi.score.scaled
cmi.completion_status
cmi.exit

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 11, 2009 11:22:23 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\Test3\PreTest3.htm

Launching the Shareable Content Object
This process may take a few minutes, please be patient...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\Test3\PreTest3.htm

The SCO Testing Summary Results

The Features Supported:
API Support
✓ Found an LMS provided API Instance
The Session Methods supported:
✓ Initialize()
✓ Terminate()
The Data Transfer Methods supported:
✓ GetValue()
✓ SetValue()
The Support Methods supported:
✓ GetLastError()
Data Model Support
✓ SCORM Run-Time Environment Data Model
cmi.mode
cmi.score.scaled
cmi.completion_status
cmi.exit

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 11, 2009 11:22:38 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\Test4\PreTest4.htm

Launching the Shareable Content Object
This process may take a few minutes, please be patient...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\Test4\PreTest4.htm

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The SCO Testing Summary Results

The Features Supported:
- API Support
  - Found an LMS provided API Instance
- The Session Methods supported:
  - Initialize()
  - Terminate()
- The Data Transfer Methods supported:
  - GetValue()
  - SetValue()
- The Support Methods supported:
  - GetLastError()
- Data Model Support
  - SCORM Run-Time Environment Data Model
  - cmi.mode
  - cmi.score.scaled
  - cmi.completion_status
  - cmi.exit

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 11, 2009 11:22:55 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO1\j_progverfunc.html

Launching the Shareable Content Object
This process may take a few minutes, please be patient...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO1\j_progverfunc.html

The SCO Testing Summary Results

The Features Supported:
- API Support
  - Found an LMS provided API Instance
- The Session Methods supported:
  - Initialize()
  - Terminate()
- The Data Transfer Methods supported:
  - GetValue()
  - SetValue()
- The Support Methods supported:
  - None Supported
  - Data Model Support
  - SCORM Run-Time Environment Data Model
  - cmi.completion_status

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 11, 2009 11:22:06 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\ModuleTest1\ModuleTest1.htm

Launching the Shareable Content Object
This process may take a few minutes, please be patient...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\ModuleTest1\ModuleTest1.htm

The SCO Testing Summary Results

The Features Supported:
- API Support
  - Found an LMS provided API Instance
- The Session Methods supported:
  - Initialize()
  - Terminate()
- The Data Transfer Methods supported:
  - GetValue()
  - SetValue()
- The Support Methods supported:
  - GetLastError()
- Data Model Support
  - SCORM Run-Time Environment Data Model
  - cmi.mode
  - cmi.score.scaled
  - cmi.completion_status
  - cmi.exit

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 11, 2009 11:23:27 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO2\j_decisionloop.html

Launching the Shareable Content Object
This process may take a few minutes, please be patient...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO2\j_decisionloop.html
The SCO Testing Summary Results

- The Features Supported:
  - API Support
  - Found an LMS provided API Instance
- The Session Methods supported:
  - Initialize()
  - Terminate()
- The Data Transfer Methods supported:
  - GetValue()
  - SetValue()
- The Support Methods supported:
  - None Supported
  - Data Model Support
  - SCORM Run-Time Environment Data Model
  - cmi.completion_status

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 11, 2009 11:23:30 PM
SCO: C:\ADL\SCORM_2004_3rd_Ext_CTS_V1.0.2_ST\PackageImport\ModuleTest2\ModuleTest2.htm

Launching the Shareable Content Object
This process may take a few minutes, please be patient...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ext_CTS_V1.0.2_ST\PackageImport\ModuleTest2\ModuleTest2.htm

The SCO Testing Summary Results

- The Features Supported:
  - API Support
  - Found an LMS provided API Instance
- The Session Methods supported:
  - Initialize()
  - Terminate()
- The Data Transfer Methods supported:
  - GetValue()
  - SetValue()
- The Support Methods supported:
  - None Supported
  - Data Model Support
  - SCORM Run-Time Environment Data Model
  - cmi.mode
  - cmi.score.scaled
  - cmi.completion_status
  - cmi.exit

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 11, 2009 11:23:56 PM
SCO: C:\ADL\SCORM_2004_3rd_Ext_CTS_V1.0.2_ST\PackageImport\SCO3\j_ionarray.html

Launching the Shareable Content Object
This process may take a few minutes, please be patient...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ext_CTS_V1.0.2_ST\PackageImport\SCO3\j_ionarray.html

The SCO Testing Summary Results

- The Features Supported:
  - API Support
  - Found an LMS provided API Instance
- The Session Methods supported:
  - Initialize()
  - Terminate()
- The Data Transfer Methods supported:
  - GetValue()
  - SetValue()
- The Support Methods supported:
  - None Supported
  - Data Model Support
  - SCORM Run-Time Environment Data Model
  - cmi.completion_status

Click here to view detailed SCO test log

SCO Test Suite being initiated
Test Identification Information:
Date: Sunday, January 11, 2009 11:21:05 PM
SCO: C:\ADL\SCORM_2004_3rd_Ext_CTS_V1.0.2_ST\PackageImport\ModuleTest3\ModuleTest3.htm

Launching the Shareable Content Object
This process may take a few minutes, please be patient...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ext_CTS_V1.0.2_ST\PackageImport\ModuleTest3\ModuleTest3.htm

