DEVELOPMENT AND EVALUATION OF AN ENGAGING WEB-BASED CONTENT SEQUENCING SYSTEM FOR LEARNING BASIC PROGRAMMING

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MASTER OF SCIENCE
UNIVERSITI UTARA MALAYSIA
2014

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Abstrak

Asas pengaturcaraan Java adalah salah satu bahasa pengaturcaraan yang akan ditawarkan kepada pelajar sebagai mata pelajaran wajib bagi yang mengambil jurusan teknologi maklumat atau sains komputer. Subjek ini memerlukan pelajar mendalami kemahiran dan teknik pengaturcaraan, berbanding teori konsep. Kebiasaannya, pelajar menghadapi masalah untuk menguasai dan memahami kandungan kursus yang menyebabkan prestasi kurang memuaskan atau penarikan diri daripada program pengajian dan juga sistem pendidikan. Secara umumnya, pembelajaran berasaskan web digunakan sebagai alat untuk meningkatkan pembelajaran termasuk kursus-kursus pengaturcaraan. Satu contoh khusus berkaitan pembelajaran berasaskan web; dipanggil sistem kandungan berurutan yang mempunyai potensi yang tinggi untuk menyediakan pembelajaran adaptif untuk bahasa-bahasa pengaturcaraan. Sistem adaptif kandungan berurutan menganalisis pelajar secara individu, dan urutan kandungan pembelajaran berdasarkan keperluan pelajar. Dengan menangani masalah berbeza mengikut pelajar secara individu, ia membantu pelajar untuk terlibat aktif dalam proses pembelajaran. Penglibatan adalah kunci utama dalam pembelajaran. Dalam kajian ini, tahap penglibatan pelajar diukur menggunakan "teori aliran". Teori ini mencadangkan tiga keadaan kognitif apabila seseorang itu melakukan aktiviti tertentu, iaitu aliran (penglibatan), kebosanan, dan kekhuatiran. Penglibatan berlaku apabila seseorang individu itu mempunyai tahap kemahiran yang sama dengan tahap cabaran yang diberikan. Kekhuatiran dan kebosanan berlaku apabila terdapat ketidakseimbangan antara tahap cabaran dan kemahiran. Konsep-konsep asas teori diwakili melalui reka bentuk antara muka pengguna melalui penyesuaian komponen yang dikenali sebagai "butang aliran". Penggunaan butang ini disifatkan sebagai teknik Imbangan Kemahiran-Cabaran (SCB) dan ia disesuaikan dalam sistem pembelajaran berasaskan web yang dikenali sebagai "LearnJava". Ia menggabungkan teknik SCB di mana komponen utamanya adalah rekaan antara muka pengguna dan enjin berjujukan. Berdasarkan teknik ini, tahap pengetahuan pelajar akan dinilai dan dianalisis untuk mengenal pasti tahap semasa kemahiran mereka. Teknik ini akan mengatur kandungan pembelajaran berdasarkan tahap kemahiran semasa pelajar untuk memastikan penglibatan mereka dalam pembelajaran berasaskan web. Satu uji kaji telah dijalankan untuk menilai bagaimana keberkesanan SCB dalam membantu pelajar melibatkan diri dalam pembelajaran berasaskan web. Keputusan menunjukkan teknik SCB meningkatkan penglibatan pelajar dalam pembelajaran berasaskan web.

Kata Kunci: Sistem kandungan berurutan, Pembelajaran berasaskan web, Pembelajaran adaptif, Perbezaan secara individu, Teori Aliran, Penglibatan, Tiada penglibatan, Kemahiran menyeimbangkan cabaran.

Abstract

Java basic programming is one of programming languages that is offered to students as a compulsory course for Information Technology or Computer Science programs. This subject requires students to learn skills and techniques of programming rather than theoretical concepts. Usually, students have problems to capture and understand the content of the course which resulted in low performance or withdrawal from the program and even the education system. In general, web-based learning can be used as a tool to improve learning including programming courses. A specific instance of web-based learning; called content sequencing systems have a high potential to provide adaptive learning for programming languages. Adaptive content sequencing systems analyze individual difference of students and sequence the learning contents based on the students' needs. By addressing students' individual differences, it helps students to be actively engaged in the learning process. An engagement is a key element in learning. In this research, the level of students' engagement is measured using "flow theory". This theory suggested three cognitive conditions when one is doing a particular activity, namely flow (engaged), boredom, and anxiety. Engagement occurs when an individual has an equal level of skill with the given level of challenge. Anxiety and boredom occur when there is unequal level of challenge and skill. The fundamental concepts of the theory are represented in a user interface design by imposing a component known as "flow buttons". The used of the buttons is described as Skill-Challenge Balancing (SCB) technique and it is adapted in a web-based learning system called "LearnJava". It incorporates SCB where its main components are a user interface design and a sequencing engine. Based on this technique, the students' level of knowledge will be evaluated and analyzed to identify their current level of skill. The technique will sequence the learning contents based on the students' current level of skill to keep them engage in the web-based learning. An experimental study was conducted to evaluate how effective SCB in helping students to engage in web-based learning. The results suggested that the SCB technique improved students' engagement in web-based learning.

Keywords : Content sequencing system, Web-based learning, Adaptive learning, Individual difference, Flow theory, Engagement, Disengagement, Skill-challenge balancing.

Acknowledgement

'By the name of Allah s.w.t., the Most Gracious and Most Merciful'

Alhamdulillah and thanks to Allah s.w.t., the Most Gracious and Most Compassionate which has given me the commitment and strength to start and complete this study. With the help and permission of Allah s.w.t., I succeeded in completing this project.

I would like to express my endless appreciation and gratitude to my supervisor, Dr Norliza Katuk for her invaluable input and guidance, patient, encouragement, advices and flourish on knowledge during completing this study. Indeed, without her assistance and numerous beneficial comments and advices, this study would have never been successful.

Special thanks to all lecturers at School of Computing, Universiti Utara Malaysia for their time and commitments given to me to finish this project and to the others who gave encouragement and support me to finish this study.

Throughout the entire study process, thanks to my strongest source of motivation and inspiration due to their underlying love, support, encouragement, blessing and pray from my both beloved parents Haji Halim bin Awang and Hajjah Faridah binti Haji Omar. In addition, thanks to my beloved brother and sisters, Muhammad Zakwan, Noor Aznin, Wan Siti Mannam and Nur Iman Fayyadhah respectively for their understanding and patience.

Special gratitude goes to my colleagues and friends for their encouragement, advice and guidance in helping me with this study. Without their help and support, this project would not finish in time. Last but not least, thanks to all my friend who have contributed to the success of this study, directly or indirectly.

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LIST OF ABBREVIATIONS

BIT (Hons)	Bachelor of Science with Honors (Information Technology)
CTT	Classical Test Theory
GUI	Graphical User Interface
KS	Kolmogorov Smirnov
IRT	Item Response Theory
IT	Information Technology
Msc (IT)	Master of Science (Information Technology)
PAT	Programming Adaptive Testing
PHP	Hypertext Preprocessor
SCB	Skill Challenge Balancing
SOC	School of Computing
SPSS	Statistical Package for Social Science
TBL	Team Based Learning
UUM	Universiti Utara Malaysia
WBCS	Web-based Content Sequencing
WBL	Web-based Learning

CHAPTER ONE

INTRODUCTION

1.1 Overview of Chapter 1

Chapter 1 describes the background of the study which includes problem statement, research questions, research objectives, scope of the research, the significance of the research and a summary of each chapter.

1.2 Introduction of the Research

Research on adaptive web-based learning (WBL) has been conducted since more than a decade ago. Adaptive WBL is a learning technology that enables students to learn independently adapting to their needs. This technology aims to provide an independent learning opportunity for students through modification of activities, methods, tools, and the learning environment. It helps them to involve in a learning process that is more effective than traditional e-learning systems.

In general, students are individually different in terms of their prior knowledge, motivation, personality, and preferences (Roberts, 2010). For that reason, students need a WBL system that acts differently and adapt to their individual differences. This is because WBL can provide students the opportunity to learn in a variety of techniques and styles. This can ensure that learning content can be delivered more effectively to each student. Adaptive learning is a learning technique that uses computers as an important medium in the learning process. It considers and manipulates students learning parameters to provide the most effective content for each student (Brusilovsky, 2004). The common approach towards adaptive e-learning is through effective content sequencing technique. The implementation of an appropriate sequencing technique is likely to foster meaningful learning so that students can actively engage in any given activity (Katuk and Ryu, 2010).

In WBL, it is important for students to focus attention on the given learning activity as learning through this process is totally independent and unsupervised. Hence, a WBL system should be designed in a way that it encourages self-directed learning, motivating students to learn and keeping them engaged. WBL system combines adaptive learning and the concept of content sequencing. It aims to provide different learning contents according to students' needs. Learning contents are very important to increase students' interest to stay focused on his/her learning. Novice students will continue to dominate his/her learning through the exploration into learning contents until his/her succeed to achieve the optimum levels of understanding.

Thus, a recent development on content sequencing by Katuk, Wang and Ryu (2011) proposed an approach towards an adaptive and engaging WBL environment known as Skill-Challenge Balancing (SCB) technique. This technique aims to facilitate learning by providing an engaging learning environment through manipulation of student's current levels of skill (knowledge) and the given levels of challenge during a learning interaction in WBL. The technique has been implemented in a WBL system for learning Basic

Computer Networks. An empirical evaluation on the technique suggested that it was effective to help students to engage in learning declarative knowledge within the WBL.

The technique has been found effective for declarative knowledge; however, the effectiveness of the technique on procedural knowledge is yet to be discovered (Ntim, 2013). Hence, this research aims to extend the existing study by implementing such technique in different domain of learning. In this research, SCB technique is implemented on a WBL for learning procedural knowledge. A module in Java programming course was selected and programmed in a WBL system. Then, the SCB technique was adapted and integrated in the system.

1.3 Problem Statement

This project is inspired by the difficulties that were faced by the researcher for almost two years while teaching mathematics at high school in Perak, Malaysia. Various teaching methods were implemented to deliver the learning contents to students including tutorial, one-to-one coaching and e-learning. In the process, it was interesting to see how students interact with the e-learning. The observation, which was done in private, concluded that a generic computer-based learning system did not effectively work on every student; only partially were engaged.

Engagement in e-learning is important to ensure that students make the most from the interactions and obtain effective learning (Krause & Coates, 2008). Students who disengage from e-learning have potential to avoid this learning environment in the future

(Katuk, 2012). Therefore, a learning environment that is adaptive and engaging is highly demanded to ensure the sustainability of e-learning (Katuk, Wang & Ryu, 2011).

WBL is a type of e-learning that enables students to learn online and independently. In the context of learning programming languages, WBL can be a good teaching resource that will assist students to acquire knowledge and develop their skills on programming. Mcdougali and Boyle (2004) classifies students' success of those undergo a programming course, based on their performance in developing a software program. Successful students can write programs and they generally learn programming with moderate effort. Meanwhile, unsuccessful students are unable to write correct programs and need more personal focus and mental support. Often, unsuccessful students contribute to the high increase in the failure rate.

