CHAPTER 8

SYSTEM TESTING AND EVALUATION

8.0   Introduction

Testing is a process of executing a program with the intent of finding an error. Once

the source code has been generated, software must be tested to uncover as many errors as

possible before being delivered to the user. There are several techniques that are suggested

in software testing strategy, such as unit test, integration test, validation test and system test.

Besides, user acceptance testing is also conducted to verify whether LOOOP system meets

the essential user requirements.

8.1   Software Testing Strategy

A strategy for software testing using in this project consists of four types of testing,

such as unit testing, integration test, validation test and system testing. Unit testing is a

testing of an individual program or module. Integration test is a testing that tests two or

more programs that depend on each other. Validation testing is a testing that validates all

the software requirements with the system developed. System test is a test involving the

entire system.

8.1.1   Unit Testing

Unit testing concentrates on each unit of the software implemented in the source

code. The objective of this test is to identify and eliminate execution errors that can cause

the program to terminate abnormally and logic errors that are missed. In this project, unit

testing is performed after a new block of source code is written. Debugger or language compiler is used in this testing. The compiler detects all the syntax errors found in the source code. Besides, an input data is also tested in this stage. The input data is used to test the control structure of every function that is implemented, such as login function and register user function.

8.1.1.1 Login Page

Login page is the place where a user registers to the system and the place for the system to recognize the existing users. This page has only two functions, including log in user and register user.

8.1.1.1.1 Login user

Table 8.1 shows the unit test for login user function. This function is tested with a valid password and an invalid password. First, a valid password is entered to the password field and the login button is clicked. The system loads the learning contents page when the input data successfully pass by all of the control structure in this function. Next, an invalid password is entered and the login button is clicked. A message box appears to let the user knows that the password is incorrect.

Table 8.1 Unit Test For Login User

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	10	8	2
	Total	10	8	2

8.1.1.1.2 Register user

Table 8.2 shows the unit test for register user function. This function is tested with an Internet connection and without an Internet connection. A new user name is entered with the password. If the user name is not found in the list of login form username

combobox, the system loads the sharable learning contents list page to let the user selects

the contents that need to add into his or her personal learning contents. After selecting the

contents, the learning contents page is loaded. An error will be raised if the connection to

the database is terminated during half way of the process. This error will cause the user

name to be saved but cannot be used in the future.

Table 8.2 Unit Test For Register User

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	31	27	4
2.	If/ Else/ Then	8	6	2
	Total	39	33	6

8.1.1.2 Learning Contents Page

Learning contents page is the place for a registered user to manage the personal

learning contents. This page provides several functions that is used to manage the contents.

8.1.1.2.1 Send contents by email

Table 8.3 shows the unit test for send contents by email function. This is a simple

test. First, the send contents by email button is clicked. This process will load the client's

mailing system such as Microsoft Outlook. The content of the current page is checked and

attaches to compose email page as attachment file. The setting of the email system on the

client machine that is not configured causes the failure of the test.

Table 8.3 Unit Test For Send Contents By Email

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	35	30	5
	Total	35	30	5

8.1.1.2.2 New page

Table 8.4 shows the unit test for new page function. First, the new page button is

clicked. An add content page is loaded for user to add a new content to his or her personal

learning contents. This function is considered successful when the input data pass by all the control structure and the database successfully creates a record for the new content. Besides, the content title is also tested to show difference within the existing learning contents topic title. A duplicate content title will make the system retrieve wrong data from database and causes an error.

Table 8.4 Unit Test For New Page

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	9	8	1
	Total	9	8	1

8.1.1.2.3 Open file

Table 8.5 shows the unit test for open file. Some different format of files is used to test for this function. An error is caused when tested with the web page file. The system cannot load the page well when the page contains some unexpected error or an error occurs during data transfer or database records missing.

Table 8.5 Unit Test For Open File

No	Control Structure	Total Test	Total Success	Total Failure
1.	Select case	9	8	1
2.	If/ Then	33	27	6
	Total	42	35	7

8.1.1.2.4 Save to database

Table 8.6 shows the unit test for save to database function. This function is considered successful when the contents is successfully saved to the database. Incomplete data transfers cause the failure from the client's machine to the server.

Table 8.6 Unit Test For Save To Database – Learning Content Page

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	38	29	9
	Total	38	29	9

8.1.1.2.5 Save as LOOOP file

Table 8.7 shows the unit test for save as LOOOP file function. After the button is clicked, the file is checked to be successfully created on the client's machine. Besides, the file is opened with the system to ensure the file can be loaded.

Table 8.7 Unit Test For Save As LOOOP File

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	15	14	1
	Total	15	14	1

8.1.1.2.6 Save as XML file

Table 8.8 shows the unit test for save as XML file. After the button is clicked, the file is checked to be successfully created on the client's machine. Besides, the file is opened with the system to ensure the file can be loaded. The unknown or confused html tag causes the failure.

Table 8.8 Unit Test For Save As XML File

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	39	28	11
	Total	39	28	11

8.1.1.2.7 Save as sharable learning contents

Table 8.9 shows the unit test for save as sharable learning contents function. After the button is clicked, the content is ensured to be included to the sharable learning contents. If the content is not found in the sharable learning contents, the function is considered not successful.

Table 8.9 Unit Test For Save As Sharable Learning Contents

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	35	29	6
	Total	35	29	6

8.1.1.2.8 Delete contents

Table 8.10 shows the unit test for delete contents function. After the button is clicked, the content is ensured that it is already deleted from the personal learning contents. The failures are caused by incomplete SQL statements or data transfer problems.