The SCO Testing Summary Results
The Features Supported:
API Support
✓ Found an LMS provided API Instance
The Session Methods supported:
✓ Initialize()
✓ Terminate()
The Data Transfer Methods supported:
✓ GetValue()
✓ SetValue()
The Support Methods supported:
✓ GetLastError()
Data Model Support
✓ SCORM Run-Time Environment Data Model
✓ cmi.mode
✓ cmi.score.scaled
✓ cmi.completion_status
✓ cmi.exit

Click here to view detailed SCO test log

SCO Test Suite being Initiated
Test Identification Information:
Date: Sunday, January 11, 2009 11:24:27 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO4\j_opninheritance.html
Launching the Sharable Content Object
This process may take a few minutes, please be patient ...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\SCO4\j_opninheritance.html

The SCO Testing Summary Results

The Features Supported:
API Support
✓ Found an LMS provided API Instance
The Session Methods supported:
✓ Initialize()
✓ Terminate()
The Data Transfer Methods supported:
✓ GetValue()
✓ SetValue()
The Support Methods supported:
✓ None Supported
Data Model Support
✓ SCORM Run-Time Environment Data Model
✓ cmi.completion_status

Click here to view detailed SCO test log

SCO Test Suite being Initiated
Test Identification Information:
Date: Sunday, January 11, 2009 11:24:35 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\ModuleTest4\ModuleTest4.htm
Launching the Sharable Content Object
This process may take a few minutes, please be patient ...
Attempting to Launch SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\ModuleTest4\ModuleTest4.htm

The SCO Testing Summary Results

The Features Supported:
API Support
✓ Found an LMS provided API Instance
The Session Methods supported:
✓ Initialize()
✓ Terminate()
The Data Transfer Methods supported:
✓ GetValue()
✓ SetValue()
The Support Methods supported:
✓ GetLastError()
Data Model Support
✓ SCORM Run-Time Environment Data Model
✓ cmi.mode
✓ cmi.score.scaled
✓ cmi.completion_status
✓ cmi.exit

Click here to view detailed SCO test log

SCO Test Suite being Initiated
Test Identification Information:
Date: Sunday, January 11, 2009 11:24:57 PM
SCO: C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\Flash\Java_Exam.html
Launching the Sharable Content Object
This process may take a few minutes, please be patient ...
Attempting to Launch SCO:
C:\ADL\SCORM_2004_3rd_Ed_CTS_V1.0.2_ST\PackageImport\Flash\Java_Exam.html
The SCO Testing Summary Results

- The Features Supported:
  - API Support
    - Found an LMS provided API Instance
  - The Session Methods supported:
    - Initialize()
    - Terminate()
  - The Data Transfer Methods supported:
    - GetValue()
    - SetValue()
    - Commit()
  - The Support Methods supported:
    - GetLastError()
  - Data Model Support
    - SCORM Run-Time Environment Data Model
    - cmi.learner_name
    - cmi.completion_status
    - cmi.score.scaled

[Click here to view detailed SCO test log]

SCORM 2004 3rd Edition Conformance Statement:
- The Content Package is SCORM 2004 3rd Edition Conformant, as tested in accordance with the SCORM 2004 3rd Edition Conformance Test Suite Version 1.0.2
- The Content Package is CP CAM 1.0 Conformant
- The Content Package is CP RTE 1.0 Conformant

Successful outcome of this test does not constitute ADL Certification unless the test has been conducted by an ADL Certified Auditor.
APPENDIX E: RELEASE NOTES

P-LEARNING RELEASE NOTES

This release note provides information on the first version of P-Learning, version 1.0. It is developed on Moodle version 1.9.2+. The P-Learning system can support SCORM 2004 3rd Edition. Although it is not fully SCORM 2004 compliant, it supports SCORM 2004 Sequencing and Navigation.

FEATURES SUPPORTED

The features that are supported in the P-Learning version 1.0 are:

- Role Management
- User Management
- Course and Course Category Management
- Blog
- Forum
- User Registration
- Course Enrollment
- Learning Progress Reporting
- SCORM 2004 3rd Edition support
- SCORM 2004 Sequencing and Navigation support

SYSTEM REQUIREMENTS

System requirements for installing P-Learning system are:

- Operating systems: Windows XP or Windows Server 2003
- Minimum hardware: Pentium 4 2.4GHz or greater, 512 MB RAM or greater, 80MB hard drive space
- Web server: Apache
- Database server: MySQL version 4 or later
- PHP Support

**INSTALLING P-LEARNING SYSTEM**

Please remove any previous failed installation folder of P-Learning version 1.0 and all the database tables installed.

2. Extract the zip file and place the whole folder in the Web server documents directory, for example: C:/xampp/htdocs/moodle if XAMPP is used.
3. Create an empty folder named ‘moodledata’ in the same folder directory with the installation files, for example: C:/xampp/htdocs/moodledata. The empty folder is used to store uploaded files.
4. Create an empty database named ‘moodle’ in the database.
5. Open the config.php file in the moodle folder and edit the system root directory information and also the database host and user information.
6. Create database tables used in the P-Learning system in the ‘moodle’ database by running the script in the tables.sql file which is placed in the moodle folder.
7. Installation is complete. Go to url [http://localhost/moodle/](http://localhost/moodle/) to access the system.
   Use the default admin account to login to the system. Username and password for the default admin account is admin. You are advised to change the password immediately after login successfully.

**REMOVING P-LEARNING SYSTEM**

You can remove the P-Learning system by deleting the whole ‘moodle’ and ‘moodledata’ folder in the web server documents directory. Remember to delete the ‘moodle’ database too.