The informal interview conducted with the program instructors (during the early stage of this research) by the researcher found that programming courses require different approaches in terms of the instructional design. The students' background of knowledge also played an important role towards their success in the course. In the case of School of Computing (SOC), Universiti Utara Malaysia (UUM), some students had learned other programming courses before they enrolled in the program, while others were just started. The heterogeneity is a challenge for programming instructors, which demands a robust and successful teaching strategy along with learning materials and tools.

As learning programming languages requires different approach of teaching and learning, there is an opportunity to figure this out through the use of WBL. Hence, this research focuses on designing a web-based content sequencing (WBCS) system for learning Java basic programming. It anticipates that the proposed WBCS can create an engaging and motivating learning environment through the use of SCB technique.

The combination between WBCS and SCB produces an optimal learning experience. It represents a mental state in which a student enjoys the WBL. At the same time, it acquires the learning objectives given in the WBL. The concept of the optimal experience is adapted from Csikszentmihalyi's that called flow theory. The flow theory concept proposes an optimal experience as a mental state where a person is totally absorbed with what he or she is doing. The optimal learning experience is reached when the optimal experience and learning objectives are paralleling in WBL systems. In other words, an optimal learning experience is reached if and only if a student really likes the learning session. At the same time, a student also achieves some academic objectives defined in the WBL. The literature has shown that students who had enjoyable WBL activities were more likely to have a greater understanding of the learning contents; and reached higher engagement on future evaluations (McKimm, Jollie & Cantillon, 2003).

At the end of this research, an e-learning system is hoped to diversify the existing WBL technique. Next, the problems associated to learning programming can be reduced, in which it will also invite more students to learn and use Java and make it as one of their preferred programming language.

1.4 Research Questions

The research questions are as followed:-

1. How to incorporate SCB technique in WBCS design for learning Java programming?
2. Does SCB technique improve student engagement in WBCS for learning Java programming?
3. Does engagement change in WBCS for learning Java programming?

1.5 Research Objectives

The objectives of this research are:-

1. To develop a WBCS system that incorporates SCB technique for learning Java basic programming.
2. To evaluate students' engagement in WBCS with SCB and non-SCB.
3. To differentiate the pattern of engagement when students learn Java using SCB and non-SCB technique.

1.6 Scopes of the Research

The scopes of the research are as followed:-

1. The WBCS was implemented for learning a 45-minutes lesson of introductory Java programming.
2. The respondents were the students in Bachelor of Science with Honors (Information Technology) and Master of Science (Information Technology) at SOC, UUM.

3. A within-subject design was implemented in this study where the respondents were required to interact with the two web-based learning systems; LearnJava with SCB in treatment group and LearnJava without SCB in the control group.

1.7 Significance of the Research

The study contributes to the body of knowledge in the following ways:-

1. The research enhances WBCS design for learning Java programming language. Hence, instructors and students can have an alternative approach for teaching and learning in the selected domain.
2. The WBCS with SCB technique for learning programming can improve student engagement and participation in online learning, hence ensuring the sustainability of e-learning in the future.
3. The information gathered from the collected data can be used appropriately to take actions or to find a more effective way for teaching and learning process.

1.8 The Research Organization

This thesis consists of FIVE (5) chapters. The first chapter explains the background of this study which includes the overview of the study, problem statement, research questions, research objectives, scope of the research, the significance of the research, and a summary of each chapter. Chapter Two presents the literature review related to WBCS and engagement in learning. The third chapter describes the methodology for the research and development of LearnJava. In Chapter Four, the results and discussions are presented. Finally, Chapter Five concludes this study and some recommendations for the future study are also presented in this chapter.

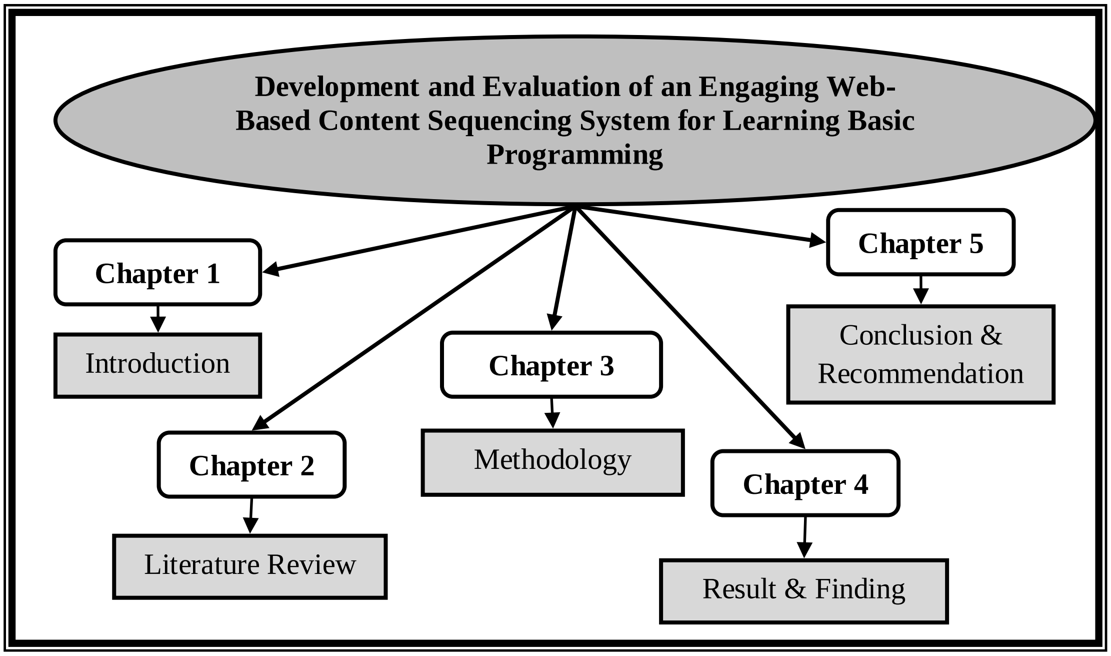

Figure 1.1. The organization of the research.

1.9 Summary of Chapter 1

There has been a significant progress made in WBL in accordance with the concept of adaptive learning. However, many important problems are yet remain. One of the most challenging issue is to ensure the level of student engagement is at the maximum level (in terms of skill and knowledge), especially in learning Java programming. This chapter explained the background of concepts, relevant problems, and the objectives of the research. There is a clear need for much more empirical works on the system development, and adaptation in the specific domain. The next chapters explore more on the way to provide an engaging and adaptive learning environment for Java programming courses.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of Chapter 2

This chapter is divided into nine sections. Section 2.1 describes about the overview of the chapter. Section 2.2 discusses about Java basic programming; the problems in learning Java, which requires proper instructional supports. Next, Section 2.3 discusses the web-based learning that provides an alternative for teaching and learning methods today. Section 2.4 discusses adaptive learning concepts, examples of applications, and its functions in learning. In Section 2.5, it discusses the sequencing of the learning objects, that the WBCS is a subset of the WBL (combination between WBL and adaptive learning sequence, become WBCS system). In Section 2.6, student engagement in learning is discussed. Next, in section 2.7, SCB technique to achieve an engaging learning environment is discussed. Section 2.8 explains other techniques that have been used to achieve engagement. Finally, in section 2.9, the summary of the whole literature is presented.

2.2 Java Basic Programming

Java is a powerful programming language that was developed by Sun Microsystems in 1995. It is an example of a high-level language, in which the program takes less time to write, is shorter and easier to read, and fewer errors (Mcdougali & Boyle, 2004). In UUM, students learn programming language through combination of lectures, laboratory exercise, and tutorials. The content covers basic syntax and to the extent that covers areas such as threaded programming and Graphical User Interface (GUI). It is also the language of choice for introductory programming courses in other universities (Barikzai, 2003). Tyma (1998) claimed that Java implements the most effective concepts developed over 10 decades ago and brings them together into one particularly effective and specifically reinforced language.

Java can be used to develop various software applications and it can be run in a cross-platform environment. It can be used in a variety of computing platforms, from embedded devices and mobile phones on the low end, to enterprise servers and supercomputers on the high end. Nowadays, Java is used almost everywhere including in mobile phones, web servers and enterprise applications.

The main reason that Java is widely used is due to its portability and flexibility. It is available for free from Sun's Solaris. It is also available for Microsoft Windows platforms, Linux and Macintosh. Since Java programs run on multi-platform, students who develop programs in Java do not need to change their code to adapt to different operating systems (Hadjerrouit, 1999). Furthermore, Java is growing to be a significant model for concurrency learning, networking, computing, interactive, and, object-oriented design (Hadjerrouit, 1999).

Java is an object-oriented language with a powerful web programming. It has concurrent programming capabilities. It also provides a solid foundation for software design which makes it very suitable for use in industry. This is because it can meet the current requirements demanded by companies and developers (Lewis & Wray, 2000). Lewis and Wray (2000) also stated that the achievement of the commercial Java and pedagogy is generally due to the revolutionary efforts of previous language in which it appears. In addition, students may want to learn Java in order to enter the highly fulfilling and fascinating world of web programming and design (Callear & King, 1997). In addition, Java enables students to get better career opportunity with high salary in Information Technology (IT) industry (Hadjerrouit, 1998).

According to Hadjerrouit (2007), Java programming is a challenging subject because it is more towards skills and techniques than knowledge. Based on Pollack and Schertz (2003), the most typical technique to programming among new students is that of "bricolage". Students develop the programs directly on the computer. Then, they usually tend to miss the phases of analysis and design. They develop their programs gradually by testing them on different examples of input. New students practicing "bricolage" are not capable to explain and justify their algorithms (Ben-David Kolikant & Pollack, 2004). So, new programmers come up with mental hurdles and misunderstandings about computing as they have difficulties to understand the function of programs or the structure of algorithms. Misunderstandings can be attributed by the scenario that students maybe understand computer programming as communication among humans (Dagdilelis, Satratzemi & Evangelidis, 2004). According to Ben-Ari (2001), misunderstandings are difficult to change, except students acquire a model of a computer program. Issues in learning programming languages can be solved using sophisticated information technology, such as online computer programming systems, web-based computer programming tutors, online learning systems, or related software. Such systems can give suitable feedback to students when working on programming assignments.

However, online learning systems for learning programming languages are limited. Furthermore, the effectiveness of such systems has not been fully tested. Therefore, it is not possible to make common conclusions about the impact of online learning systems and similar software (Hadjerrouit, 2005) for learning programming languages with other domain of knowledge. Most of e-learning applications concentrate more on technological aspects based on learning theories in the particular domain of learning. It is not sufficient for helping students acquire programming skills. For this purpose, a WBL system can be a solution. It can help students during their learning process and give them a new experience in learning Java.

2.3 Web-based Learning (WBL)

WBL is also known as online learning or e-learning (McKimm, Jollie & Cantillon, 2003). It is able to exploit the interactive technologies and communication systems to enhance the learning experience (Clarke, 2003). WBL is also a learning process created by the interaction, in which the content is delivered digitally (McKimm, Jollie & Cantillon, 2003). It involves the use of Information and Communication Technology (ICT) for the purpose of intensive services, facilities, and the revolution of the learning process (Mcdougali & Boyle, 2004).