Table 8.10 Unit Test For Delete Contents

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	18	14	4
	Total	18	14	4

8.1.1.2.9 Print content

Table 8.11 shows the unit test for print content function. The print out copy is ensured that it is same with the content viewed in learning contents page.

Table 8.11 Unit Test For Print Content

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Else/ Then	37	28	9
2.	If/ Then	32	26	6
	Total	69	54	15

8.1.1.2.10 Navigation buttons

Navigation buttons function includes first page, previous page, next page function and last page function. These functions are used for navigating personal learning contents. When the first page button is clicked, the browser will open the first page of personal learning contents. When the previous button is clicked, the browser will open the page before the currently viewed page. The test on this function is tested for the correctness of content opening and ensured no error will occur when there are end of file or before of file. Table 8.12 shows the unit test for navigation buttons function on its control structure.

Table 8.12 Unit Test For Navigation Buttons

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	24	22	2
	Total	24	22	2

8.1.1.2.11 Editing tools

Table 8.13 shows the unit test for editing tools function. The test for editing tools is tested for the functions such as bold, underline, italic, redo, undo and other tools that is provided. This function does not have any control structure.

Table 8.13 Unit Test For Editing Tools

No	Control Structure	Total Test	Total Success	Total Failure
1.	-	0	0	0
	Total	0	0	0

8.1.1.2.12 Internet search

Table 8.14 shows the unit test for Internet search function. This test is performed by selecting a word or a phrase and clicking the Internet search button. The word or the phrase will appear on the keyword field and the Internet searching is executed. The failures are caused by no Internet connection or result is not found from Google.com. Result is not found from Google.com will cause the function unable to retrieve the results.

Table 8.14 Unit Test For Internet Search

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	42	37	5
	Total	42	37	5

8.1.1.2.13 Reader agent

Table 8.15 shows the unit test for reader agent function. After the button is clicked, the system will read the entire text found in the current content or selected text. There is an error to this function. The agent is only operated in operating system that supports the agent.

Table 8.15 Unit Test For Reader Agent

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	28	23	5
2.	If/ Else/ Then	23	20	3
	Total	51	43	8

8.1.1.2.14 Highlight text and clear highlighted text

Table 8.16 shows the unit test for highlighting text and clear highlighted text function. For this test, a clear text is selected for highlighting text test. After the highlighting text button is clicked, the background of the selected text ensures that the text has already been highlighted. For clear highlighted test, this is a problem that still cannot be solved. The problem is when the highlighted text is highlighted a couple of times, user needs to click the clear highlighted text button a couple of time to clear the highlighted color.

Table 8.16 Unit Test For Highlight Text And Clear Highlighted Text

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	32	30	2
2.	If/ Else/ Then	27	22	5
	Total	59	52	7

8.1.1.2.15 Play board file

Table 8.17 shows the unit test for play board file. This function does not contain any control structure. In this test, the selected file ensures that it can be opened on the provided browser.

Table 8.17 Unit Test For Play Board File

No	Control Structure	Total Test	Total Success	Total Failure
1.	-	0	0	0
	Total	0	0	0

8.1.1.3 Search Information Page

Search information page is the place for user searching the keyword from the Internet or sharable learning contents. The result page found can also be a source for a user to add it as learning contents.

8.1.1.3.1 Search from Internet or contents

Table 8.18 shows the unit test for search from Internet or contents function. First, a word or a phrase is entered to the keyword field. The search from Internet checkbox and search from contents checkbox are checked. Then only the search button is clicked. The results listed out ensures it can be linked to the related page.

Table 8.18 Unit Test For Search From Internet Or Contents

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	46	32	14
	Total	46	32	14

8.1.1.3.2 Save to contents

Table 8.19 shows the unit test for save to contents. First, the save button is clicked. Then, a topic title is selected and the 'ok' button is clicked. The problem that still occurs in this function are the images on a web page is not fully save to the database. Besides, some of the files cannot be saved properly.

Table 8.19 Unit Test For Save To Contents

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	53	39	14
2.	For/ Next	48	41	7
	Total	101	80	21

8.1.1.3.3 Save as board file

Table 8.20 shows the unit test for save as board file function. First, the save button is clicked. Then, a content title is selected to add the selected file as board file. The problem that still occurs is some of the links on the web page are shown in the file selection box and causes the system not able to find the file at the specific link.

Table 8.20 Unit Test For Save As Board File

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	45	34	11
2.	For/ Next	32	24	8
	Total	77	58	19

8.1.1.4 View file Page

View file page is the place for the user to view and manage the board file, which is the file that is associated with the personal learning contents.

8.1.1.4.1 Save to database

Table 8.21 shows the unit test for save to database. This function does not contain any control structure. This function is considered successful when the contents is successfully saved to the database.

Table 8.21 Unit Test For Save To Database – View File Page

No	Control Structure	Total Test	Total Success	Total Failure
1.	-	0	0	0
	Total	0	0	0

8.1.1.4.2 Save as external file

Table 8.22 shows the unit test for save as external file function. After the button is clicked, the file is ensured to create in the original file format.

Table 8.22 Unit Test For Save As External File

No	Control Structure	Total Test	Total Success	Total Failure
1.	-	0	0	0
	Total	0	0	0

8.1.1.4.3 Delete file

Table 8.23 shows the unit test for delete file function. After the button is clicked, the record is ensured and already deletes from the personal learning contents.

Table 8.23 Unit Test For Delete File

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	12	11	1
	Total	12	11	1

8.1.1.5 Forum Window

Forum window is the place for a registered user to communicate with another online LOOOP registered user.