McKimm, Jollie and Cantillon (2003) divided WBL into two types namely, the traditional e-learning and rapid e-learning. Traditional e-learning is courses that have content and detailed of the preparation. It is typically produced by experts, to give students a real understanding of learning, related to the topics that will be covered. Rapid e-learning is divided into two types, namely synchronous and asynchronous. Synchronous learning modules are occurring in real time. At the same time, students can interact with each other. It involves the exchange of ideas and information with one or more students in a period of time. An example for this category is face-to-face discussion. In contrast, the asynchronous learning module enables the students to involve in the exchange of ideas or information without the need to have all participants to be online simultaneously. The examples for this model of e-learning are email, blogs, audio, and other social networking using the web. Students can complete their tasks in a low stress environment and in a more flexible time frame. However, both of the models rely on self-motivation, discipline, and determinations of the individuals who take part in learning to ensure they gain an effective learning process.

Today, WBL is very important because it can raise standards of teaching and learning at an institution in a country (Clarke, 2003). This opinion is also supported by Chen, Lee and Chen (2005) where they argued the use of WBL system is very important to adapt the current knowledge of students and the level of their ability. Through their system (i.e., PER-IRT system), students were able to learn independently through the WBL. It is based on Item Response Theory (IRT); a modern test theory, which replaces the Classical Test Theory (CTT). It was developed to analyze the items in the test, in order to improve the accuracy of measurement results of education. IRT has been used with computer-based standardized tests, such as the GMAT, GRE, and TOEFL. Difficulty of a given material shows the level of students understanding. It will indirectly raise the questions to activate students' learning. The ability for students trying to answer the questions provided a useful input in order to grasp the subject as a whole.

Indeed, the world is growing rapidly with technological advances. It makes WBL environments as an important platform for the teaching and learning process. Students are interested to learn the subject, not only as inputs of their learning that they must know, but the materials are used as medium of instruction. According to Mcdougali and Boyle (2004), instructional design for WBL system is a complex process of applying a systems approach to solve learning problems effectively. This system is referred to integration of a set of elements interacting with each other. The system should have the following characteristics: (1) The interdependent, where no element can be detached from the system, (2) Synergistic, where the combination of all the elements is able to achieve more objective than just one element, and (3) Dynamic, where the system can be modified to change the environment, and (4) Cybernetic where the elements interact with each other.

In the context of this study, the researcher tried to propose an adaptive WBL. It is hoped that the system can help students develop their skills in programming. Students can lead the process of learning, thus determine the level of knowledge and skills. The instructors will continually update learning content to ensure that students enjoy their learning process.

2.4 Adaptive Learning

According to Riad, El-Minir and El-Ghareeb (2009), adaptive WBL is an initiative to support the traditional WBL systems. With the combination of intelligent techniques and methods, adaptive WBL can solve the problem of students with different backgrounds, in terms of skills and experience of the subject. This situation also gives problems for instructors, particularly to identify different teaching presentation techniques for different learning styles. Therefore, the adaptive WBL resources can be viewed as a basic requirement for maintaining learning opportunities to be more competitive in the global education market. On that basis, higher learning institutions are working to provide WBL systems to students, instructors or lecturers.

According to Azemi (1997), adaptive learning is an instructional design that allows online learning systems to act as a human tutor. Normally, human tutor will modify the strategy, sequence and style of teaching, in order to know the personality of students based on the pre-determined students' characteristics. The systems include the students' existing knowledge, learning styles and strategies, the tendency of learning modalities as well as the type of skill or concept being taught. Moreover, it is a method to train students to actively engage in the learning process. Student involvement in this process will provide them with a better understanding and develop their higher-order thinking skills (Karim & Shah, 2012).

Shute and Zapata-Rivera (2003) described that adaptive learning component consists of the content model, student model, and teaching model. The content model combines the elements of knowledge and skills which are considered as the knowledge that needs to be assessed and seeks to capture the important aspects of the course content to be delivered. The student model represents knowledge and progress of individual students, and it may include other student characteristics. Meanwhile, the teaching model is a material management that ensures the students' skills are monitored by arranging and organizing the content model. This will give students learning content that is different according to their individual needs.

The advances in web technology have enabled the implementation of adaptive learning in educational institutions (Yusuf, Zin & Adnan, 2012). For example, WBL with the capability to identify different learning objects for students with different levels of knowledge and skill are now being developed. Tools for monitoring the learning progress have also improved the overall teaching and learning process. It contributed to a substantial improvement in cognitive science, psychometrics, and technology which provides a new paradigm that makes it more effective and efficient (Hambleton & de Gruiter, 1983).

Now, there are a lot of research and development of web-based adaptive learning systems that can be used as references in implementing and developing new systems. The first example is Programming Adaptive Testing (PAT) by Chatzopoulou and Economides (2010). He proposed a web-based adaptive testing system for assessing students' programming knowledge. It was used in two high school programming classes by 73 students. The system had a question bank composed of 443 questions. A question is categorized in one out of three difficulty levels. Students' cognitive domain was first examined using the questions. If a student answered a question correctly, a harder question is presented. Otherwise, an easier one will be given. Easy questions examine the student's knowledge. The system was found to be useful for both students and teachers. For example, students could discover their programming mistakes while a teacher could logically assess the performance as well as finding out the topics that need to be repeated.

JointZone is another example of adaptive WBL applications. It was developed for learning Rheumatology, especially for students who took medical courses (Ng, Armstrong, Hall & Maier, 2002). The system comprised user model, domain model, and adaptive hypermedia techniques. It aimed to provide a personalized WBL environment. Keyword indexing and site layout structure were used to model the domain of knowledge that gave a conceptual and structural representation of the content. The student model consisted of the fresh concept of using effective reading speed to better assess if a student has read a page. The project combined adaptive link hiding and link annotation on a completely functional web site to provide an adaptive WBL environment.

The next example is taken from a study by Popescu, Badica and Moraret (2009), about WELSA. By using this system, students can learn by exploring the content, and perform the suggested instructional activities, such as run simulations, and do exercises. They can also communicate and collaborate with their peers through the forum and chat. Students' actions are logged and analyzed by the system in order to create accurate learner models. Based on the identified learning preferences and the built-in adaptation rules, the system offered students individualized courses. The system also provided functionalities for the teachers, who can create courses by means of a dedicated authoring tool.

Through this research, an adaptive WBL has been developed to organize different teaching materials according to student's skill. Organization was made through adaptive content sequencing that is implemented through a WBCS. It aims to provide students with a learning environment that is engaging.

2.5 Web-based Content Sequencing (WBCS) Method in Learning Materials

According to Sharma, Banati and Bedi (2011), adaptive sequencing of content is a stochastic mechanism (also known as probability or random process). It involves prediction of a direction for a student, based on the collective performances of other students, enrolled in the system. An alternative sequencing method should be selected varies according to the requirements. Hence a static sequence of contents cannot satisfy different students in terms of their skills and knowledge. Sequencing content according to the students' requirements is an objective of designing adaptive systems.

Ros and Lizenberg (2005) through her research paper entitled, "*Sequencing of Contents and Learning Objects*" clearly explained the terms and concepts related to the study. The term "contents" is described as a cognitive content that adjusted, according to the learning process. It exists in 3 types; concepts, procedures and attitudes. The term “sequence” is expressed as a curriculum component which has its own benchmark. It includes the elements of learning which is more transparent (whether in modules, subjects and chapters). It also has multi-dimensional curriculum (such as goals, content, methods, evaluation, resource, etc).

In addition, it is also an important component in the fields of many tasks that lead to the intelligent systems. The task areas contained in intelligent systems are robotics, natural language processing, inference, reasoning, planning, and so on. A very unique perspective to this domain leads to the sequence of learning solutions using different approaches. The right approach to enhance the learning sequence is to better understand the situation in the various disciplines related to the topics that are studied.

Ros and Lizenberg (2005) also suggested tools to standardize the content material for WBL. It aims to guide the design of learning objects and how to sequence them. The main target is to establish a proper sequence of content for instructors and to verify the path that students have to follow in order to achieve educational goals of students. This situation will ensure a formative work organization which can realize the formative communication between each other.

Ros and Lizenberg (2006) also proposed three methods for sequential learning content: (1) Content analysis technique, (2) Task analysis technique, and (3) The theory of elaboration (combination of the first method and the second method).

The first method is suitable to be implemented in the adaptive WBCS's learning system. In its most developed period, content analysis offers sequencing criteria that seize into reports both the inner construction of learning contents and the cognitive procedures that seize the fraction in meaningful learning. Three methods were proposed: (1) Find out and emphasize the main axis of the contents students must learn, (2) Find out and emphasize the main contents and coordinate them in a hierarchical and relational structure, and (3) Sequence contents according to the principles of the psychological association of knowledge.

Ros and Lizenberg (2006) also listed the principles that lead organizational psychology knowledge, like: (1) All students can accept meaningful learning endowed they have relevant and inclusive idea inside their cognitive structure, (2) Learning contents must be arranged in such a way that common and inclusive idea, for example the main idea is shown first. This supports the creation of extra inclusive idea in the cognitive construction of students, enabling meaningful learning of supplementary content aspects afterward on, (3) In order to accomplish a progressive differentiation of student's learning, for example the combination or new inspiring and diversifying factor for the preliminary inclusive ones in the cognitive construction of students, the learning sequences must be arranged from the common and complex to the precise and exact, (4) After delivering the common and inclusive ideas, the rest of the aspects must be completed by displaying the connections alongside the formers and with themselves. In this method, progressive deviation and integrative settlement is simplified, and (5) The early presentation of the inclusive, finished and significant thoughts must be exemplified alongside empirical concrete examples.

Furthermore, Ros and Lizenberg (2006) also explained three main principles to be taken into account for the sequence of content that is a reference to student learning. The criteria are elaborated as:-

1. First principle.

The elaboration of learning sequences by teachers must reflect on of construction of the learning content that need to be suggested to the students as well as the method in which students construct their own knowledge.

2. Second Principle.

The contents selected as basic must be the most inclusive. For example the ones that can contain supplementary contents in which students will additionally have to discover, and the extra contents they can contain the better.

3. Third Principle.

Extra inclusive and common thoughts must be given beforehand extra concrete and irrelevant aspects.

In summary, adaptive sequences of learning content can provide a structure and pathways for students to achieve meaningful learning, thus helping to produce positive results for them.

2.6 Student Engagement with Flow Theory Concept

Student engagement can be used as an indicator of teaching quality in an institution (Kuh, 2001). Krause and Coates (2008) stated that the first year experience in higher education is a very important time for students' outcomes, such as retention, persistence, completion, and achievement. To promote high quality learning among students, the instructor must be able to think of effective learning techniques and methods to attract students during their learning process. This is true when the definition of engagement is often widely used to describe the diversity of students' behavior.

There are many definitions on student engagement have been found in the literature. Stovall (2003) suggested that engagement is a combination of the time taken by students to complete a task, and their willingness to participate in activities. Krause and Coates (2008) also relate the definition of participation as the quality of work students engage in educational activities to obtain the desired results. Additionally, Kuh (2001) pointed out that the engagement is the degree for students within their educational activities, closely related to the desired results (including high grade, student satisfaction, and persistence). Other studies described the definition of engagement in terms of student's interest, effort, motivation, and time taken to complete a task. The relationship between length of time, in which the students are really focused on and they take part in the learning task that will affect their academic achievement (Bulger, Mayer, Almeroth & Blau, 2008).

Through all the research definitions above, it can be concluded that, the level of student engagement can be measured through a variety of approaches to assess the experience and skills acquired. This situation requires initiatives from instructors to increase students' interest, which reflect changes in their behavior and learning condition.

Additionally, the emotional aspects were also considered as part of engagement. Shernoff, Csikszenmihalyi, Schneider and Shernof (2003) specified student involvement in the classroom, including concentrated attention, interest, and excitement compared to the apathy and lack of interest in teaching. This definition certainly comes from the "flow theory" of Csikszentmihalyi (1990). It appeared as a model of student engagement, allegedly leading to an optimal learning experience.

The flow theory introduced by Csikszentmihalyi (1990) describes that the best learning experiences are similar with positive feelings and improve cognitive processing. He found that participation in an activity may produce some individual mental level. Optimal participation can give an incredible fun reward, where it is known as "flow" or engage. Meanwhile, the non-optimal engagement could lead to one of two cognitive experiences; anxiety, and boredom. Anxiety occurs when a person's skills are not enough to overcome a challenge, while boredom arises when the person has a higher level of skill but challenges are very low. Anxiety and boredom are two negative feelings that limit one's potential of achieving the maximum level. Therefore, both feelings prevent a person from achieving an optimal experience in performing an activity.

2.7 Skill-Challenge Balancing (SCB) Technique

The skill-challenge balancing (SCB) techniques have been proposed by Katuk (2012). The technique aims to improve students' engagement in computer-based learning and designed based on the flow theory. The theory suggested that optimal experience (engagement) can be achieved when the given levels of challenge is corresponding to the current level of skill of a person.

SCB technique was implemented by customizing WBCS user interface module and sequencing engine. The sequencing engine will assess students' prior knowledge through a set of quiz. The answers given by the students will be analyzed and manipulated to generate a dynamic learning path. Then, a sequence of learning materials will be presented to students.

The main concept of the SCB technique is to make flexible adjustments according to the learning module. The level of challenge is characterized by increasing levels of difficulty of the learning content. In order to ensure that students are engaged in the given learning activity, the level of difficulty must always be on par with their skills. In other words, the current levels of knowledge or skill must be able to withstand a certain level of challenge. Inequality in the levels of challenge and skill can be a source reason for boredom and anxiety in learning.

SCB's core technique is to enable students to have their own assessment of their individual levels of knowledge throughout a computer-based learning session. The students were given the opportunity to evaluate their own knowledge whether a given learning unit is too easy or too difficult. If students find that learning unit is too easy, they can choose to move forward to a higher level or to a more difficult learning unit. Conversely, if students find that learning unit is too difficult, they can move back to a lower level of difficulty during the learning unit.

2.8 Previous Research on Techniques to Achieve the Maximum Level of Student Engagement in Learning

Through the literature search that has been done before, many previous studies only focused on the techniques to achieve the maximum level of student engagement in the classroom, rather than in e-learning environment. Among the techniques used to motivate students in providing a fun experience in the learning process are as follows: -

Aronson's jigsaw classroom's technique by Aronson and Patnoe (1997) aimed to promote student engagement by changing the classroom setting to one. This situation assumes that success is dependent on the cooperation and active participation of students, and each student will be formed and trained to engage in a variety of situations to achieve success. The used of the technique gives students a new learning experience, other than changing the previous passive habits in which students will only attend the class to listen to lectures. This situation was actually quite good because they only learned the content of the course that has been set without in depth knowledge in practical learning. It was a good initiative to attract students actively in learning the course material. Jigsaw techniques was proven to increase students' learning experience and transform passive habits of students in which students will only attend the class to listen to the lecture to more active learning activities.

For many years, educators often discuss cooperative learning strategies to increase student involvement in all levels of education (Johnson, Johnson & Smith, 1998). One of the specific techniques of cooperative learning in postsecondary settings is Team Based Learning (TBL). TBL is a learning strategy where the instructors assign students into learning teams. The students stay in learning teams throughout the duration of the course (Michaelsen, Knight & Fink, 2002). TBL emphasizes on developing a permanent learning teams throughout the semester. It is a fundamental strategy to enhance the learning process (Michaelsen, Knight & Fink, 2004). Teams stay together throughout the term, allowing team members to develop a connection with each other and become invested in the team’s success. According to the tenets of TBL, as students create a positive team dynamic they are able to stay motivated and build on each other’s strengths to move their learning to deeper and deeper levels. TBL also emphasize on using class time for applications of content knowledge and problem solving. So, students can learn a majority of the basic content of the course through a process of individual study and individual and team-based testing.

2.9 Summary of Chapter 2

Java basic programming is a challenging subject because it requires students to acquire many skills and techniques rather than knowledge. Java learning problems can be solved using IT technology that is adaptive WBCS. It can help students in their learning process, improve their performance in developing computer programs, and give them a new experience in learning Java.

WBCS promotes meaningful learning, thus attracting students' interests and motivates them to keep learning. This will keep the students engage in WBL activity. In the context of this research, engagement is defined according to the flow theory (Csikszentmihalyi, 1990). It can be described as an optimal learning experience that leads to positive feelings and improve cognitive processing. Optimal engagement can give one incredible fun rewards, where it is known as "flow" or engage. Meanwhile, the non-optimal engagement could lead to one of two cognitive experience, either anxiety, or boredom. Anxiety and boredom are two negative feelings that limit one's potential of achieving the maximum level. SCB technique by Katuk (2012) was adapted from this theory. The SCB approach for sequencing learning content looked to improve the overall learning experience. It aims to improve students' engagement in WBL by providing a flexible way to adjust between individual levels of skill and the given level of challenges.

CHAPTER THREE

METHODOLOGY

3.1 Overview of Chapter 3

Chapter 3 describes about the web-based content sequencing system (WBCS) and skill challenge balancing (SCB) approach that is used to enhance the experience in web-based learning (WBL). The purpose of this chapter is to show how WBCS differs from other WBL systems in terms of its learning contents and how it functions. The overall activities of the research were described; the overall research framework with the explanation on design of LearnJava.

Section 3.2 provides an overview of WBCS and SCB approach that has been used. Section 3.3 presents the research framework during the development process of a WBCS known as LearnJava; which is an apparatus used for research in this report. It also describes the usability evaluation LearnJava.

3.2 An Overview to LearnJava: An Adaptive Web-Based Learning (WBL) System

Before the description of the methodology is presented, the researcher thought that it is necessary to describe how the apparatus was developed and whether it is usable and suitable for the experimental study. This can demonstrate the reliability of the results presented in this thesis. A brief description of LearnJava; the concept, purpose, relationships between the methods and techniques were combined to produce a medium of teaching and learning.

Web applications in education are now typical as the complementary to classroom teaching and learning activity. On the other hand, an allegedly obscure area in the WBL is how it can systematically put into practice the various learning path based on the diverse background of students. In this regard, the adaptive learning combination with WBCS methods is quick to declare its strengths, and displays the most effective way forward in the WBL, matching the content with each student's learning performance. The combine process with the 'flow theory'; one particular can attract upon a way to find the most effective learning path. Hence, a WBL system called LearnJava was developed and applied to investigate this matter further.

3.2.1. Flow Theory to Achieve Students' Engagement in WBCS

Adaptive WBL is a popular topic among many educators, and software or web developers. In the WBCS perspective, adaptive features are the most important element that ascertains the performance of the WBL system. In the process of LearnJava system development, the WBCS's adaptive features were reviewed in terms of course plotting and learning material. The learning path that the WBCS dynamically organized based to student learning parameters is predicted to help students to reach the objectives of learning. The goal of this system is to demonstrate a technique for the WBCS course plotting and learning material, so that students could have a more engaging and enjoyable during learning experience with WBL.

The Flow Theory from Csikszentmihalyi has been adapted as the basis in LearnJava's development process. It is also the main concept for developing the SCB technique. Essentially, the theory proposes the flow condition; a mental state in which a person is totally absorbed in a particular activity. The flow condition gives a person a very fulfilling experience and a feeling of enjoyment. It is considered to be an important factor to enhance individual quality of life and achieve happiness. In the context of WBL, the enjoyable learning could encourage independent learning (Shute & Zapata-Rivera, 2003).

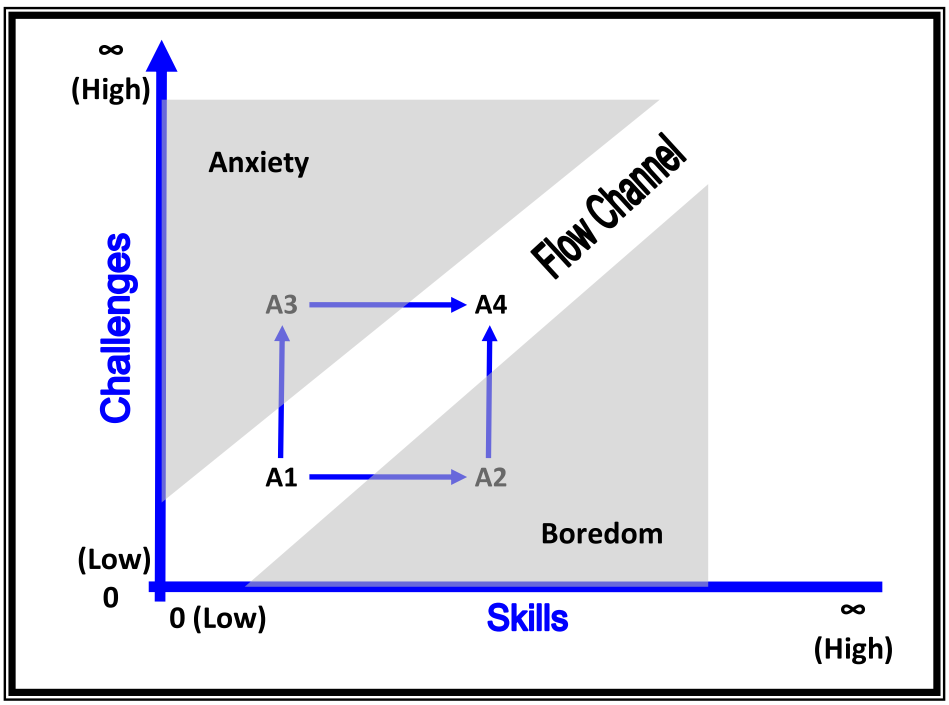

Figure 3.1. Changes of mental states based on flow theory concept.

In spite of flow, boredom and anxiety are two contrary mental states that could change the quality of learning experience. These mental states are determined through analysis of one's current levels of skills towards the given levels of challenges of an activity. Figure 3.1 displays four points of the mental states (i.e., A1, A2, A3, and A4) that one may experience when engaging in a learning activity. The flow theory suggested that a balance between one's skills and the given challenges would produce flow or engagement. The flow channels are showed by points A1 and A4. Point A3 occurs when a person's levels of skill are not adequate to fulfill the given levels of challenge, he or she is in the state of anxiety. Point A4 occurs when a person has a high level of skill with a low level of challenge that could induce boredom. In order to stay in flow channel, a balance between the given levels of challenge and one's skill is needed.