8.1.1.5.1 Send file

Table 8.24 shows the unit test for send file function. First, a file is selected and the send file button is clicked. The function is considered a success when the recipient receives the file successfully and the file can be opened.

Table 8.24 Unit Test For Send File

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Then	31	28	3
2.	For/ Next	27	24	3
	Total	58	52	6

8.1.1.5.2 Send message

Table 8.25 shows the unit test for send message function. First, a message is typed in the message box. Then the send message button is clicked. This function is considered a success when the recipient receives the message send to them.

Table 8.25 Unit Test For Send Message

No	Control Structure	Total Test	Total Success	Total Failure
1.	If/ Else/ Then	43	31	12
	Total	43	31	12

8.1.2 Integration Testing

Integration test focuses on design and the construction of the system architecture. The objective of this test is to take unit test components and built a program structure that has dictated during system design. During this testing, LOOOP server-side application, LOOOP Socket is tested with the LOOOP client-side application. LOOOP socket, which is a data processing system, sends the data to the client-side application when it is requested.

The data that is in LOOOP language is the input data on the client-side application. The valid characters for data record replaces the invalid characters or spaces and the replacement process is called again when the user retrieves the specific data. Besides, LOOOP ActiveX control merges with several of COM components in the system. Integration testing is not only tested for the data passing within LOOOP ActiveX control and the COM components, but also with the database. The integration tests that are carried out for system and database are user verification, registered user, retrieve learning contents, save learning contents and others. SQL statement is used in this integration test by retrieving the data from the database.

8.1.3   Validation Testing

Validation test is achieved through a series of black box tests that demonstrate conformity with requirements. Black box testing is also known as behavioral test focused on the functional requirements on the software. During this testing, the functionality and features built are checked whether they meet the functional and non-functional requirements of this project. These features are information searching, highlight text tool, reader agent, play multimedia file, user registration, user verification, add new learning contents, modify, delete learning contents and others. The test is checked for the availability of features, the accessibility and the functionality. Validation test is also tested for the reusability, durability, accessibility and interoperability. For example, a highlight text feature is planned to be included in this system. The highlight text tool is built and its function has been tested that it can highlight the text on learning contents and clear the highlighted text. The verification and validation are very important because these ensure the system is built in the correct way. Figure 8.1 illustrates the validation for highlight text.
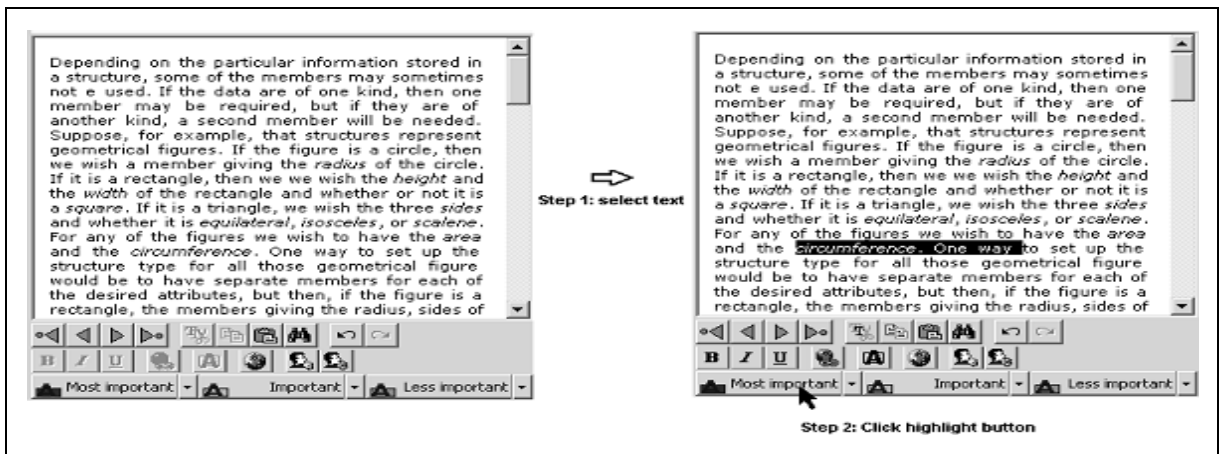
Figure 8.1 Validation Test For Highlight Text

8.1.4 System Testing

System testing is actually a series of different tests where the primary objective is to fully exercise the system. Although each test has a different objective, all work to verify that system elements have been properly integrated and perform allocated functions. The testing includes recovery testing that run though LOOOP system with some different value input and try to find out some unexpected errors. Besides, security testing has also been tested for the security of the user login into the system and ensures there is no duplicated user name in the database. Furthermore, a stress testing and performance test is also tested in this stage. For example, a new user wants to use LOOOP. First, the user needs to register to the system. After a few seconds, system displays the sharable learning contents for the user to select to add in the personal learning contents. At the same time, the system performs a number of SQL query with the database, such as recording the user name, creating table, copy learning contents and others. After the registration is completed, the user may perform highlight text, information searching, text reading and play media file. Lastly, user terminates the system. System test is considered complete and successful if the system does not raise any error from loading to termination.

8.2 A Survey On User Acceptance Testing

Below is the analysis of the survey based on the results gathered from questionnaires done.

8.2.1 Justification of the survey

The objective of the user acceptance testing (UAT) is to verify whether a new application meets the essential user requirements. UAT enables the capture of the user requirements in a directly verifiable way and measures the level of the system that meets these requirements. Besides, UAT also exposes problems that cannot be found during unit tests and provides a ready-made definition on the completion of the system. In this project, a survey is conducted for UAT purposes. This survey consists of a questionnaire that requires respondents to fill it after they have tested the system.

8.2.2 Survey method

Thirteen people are involved in the survey. The respondents are from both IT and non-IT fields. Their ages range from twenty-two to twenty-six and use moderately with the computer. The questionnaire use is a closed-ended type of question. Closed-ended question is used to limit or restrict the responses.

8.2.3 UAT results

The questionnaire contains two parts. Part one regarding the respondent's information and part two regarding respondent's satisfaction to the system.

8.2.3.1 Respondent information

Five respondents are from ages ranging twenty-two to twenty-four and seven are from ages ranging twenty-four to twenty-six. Eight of them are male and five of them are female. Figure 8.2 illustrates the column chart for the ages range and Figure 8.3 illustrates the pie chart for the gender.
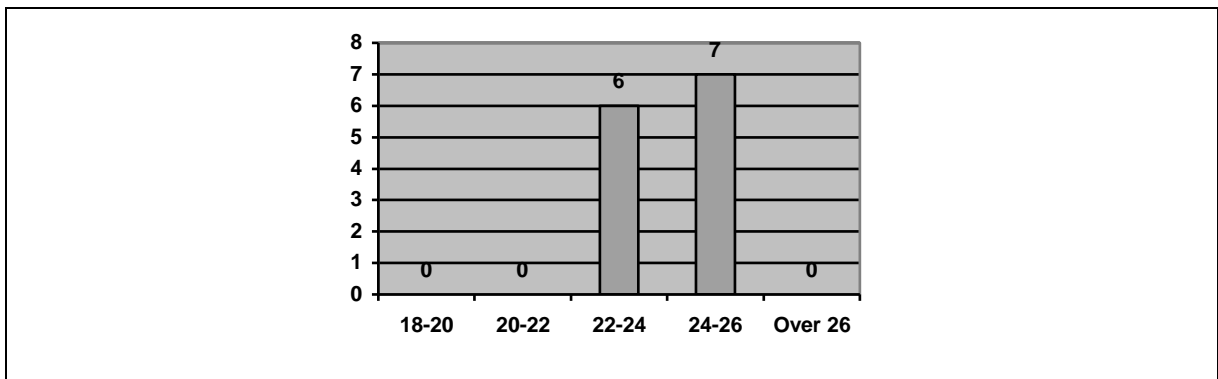
Figure 8.2 User Acceptance Testing Respondents' Ages Range
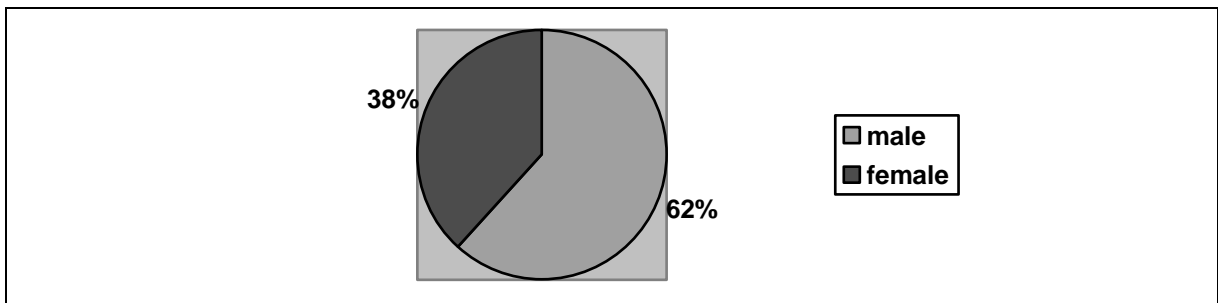
Figure 8.3 User Acceptance Testing Respondents Gender

8.2.3.2 Graphical user interface

Section B is the questionnaire which asks for the user feedback after the user has tested the system. Eleven respondents like the system GUI design and two respondents dislike the LOOOP system interface design because of the toolbars location. The width of the toolbars is fixed and some buttons are hidden if the width of screen is smaller than the width of the toolbars. Ten respondents agree with the GUI design as it is compatible to the