The literature review in Chapter 2 highlighted that common WBCS is unable to keep students engage in learning. To the knowledge of the researcher, research on investigating engagement in WBCS is still at its infancy stage and more efforts are required to be done to improve the learning environment.

In so doing, the researcher adapted flow theory concept in the design of WBCS. The flow theory is versatile and very useful towards designing adaptive WBL. The flow theory suggests that an optimal experience is achieved when the right levels of challenge are given to a person. Specifically, when the person's level of skill is equivalent to the level of the given challenges of an activity, the person obtains an optimal learning experience which in this case is referring to engagement. It is also suggested that the levels of challenge are increasing in conjunction with the improved levels of skill over time. Obviously, skill and challenge are the components of learning, while skill improvement is the objective or outcome of learning. From the WBL perspective, adaptive learning can be represented by a balanced adjustment of the levels of challenge to cope with the current skill.

3.2.2. Implementation of SCB in LearnJava

The SCB technique aims to enhance relationships between students and WBL systems. It is developed based on one of the flow theory's assumptions. To carry out the best WBL activity, the flow theory proposes that engagement could be obtained when the level of the given challenge equals the individuals' levels of skill. It is very important to take note that individual levels of skill are progressing from time to time and equally for the level of the given challenges.

The SCB technique is implemented by adjusting the user interface module and the sequencing engine of the WBCS architecture. In LearnJava, the combination between SCB technique and WBCS allows students to self-adjust the individual learning path through self-assessment of their knowledge about the course. To implement the self-assessment capability, the SCB technique introduces "flow buttons" in the user interface module of the WBCS architecture. The buttons comprise two types; an "anxiety" button comes along with the tutorial questions and a "boredom" button appears with the explanation of the concept. The flow buttons will be used wherever necessary, and the automatic sequencing of learning content would work otherwise.

The sequencing engine controls the interactions of these buttons during learning experience session. Manipulation of the "flow buttons" helps the students to maintain their learning experiences at least in a consistent pattern. The SCB components and how they work are further discussed in the section 3.3.2.2.

3.3 Research Framework

The process for implementing the research was divided into three main phases as shown in Figure 3.2. The three phases are: (1) Phase I: Literature analysis, (2) Phase II: System analysis and design, and (3) Phase III: Evaluation.

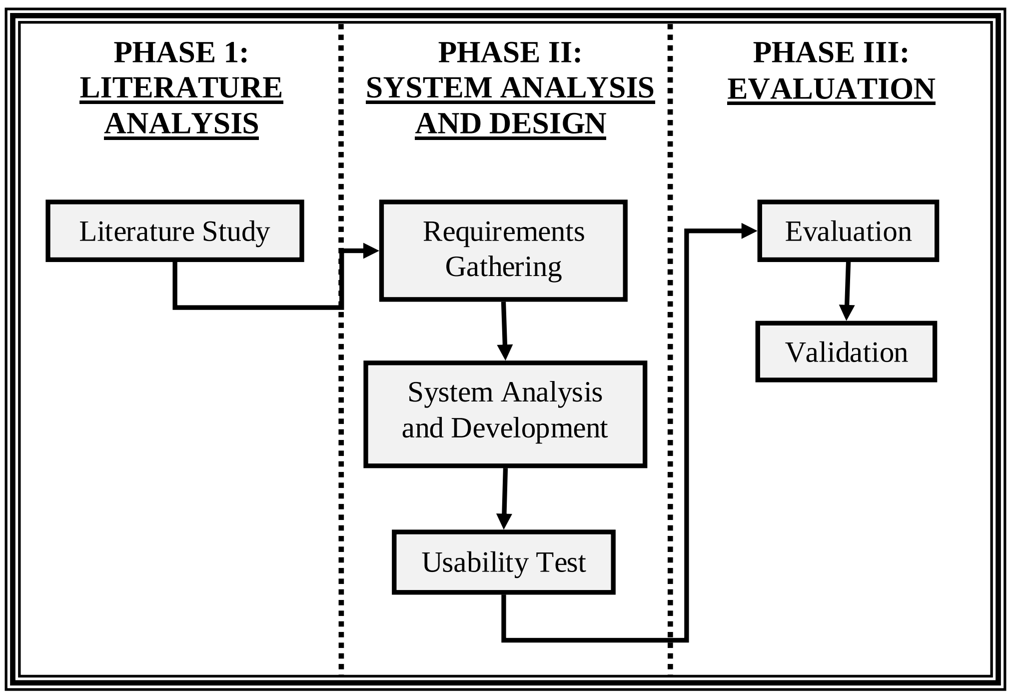

Figure 3.2. The overall research activities.

3.3.1. Phase I : Literature Review

Phase I consists of activity on reviewing literature related to the research. This phase attempts to describe the importance of engagement among students, especially during the WBL sessions. Figure 3.3 visualizes the literature studies that focused on six keywords: (1) basic programming, (2) web-based learning, (3) adaptive learning, (4) contents sequencing methods, (5) engagement, (6) skill-challenge balancing. This phase also reviewed the previous research on techniques that were used to achieve the maximum level of student engagement in learning. Refer to Chapter 2 for the outcome of this phase.

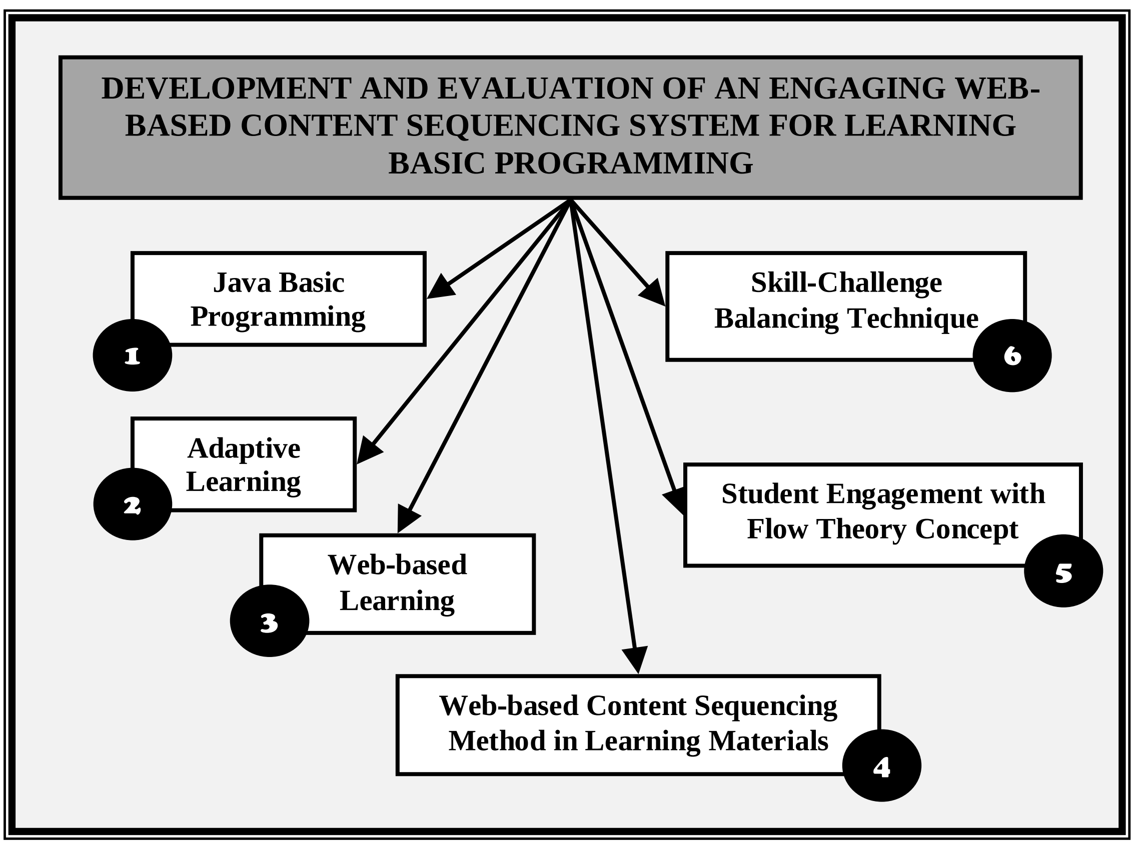

Figure 3.3. The keywords of this study.

3.3.2. Phase II : System Analysis and Design

As mentioned earlier in Section 2.4, adaptive WBL is an initiative to support teaching and learning in online environment. It was developed to organize different teaching materials according to student's individual needs. Organization will be made through adaptive content sequencing that is implemented through a WBCS. It aims to provide students with a learning environment that is engaging. An adaptive sequence of learning content can provide a structure and pathways for students to reduce anxiety, thus helping to produce positive results for them. It is an effective way to achieve flexibility in adaptive WBL.

Phase II describes about WBCS and SCB as the major apparatus for this research. The adaptive characteristics were combined to produce a system named LearnJava. Next, the design, development, and usability test are presented here. All the components and architecture of a SCB technique are also discussed. Usability study in this case is very important to demonstrate the reliability of the results produced by the study using the learning tool. A usable and error-free tool will be able to produce a reliable research outcome.

3.3.2.1. Requirements Gathering

For the first activity in phase II, all requirements that have been suggested by users were gathered and analyzed. The initial requirements were made by literature survey. Besides, the requirements were collected through interviews with instructors, undergraduate students, and postgraduate students who were enrolled in Information Technology courses offered by School of Computing, UUM.

The requirements were analyzed and the functional requirements and non-functional requirements were recorded. Table 3.1 to Table 3.9 listed the entire functional requirements that had been filtered out from the requirement stage. There are eight main requirements needed for LearnJava system. The tables below list all the requirements that were captured during the requirement analysis stage. In the priority column, the following symbols are used to denote their corresponding meanings:-

M - mandatory requirements (something the system must do)

D - desirable requirements (something the system preferably should do)

O - optional requirements (something the system may do)

Table 3.1

List of Functional Requirements for LearnJava (Sign Up).

No.	Requirement ID	Requirement Description	Priority
	LearnJava_01	**Sign Up**	
1.	LearnJava_01_01	New user: Student/admin clicks on the Sign Up button.	M
2.	LearnJava_01_02	Student/admin (new user) must enter the required inputs before using the system.	M
3.	LearnJava_01_03	Student/admin clicks the Submit button to go to the main page.	M

Table 3.2

List of Functional Requirements for LearnJava (Login).

No.	Requirement ID	Requirement Description	Priority
	LearnJava _02	**Login**	
1.	LearnJava_02_01	Student/admin clicks on the Login button.	M
2.	LearnJava_02_02	Student/admin must enter his/her email and password.	M
3.	LearnJava_02_03	Student/admin clicks the Submit button to go to the main page.	M

Table 3.3

List of Functional Requirements for LearnJava (Forgot Password).