use of the system. Figure 8.4 illustrates the column chart for the user likeliness to the system GUI and Figure 8.5 illustrates the column chart for the compatible of design.
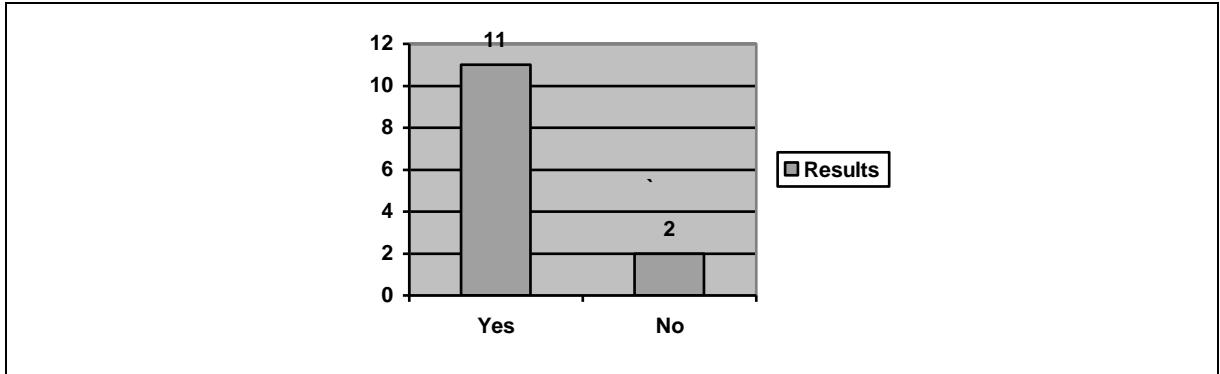
Figure 8.4 User Likeliness On System GUI
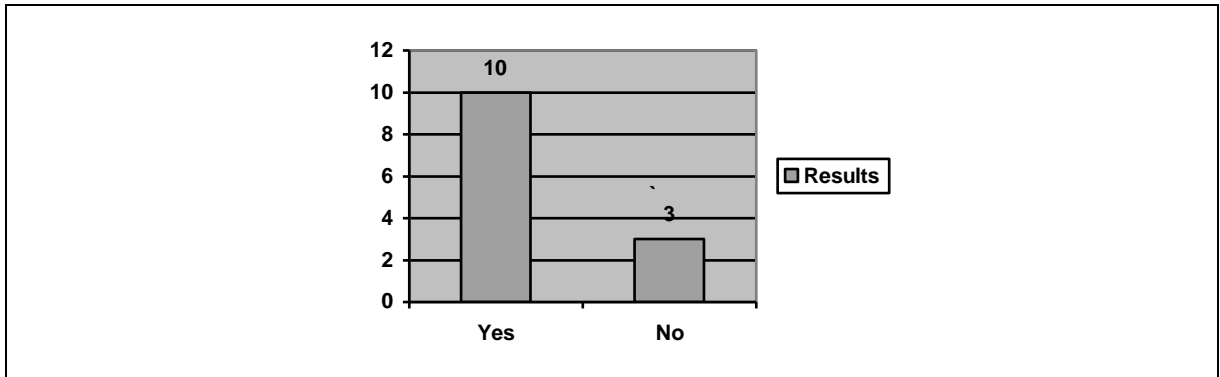
Figure 8.5 Compatible Of GUI Design To The System

8.2.3.3 Functionality

Eleven respondents are satisfied that the system has the features and capabilities needed and another two respondents need more editing tools for editing the learning contents. Twelve respondents think that the system is easy to use and one respondent finds the system lacks of the tooltips on the features provided.   Nine respondents are satisfied with the information provided in the sharable learning contents and four need more sharable learning contents. Figure 8.6 illustrates the column chart for features and capabilities satisfaction and Figure 8.7 illustrates the column chart for the satisfaction of easy use. Figure 8.8 illustrates the column chart for the satisfaction of providing information.
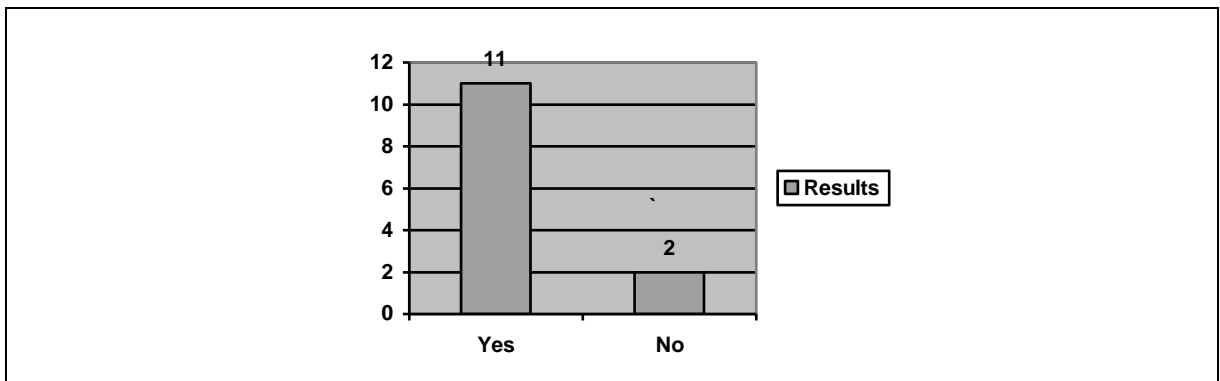
. Figure 8.6 Features And Capabilities Satisfaction
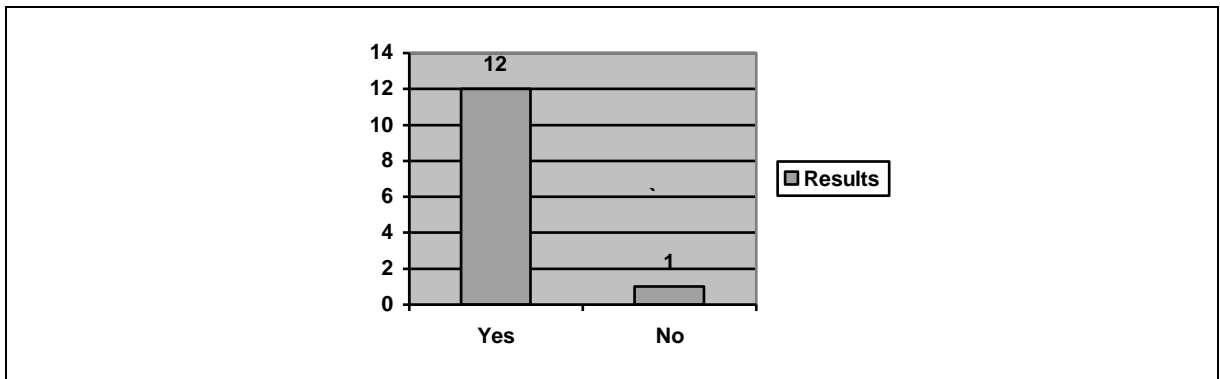
Figure 8.7 Satisfaction Of Easy Use
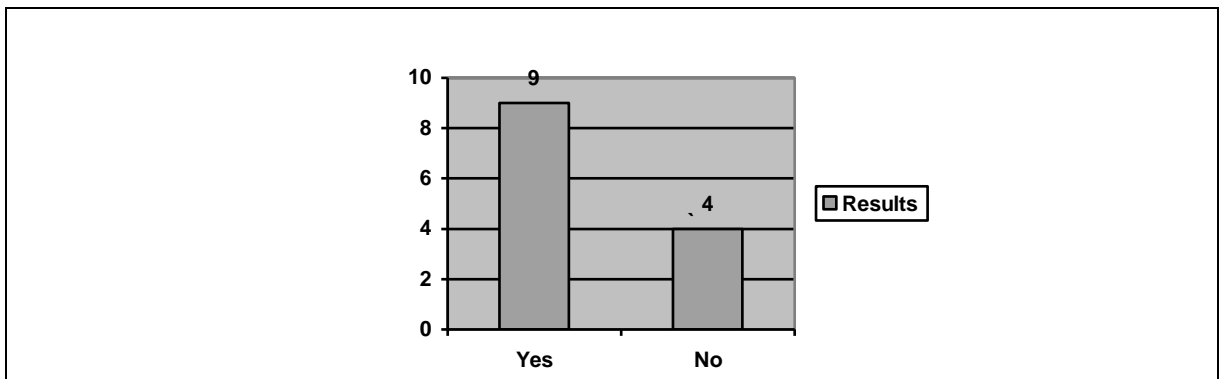
Figure 8.8 Satisfaction Of Provided Information

8.2.3.4 Learnability

All respondents are able to use the system without any learning even with the lack of the tooltips provided. Eight respondents understand the information provided. The information is the content of sharable learning contents. Five respondents suggest more details on the contents provided. Eleven respondents fell comfortable using the system. Two respondents do not because of the design of the system GUI design. Eight respondents

are satisfied with the alert messages or pop-up message boxes provided and five suggest that the system needs to provide more alert messages and provides a status bar on the client-side application to show out the status of sending and retrieving data from LOOOP server-side application. Figure 8.9 illustrates the column chart for easier learning on how to use the system. Figure 8.10 illustrates the column chart for understanding on information provided and Figure 8.11 illustrates the column chart for comfortable use with the system. Figure 8.12 illustrates the column chart for the alert messages provided.
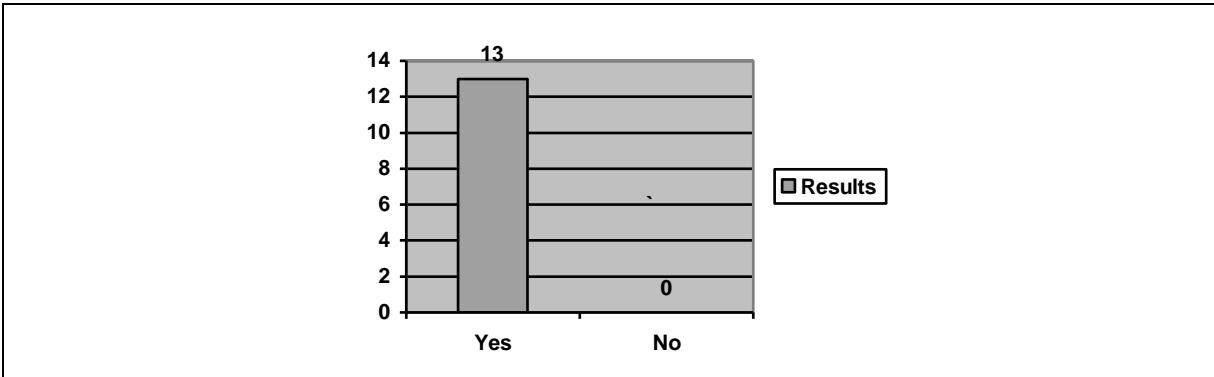
Figure 8.9 Easy To Learn How To Use The System
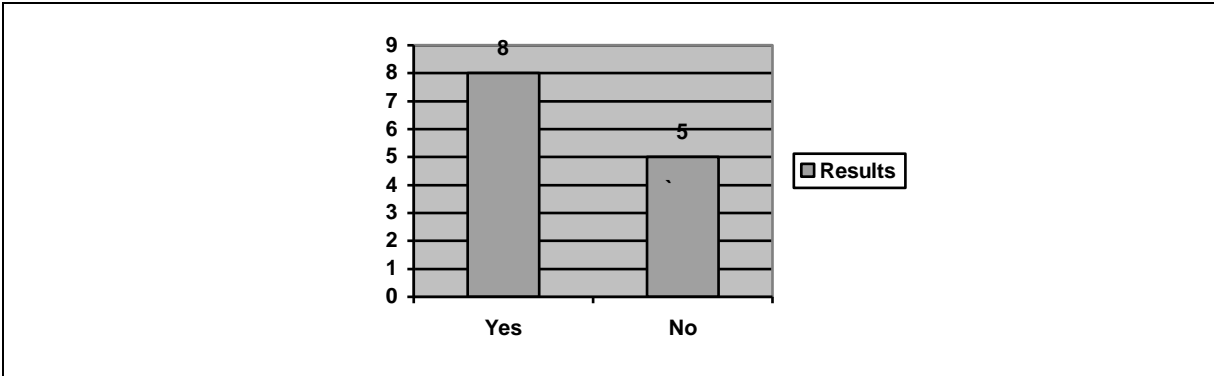
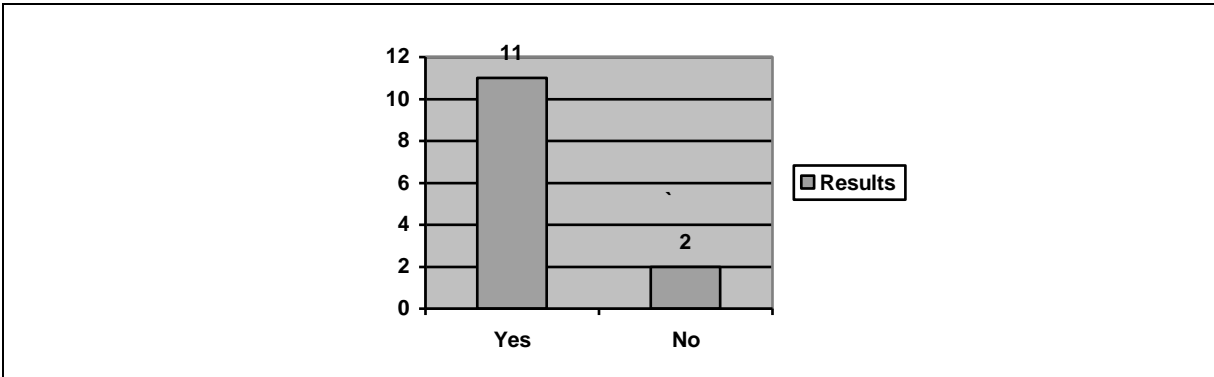. Figure 8.10 Not Really Understand The Information Provided