No.	Requirement ID	Requirement Description	Priority
	LearnJava _03	**Forgot Password**	
1.	LearnJava_03_01	Student/admin clicks on the Forgot Password button.	M
2.	LearnJava_03_02	Student/admin must enter their email.	M
3.	LearnJava_03_03	Student/admin clicks Submit button.	M
4.	LearnJava_03_04	Student/admin should check their e-mail to get their current password.	D
5.	LearnJava_03_05	Student/admin must click "Login" button to start the learning process again.	D

Table 3.4

List of Functional Requirements for LearnJava (Test).

No.	Requirement ID	Requirement Description	Priority
	LearnJava _04	**Test**	
1.	LearnJava_04_01	Student clicks the "Start the Tutorial Now" button.	M
2.	LearnJava_04_02	Student can answer the question, and check their answer.	M
3.	LearnJava_04_03	Student can answer next question by click "Next" button.	M
4.	LearnJava_04_04	Student can click "anxiety button" during learning process if he/she is unable to answer the question.	O
5.	LearnJava_04_05	Student can click "boredom button" during learning process if he/she knows the answer of the question, then continue answer the quiz.	O
6.	LearnJava_04_06	Student must answer the Progressive Learning Experience in three stages (i.e., Stage 1, Stage 2 and, Stage 3). There are five quiz questions in every stage followed by four questionnaires.	M
7.	LearnJava_04_07	Student must answer the Learning Experience Questionnaire (i.e., 12 questions) at the end of the test.	M
8.	LearnJava_04_08	Student can click the "Submit" button to see the result of the test.	M

Table 3.5

List of Functional Requirements for LearnJava (Notes).

No.	Requirement ID	Requirement Description	Priority
	LearnJava _05	**Notes**	
1.	LearnJava_05_01	Student clicks the “Notes” button.	O
2.	LearnJava_05_02	Student can review next notes by click “Next” button.	O
3.	LearnJava_05_03	Student can click “Home” button to return back into main menu.	O

Table 3.6

List of Functional Requirements for LearnJava (Result).

No.	Requirement ID	Requirement Description	Priority
	LearnJava _06	**Result**	
1.	LearnJava_06_01	Student clicks the “Result” button.	D
2.	LearnJava_06_02	Student can view their result.	D
3.	LearnJava_06_03	Student can click “Home” button to return back into main menu.	M

Table 3.7

List of Functional Requirements for LearnJava (Participants).

No.	Requirement ID	Requirement Description	Priority
	LearnJava _07	**Participants**	
1.	LearnJava_07_01	Admin click the “Participants” button.	O
2.	LearnJava_07_02	Admin can see all the students' marks, time of the learning process, name, metric number, and the log record for "anxiety" and "boredom" buttons usage.	O

3.	LearnJava_07_03	Admin can click "Home" button to return back to the main menu.	O

Table 3.8

List of Functional Requirements for LearnJava (Change Password).

No.	Requirement ID	Requirement Description	Priority
	LearnJava _08	**Change Password**	
1.	LearnJava_08_01	Student/admin clicks the "Change Password" button.	O
2.	LearnJava_08_02	Student/admin must enter the new password.	O
3.	LearnJava_08_03	Student/admin clicks "Submit" button.	O
4.	LearnJava_08_04	Student/admin is required to register again on Login Page to continue the learning session. Click button "Login" to start the learning session.	M

Table 3.9

List of Functional Requirements for LearnJava (Logout).

No.	Requirement ID	Requirement Description	Priority
	LearnJava _09	**Logout**	
1.	LearnJava_09_01	Student/admin clicks the "Logout" button to exit the application.	D

Non-functional requirements mainly contain the quality attributes of the system. Table 3.10 below lists all the non-functional requirements of LearnJava.

Table 3.10

List of Non-Functional Requirements for LearnJava.

No.	Requirement ID	Non Functional Requirement	Type	Requirement Description
1.	**LearnJava_10**	Usability	Process	The system should be easily understood by the user. It should be user-friendly
2.	**LearnJava_11**	Modifiability	Process	The system should be easily modifiable by the developer at anytime and anywhere.
3.	**LearnJava_12**	Accessibility	Process	The system can be accessed by the user ant anytime and anywhere by many people.
4.	**LearnJava_13**	Reliability	Data / Information	The knowledge content should be in accordance with national standards.

Basically, all the listed requirements above were captured and represented as illustrated in Figure 3.4. There are nine requirements that LearnJava should have which are sign up, login, forgot password, test, notes, result, change password and logout. During the learning process, all the requirements can be used by both students and administrators except the "check participants info" requirement that is intended for administrators.

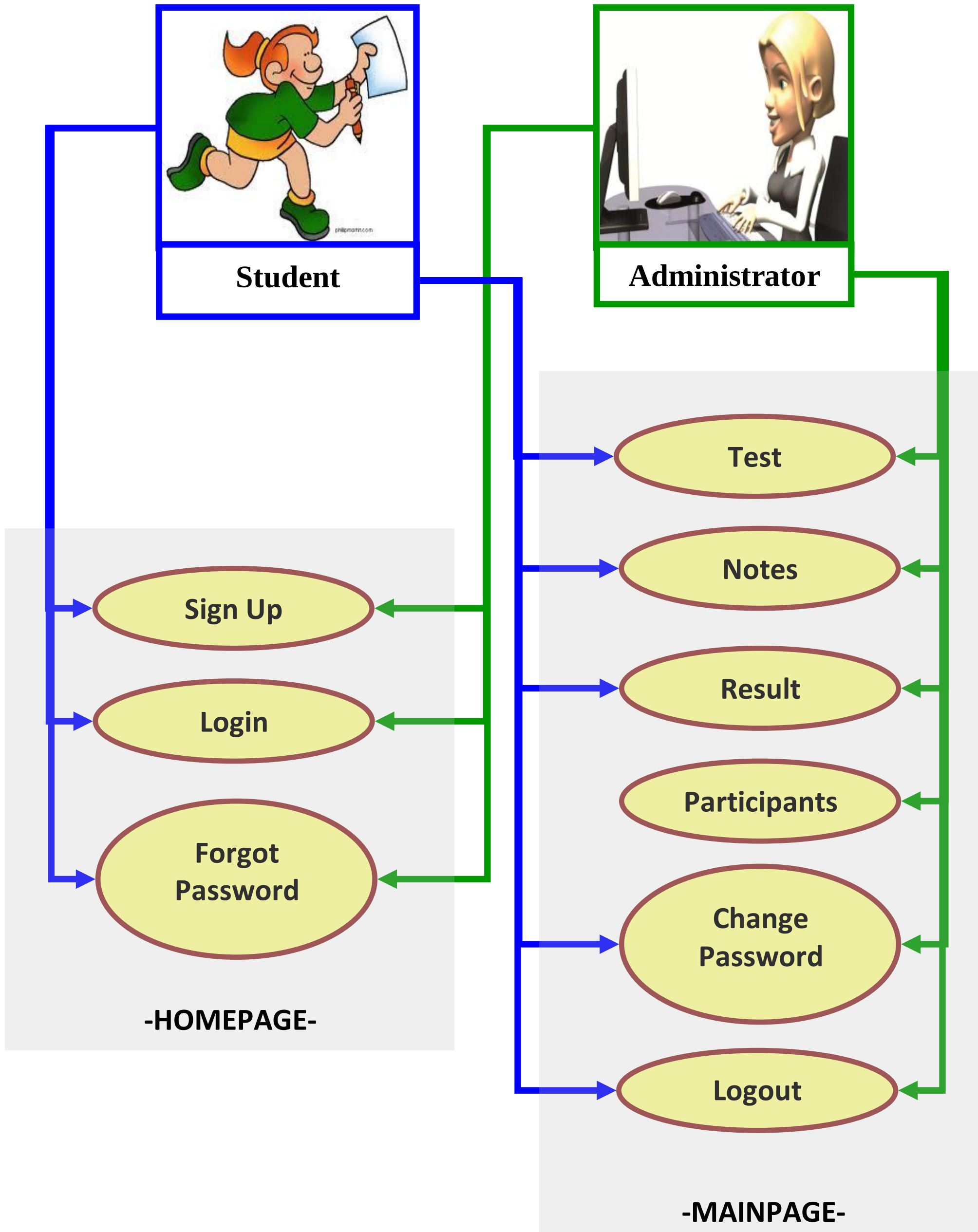

Figure 3.4. Requirements for LearnJava system.

Table 3.11 to Table 3.19 summarized the complete use case description of each requirements involved in the Figure 3.4.

Table 3.11

Use Case Description of LearnJava for Sign Up.

Use Case Name :- Sign Up	**Use Case ID: -** LearnJava_UC_01	**Importance Level :-** High
Primary Actor :- Student / Admin		**Type :-** External
Short Description :- The description on how the user can sign up through LearnJava learning system		
Trigger :- The user needs to click on the LearnJava button in the homepage of the system.		
Major Steps Performed :-		**Information for Steps :-**
1. A new user should click the "Sign Up" button for the registration before start the learning session.		“Sign Up” button
2. User is required to fill up all the identification details completely.		Identification Details user interface will be displayed
3. User needs to click "Submit" button.		“Submit” button
4. The system will display the identification details for users who have been registered.		Identification Details page will be displayed
5. The system will send an email to user upon successful process.		Email will appear
6. User needs to click the "Edit Profile" button if he/she wants to edit his/her identification details.		“Edit Profile” button
➢ User needs to click "Submit" button.		“Submit” button
7. If the identification details completed, user should click "Home" button.		“Home” button
8. The system will display the main page of LearnJava learning system.		Main page will be displayed

Table 3.12

Use Case Description of LearnJava for Login.

<table>
<tr><td colspan="2">Use Case Name :-
Login</td><td colspan="2">Use Case ID: -
LearnJava_UC_02</td><td>Importance Level :-
High</td></tr>
<tr><td colspan="4">Primary Actor :- Student / Admin</td><td>Type :- External</td></tr>
<tr><td colspan="5">Short Description :-
The description on how the user can login through LearnJava learning system</td></tr>
<tr><td colspan="5">Trigger :-
The user needs to click on the LearnJava button in the homepage of the sistem.</td></tr>
<tr><td colspan="4">Major Steps Performed :-</td><td>Information for Steps :-</td></tr>
<tr><td colspan="4">1. User should click the "Login" button before start the learning session.</td><td>“Login” button</td></tr>
<tr><td colspan="4">2. User needs to enter their email and password.</td><td>Email and password textbox</td></tr>
<tr><td colspan="4">3. User needs to click “Submit” button</td><td>“Submit” button</td></tr>
<tr><td colspan="4">4. If the email and password entered by the user were correct and match, the system will display the main page of LearnJava learning system.</td><td>Main page will be displayed</td></tr>
<tr><td colspan="4">5. If the email and password entered by the user were incorrect or did not match, the message "Incorrect email or password. Please try again!!" will be displayed through the system.</td><td>Unsuccessfully message will be displayed</td></tr>
<tr><td colspan="4">➢ User needs to click "Login" button and repeat step 1 and step 2,
or</td><td>“Login” button</td></tr>
<tr><td colspan="4">➢ User needs to click on the "Forgot Password" button to retrieve their current password.</td><td>“Forgot Password” button</td></tr>
</table>

Table 3.13

Use Case Description of LearnJava for Forgot Password.