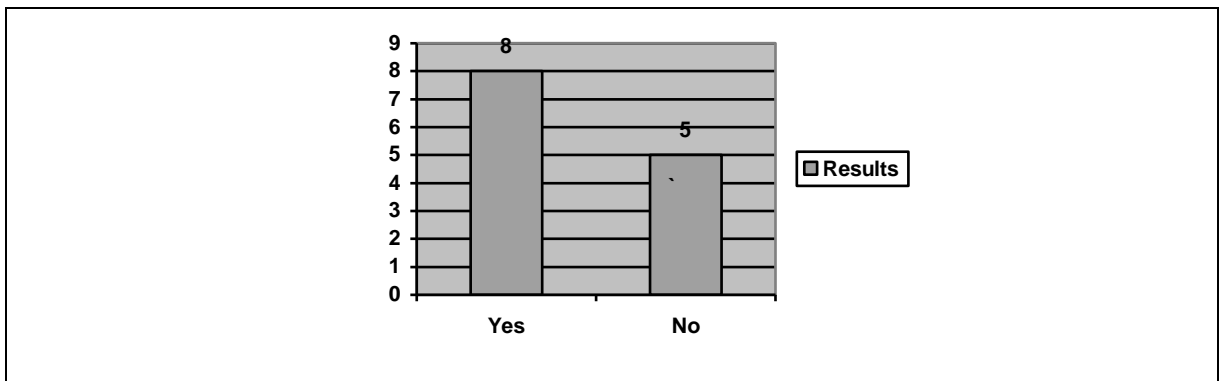Figure 8.11 Comfortable Use With The System

Figure 8.12 Alert Messages Provided

8.2.3.5 Satisfaction

Twelve respondents are satisfied with the system and one respondent suggests that more features need to be included in the system. Figure 8.13 illustrates the satisfaction to the system.
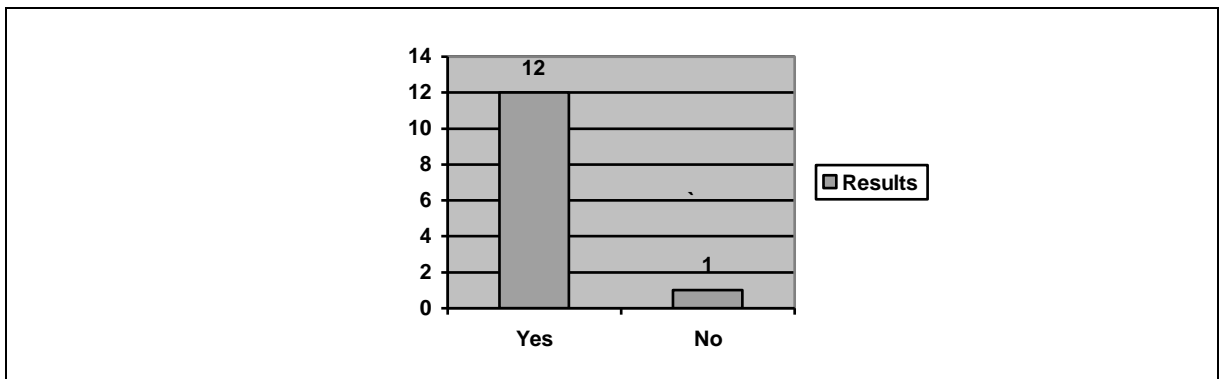

Figure 8.13 Satisfaction To The System

8.2.4   Survey conclusion

In conclusion, many features need to be added to the system to make the system more functional such as the learning contents editing tools.   Besides, more system information is needed to add to the system, such as the tooltips, message box and status bar. Finally, most of the respondents are satisfied with the system and only one suggests more features should be provided on the system