<table>
<tr><td>Use Case Name :-
Forgot Password</td><td>Use Case ID: -
LearnJava_UC_03</td><td colspan="2">Importance Level :-
High</td></tr>
<tr><td colspan="3">Primary Actor :- Student / Admin</td><td>Type :- External</td></tr>
<tr><td colspan="4">Short Description :-
The description on how the user retrieves his/her password through LearnJava learning system</td></tr>
<tr><td colspan="4">Trigger :-
The user needs to click on the LearnJava button in the homepage of the system.</td></tr>
<tr><td colspan="2">Major Steps Performed :-</td><td colspan="2">Information for Steps :-</td></tr>
<tr><td colspan="2">1. User should click the "Forgot Password" button in the main page.</td><td colspan="2">“Sign Up” button</td></tr>
<tr><td colspan="2">2. User needs to enter their email.</td><td colspan="2">Email textbox</td></tr>
<tr><td colspan="2">3. User needs to click "Submit" button.</td><td colspan="2">“Submit” button</td></tr>
<tr><td colspan="2">4. If the email entered by the user was incorrect, the message "Your email was not found. Please try again!! will be displayed through the system.
➢ User needs to repeat step 2 and step 3.</td><td colspan="2">Unsuccessful message will be displayed</td></tr>
<tr><td colspan="2">5. If the email entered by the user was correct, the message "Your Password has been successfully reset. Please check your email” will be displayed by the system.
➢ User needs to check their email to know the password.
➢ User needs to click "Login" button to enter the email and new password that were given by system before starting the learning sessions.</td><td colspan="2">Successfully message will be displayed
User email
“Login” button
Email and password textbox</td></tr>
</table>

Table 3.14

Use Case Description of LearnJava for Test.

Use Case Name :- Test	**Use Case ID: -** LearnJava_UC_04	**Importance Level :-** High
Primary Actor :- Student		**Type :-** External
Short Description :- The description on how the user can start the test through LearnJava learning system		
Trigger :- The user needs to click on the LearnJava button in the main page of the system.		

Major Steps Performed :-	**Information for Steps :-**
1. User should click the "Test" button in the main page.	"Test" button
2. System will display the information regarding test requirement.	Test Information will be displayed
3. Student needs to click the "Start the Tutorial Now!!" to start the learning session.	"Start the Tutorial Now!!" button
4. Student should answer the questions that are given in the learning session.	Question will be displayed
5. If student does not know the answer for the questions, student needs to click "Click here if you do not know the answer" button. ➢ System will display the notes related to the questions. ➢ Student needs to click "Next" button to review more. ➢ If student knows the answer for the particular question, he/she needs to click the "Click here if you want to continue this test". Then, the system will display the question that must to be answered.	"anxiety" button Notes will be displayed "Next" button "boredom" button

6. If student knows the answer for this question, student needs to select the answer in the checkbox.	Select the checkbox
7. Student needs to click the "Next Question" button to answer the next question. ➢ Student needs to repeat step 4 and step 6 until all questions are answered in every stage. ➢ Student needs to repeat step 5 if necessary.	“Next Question” button
8. If student does not select the answer on the checkbox, but he/she clicks the "Next Question" button, system will display the message "Please select an answer first".	Error message will be displayed
9. Student needs to click the "Check My Answer" button to check whether the answer for the particular question is correct.	“Check My Answer” button
10. After student answered all the 5 questions in stage 1, 5 questions in stage 2, and 5 questions in stage 3, student needs to answer the "Learning Experience Questionnaire" at the end of every stage. ➢ If all the questions were answered completely, student needs to click "End of Test Session" button. ➢ If some of the questions were not answered, system will display the message "Please answer all the questions" as reminder for student to answer the whole questionnaire.	Answer “Learning Experience Questionnaire” in 3 stages “End of Test Session” button Error message will be displayed
11. System will display the results for the test. ➢ Student needs to click "Next" button".	Result will be displayed “Next” button
12. Student needs to complete the demographic questions. ➢ User needs to click "End of Session" button. ➢ If some of the demographic questions were not	Answer Demographic Information. “End of Session” button Error message will be

answered, the system will display the message "Please complete all the information".	displayed
13. Student needs to complete "Progressive Learning Experience". ➢ Student needs to click "Submit" button. ➢ System will display the message "Thank You. The system will be redirected to homepage". ➢ If some of the questions were not answered, the system will display the message "Please answer all the questions".	Answer "Progressive Learning Experience" "Submit" button Successful message will be displayed Error message will be displayed

Table 3.15

Use Case Description of LearnJava for Notes.

<table>
<tr><td>Use Case Name :-
Notes</td><td>Use Case ID: -
LearnJava_UC_05</td><td colspan="2">Importance Level :-
High</td></tr>
<tr><td colspan="3">Primary Actor :- Student</td><td>Type :- External</td></tr>
<tr><td colspan="4">Short Description :-
The description on how the user can view notes through LearnJava learning system</td></tr>
<tr><td colspan="4">Trigger :-
The student needs to click on the LearnJava button in the main page of the system.</td></tr>
<tr><td colspan="2">Major Steps Performed :-</td><td colspan="2">Information for Steps :-</td></tr>
<tr><td colspan="2">1. Student needs to click the "Notes" button in the main page.</td><td colspan="2">"Notes" button</td></tr>
<tr><td colspan="2">2. System will display the overview related to the notes session.</td><td colspan="2"></td></tr>
<tr><td colspan="2">3. Student needs to click the option URL for each the relevant subtopics.</td><td colspan="2">Option URL</td></tr>
<tr><td colspan="2">4. System will display notes.</td><td colspan="2">Notes page will displayed</td></tr>
</table>

5. Student needs to click the "Next" button to review more notes.	“Next” button
6. Student needs to click "Home" button to return back to main page.	“Home” button

Table 3.16

Use Case Description of LearnJava for Result.

<table>
<tr><td>Use Case Name :-
Result</td><td>Use Case ID: -
LearnJava_UC_06</td><td colspan="2">Importance Level :-
High</td></tr>
<tr><td colspan="3">Primary Actor :- Student</td><td>Type :- External</td></tr>
<tr><td colspan="4">Short Description :-
The description on how the user can view their result through LearnJava learning system</td></tr>
<tr><td colspan="4">Trigger :-
The student needs to click on the LearnJava button in the main page of the sistem.</td></tr>
<tr><td colspan="2">Major Steps Performed :-</td><td colspan="2">Information for Steps :-</td></tr>
<tr><td colspan="2">1. Student needs to click the "Result" button in the main page.</td><td colspan="2">“Result” button</td></tr>
<tr><td colspan="2">2. System will display the history of the tutorials result (time and date).</td><td colspan="2">History of the tutorial result page will be displayed</td></tr>
<tr><td colspan="2">3. Student needs to click the "Next" button.</td><td colspan="2">“Next” button</td></tr>
<tr><td colspan="2">4. System will display the results of the learning session.</td><td colspan="2">Result page will be displayed</td></tr>
<tr><td colspan="2">5. Student needs to click "Home" button to return back to main page.</td><td colspan="2">“Home” button</td></tr>
</table>

Table 3.17

Use Case Description of LearnJava for Participants.

Use Case Name :- Participants	Use Case ID: - LearnJava_UC_07	Importance Level :- High
Primary Actor :- Admin		**Type :-** External
Short Description :- The description on how the user can view participants information through LearnJava learning system		
Trigger :- The user needs to click on the LearnJava button in the main page of the system. (Only for administrator usage)		

Major Steps Performed :-	**Information for Steps :-**
1. Administrator needs to click the "Participants" button in the main page.	“Participants” button
2. System will display a list of users who have used the LearnJava learning system.	
3. Administrator needs to click the hyperlink (based on user's name) to find the specific learning information for the user.	Option hyperlink
4. Administrator needs to click the "Back" button to return back into the entire list of users.	“Back” button
5. Administrator needs to repeat step 3 and step 4 if necessary.	
6. Administrator needs to click "Home" button to return back to main page.	“Home” button

Table 3.18

Use Case Description of LearnJava for Change Password.

Use Case Name :- Change Password	**Use Case ID: -** LearnJava_UC_08		**Importance Level :-** High
Primary Actor :- Student / Admin			**Type :-** External
Short Description :- The description on how the user can change their current password through LearnJava learning system			
Trigger :- The user needs to click on the LearnJava button in the main page of the system.			
Major Steps Performed :-		**Information for Steps :-**	
1. User needs to click the "Change Password" button in the main page.		"Change Password" button	
2. User needs to enter their current password, new password, and reentered new password.		Fill up information in textbox	
3. User needs to click the "Submit" button.		"Submit" button	
4. System will display confirmation about users' new password.		New Password confirmation will be displayed	
5. System will send the confirmation information into the users' email. User needs to check their email.		Confirmation Information will be send to users' email	
6. User needs to click "Home" button to return back to main page.		"Home" button	

Table 3.19

Use Case Description of LearnJava for Logout.

Use Case Name :- Logout	**Use Case ID: -** LearnJava_UC_09	**Importance Level :-** High
Primary Actor :- Student / Admin		**Type :-** External
Short Description :- The description on how the user can logout through LearnJava learning system		
Trigger :- The user needs to click on the LearnJava button in the main page of the system.		
Major Steps Performed :-	**Information for Steps :-**	
1. User needs to click the "Logout" button in the main page. System will be displayed the main page of LearnJava learning system.	“Logout” button	

An activity diagram is further implemented and explained as an extension to the use case diagram. The activity diagrams as illustrated in Figure 3.5, Figure 3.6, and Figure 3.7 further explain the flow of the system and how LearnJava works. These activity diagrams present the entire flow of each requirement.