8.3   Comparison Between LOOOP System Architecture to DSpace System

Architecture

Dspace is an open source system that is designed to run on UNIX platform and programming in JAVA programming languages. Dspace consists a three layers architecture including storage, business logic and service layer. Storage layer is a layer consisting of a relational database for saving metadata and 'bitstream' module for saving content data. Business logic layer is a layer that contains the modules to perform business logic of the system where all of the required functions such as search function, browse function, content management API and administration toolkit are located in this layer. Service layer is the layer that contains web user interface. Each of the layers links with API (Application Program Interface) interface. For storage layer and business logic layer, the API interface is called storage interface. For business logic layer and service layer, the API interface is called Dspace in-proces application interface (Michael & David, 2002). Figure 8.14 illustrates the Dspace system architecture.
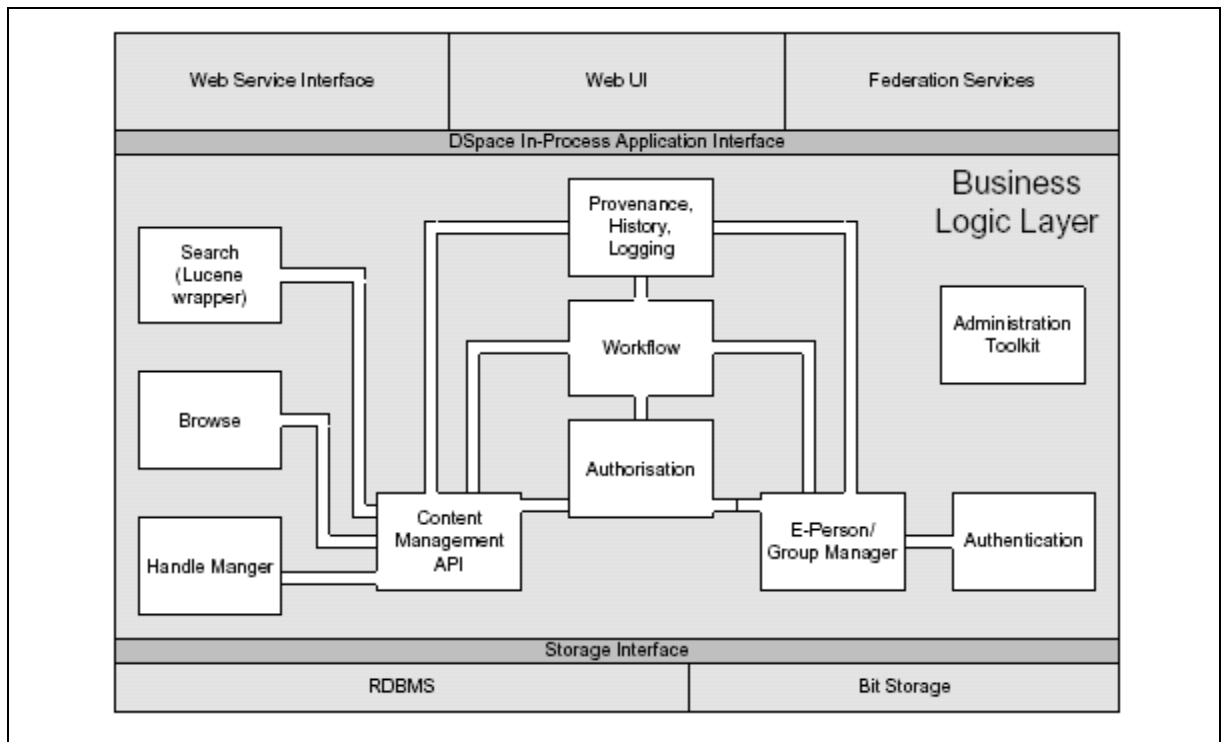

Figure 8.14 DSpace System Architecture

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The system architecture of LOOOP is designed based on the SCORM standard. There are only two part in LOOOP system architecture including the client-side and the server-side. The client-side is the part that contains all the functions needed to communicate with Learning Objects including search function, browsing function and information searching. The server-side is the part for storing Learning Objects in a relational database. As a comparison, the client-side of LOOOP is similar to a combination of business logic and service layer for DSpace. The server-side of LOOOP is similar to the storage layer for DSpace. Besides, Dspace consists of a relational database for storing metadata and 'bitstream' module to save contents data while LOOOP consists of a relational database to save Learning Objects and the field name for the table is the metadata for Learning Objects. Thus, Dspace uses JAVA programming language which is one of the object-oriented programming languages in its implementation and LOOOP uses Visual Basic programming language in its implementation. The system architecture that is designed based on SCORM standard is selected to be used in this system because SCORM standard is simple to construct a new system architecture and the way deals with Learning Objects is more direct than the DSpace system architecture. Besides, LOOOP uses a relational database as Learning Objects repository that contains all created Learning Objects and its metadata while Dspace uses a relationship database for storing metadata and 'bitstream' to store contents data. These reasons explain why LOOOP uses the architecture based on SCORM standard in implementation. Table 8.26 shows the comparison within LOOOP system architecture and the DSpace system architecture.

Table 8.26 Comparison Within LOOOP System Architecture And Dspace System Architecture

	LOOOP	**DSpace**
Layer/ Parts	Client-side and server-side	Storage layer, business logic layer and service layer.
Repository and metadata	-Data store at server-side and store at client-side for offline version. -Table field name as metadata, record as Learning Objects	- data store at storage layer - Metadata store in database and content data store in 'bitstream'
Programming languages	JAVA - Object-Oriented Programming	Visual Basic - Event-driven and Object-oriented programming

8.4   Summary

Coming to the system testing, the software development life cycle has almost reach the final step. The system is performed with a list of testing method such as unit test, integration test, validation test and system test. Unit test is tested for every block of code written and every single component or functions built. Integration test is tested for interaction between two or more components. Validation test is tested for ensuring the entire features and requirements stated have been included in the system and are functioning well. System test is tested for the whole system, from system loading to system termination. Finally, a survey that performs as user acceptance test is conducted to know the user satisfaction to the system.