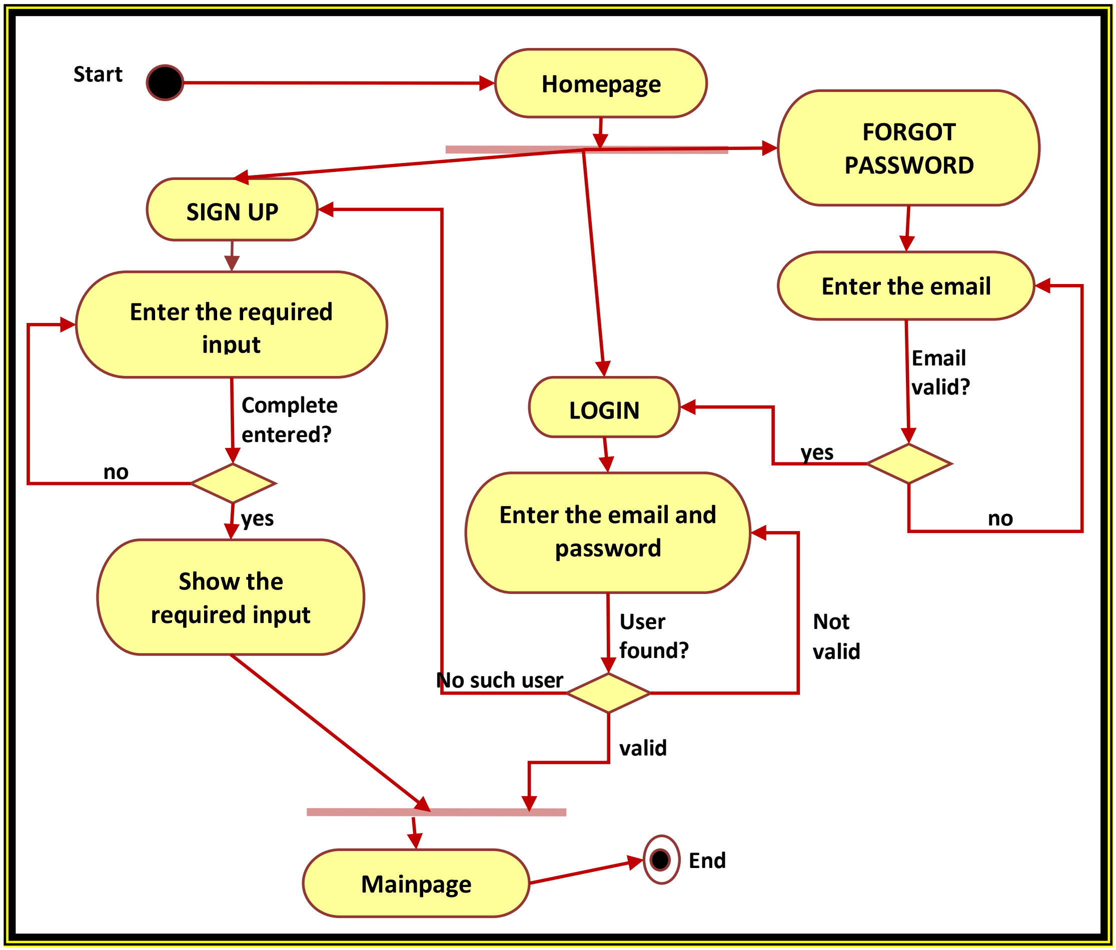

Figure 3.5. Activity Diagram for Login, Sign Up, and Forgot Password.

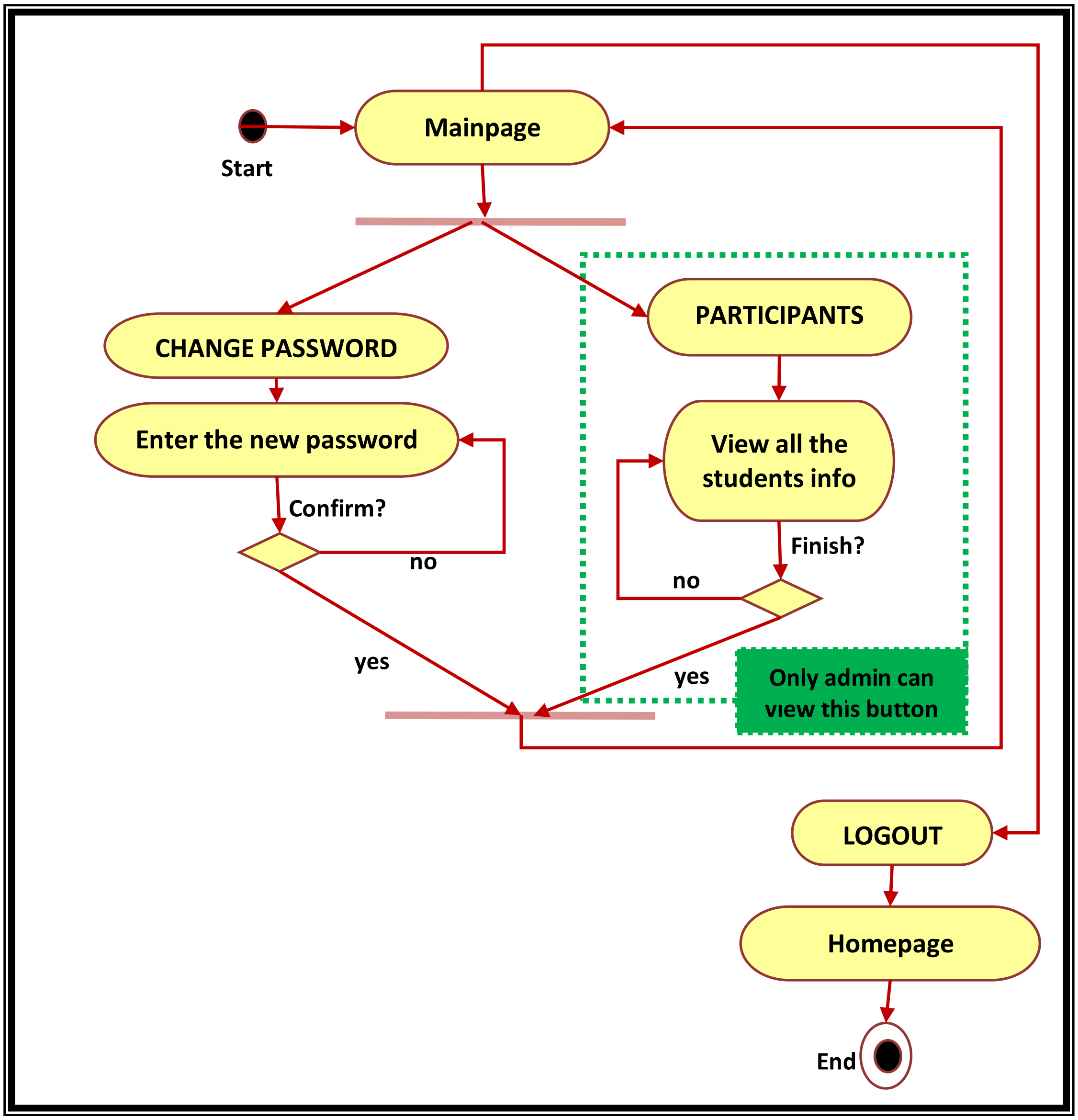

Figure 3.6. Activity Diagram for Change Password, Participants, and Logout.

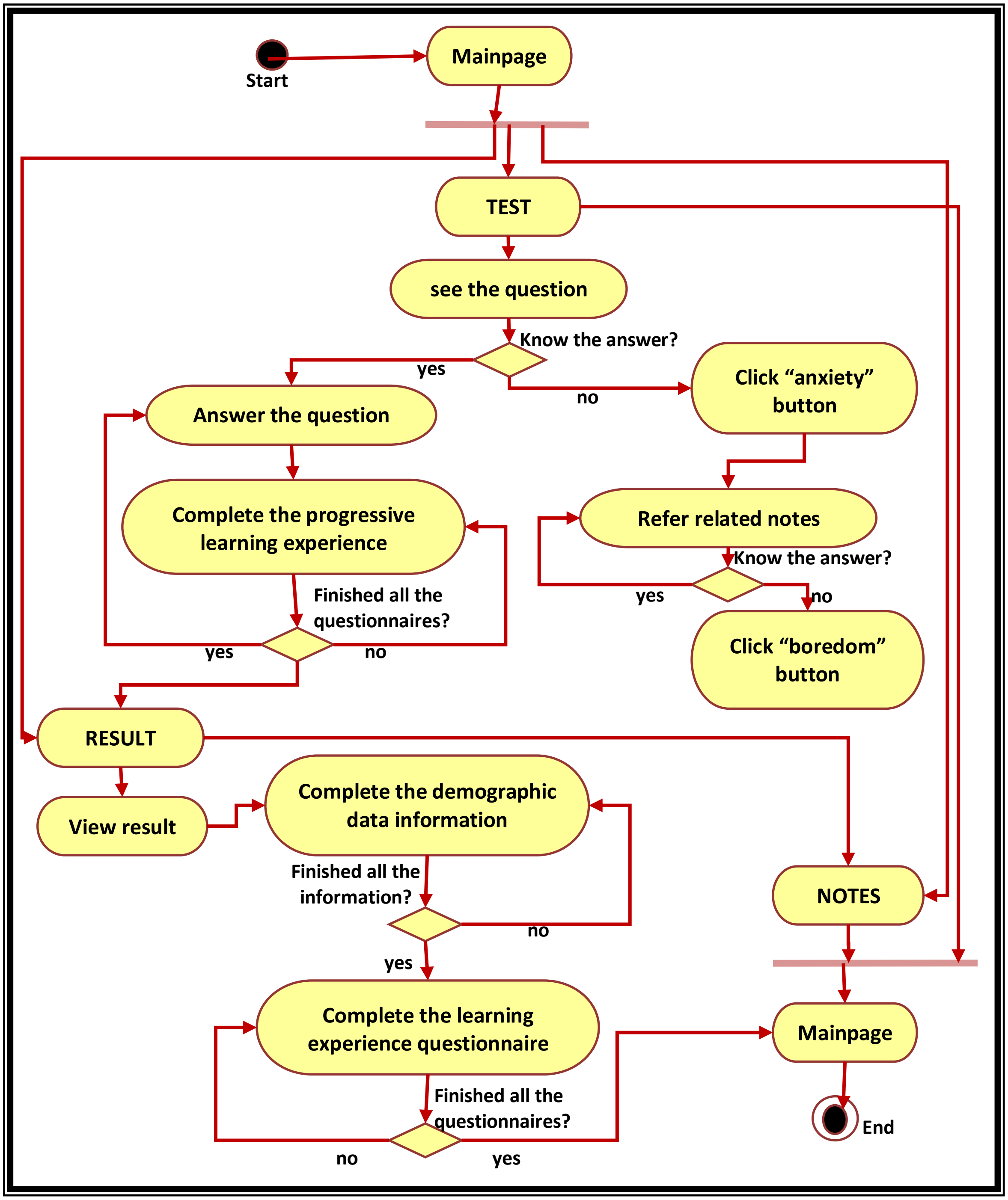

Figure 3.7. Activity Diagram for Test, Notes, and Result.

Table 3.20 lists in detail of the tool specifications used in this study.

Table 3.20

Tool used.

Module :-	Learning basic Java programming
Programming language :-	PHP
Database :-	MySQL and APACHE
Web development tool :-	Macromedia Dreamweaver
Operating system :-	Window 7
Server :-	JOMHosting.net
Other Software Used:-	1. Rational Rose Enterprise Edition 2000 2. IBM SPSS Statistics 20

3.3.2.2. System Analysis and Development

LearnJava is a web-based learning system designed for learning basic JAVA programming. It can be used as a complement to classroom lectures or for formal and technical learning courses in online environment. This system aims to teach students with programming knowledge as well as to investigate the level of knowledge a student has throughout the learning process.

LearnJava is a WBCS that is embedded with flow theory. The system provides dynamic sequence of learning materials based on a student's parameter that is prior knowledge. The aim of the system is to promote engagement. Student engagement while interacting with WBL system as suggested by flow theory is another important part of the research. A technique known as SCB was adopted in the system, in which flow theory was its' fundamental.

3.3.2.2.1. The Architecture and Components of LearnJava

The LearnJava architecture consists of three major components, namely: (1) Database, (2) User interface, and (3) Sequencing engine. The details information regarding each of the components is as below:-

1. Database

The database was developed to store the relevant information about LearnJava particularly on students' in the learning process; goals, student background knowledge, personal characteristics, historical behavior, etc. Besides, it also contains all characteristics of the knowledge to teach. The hierarchical structure of topics is used for the domain knowledge, where each topic is divided in other topics and tasks (sets of definitions, examples, problems, exercises, etc.) in several formats (image, text, etc.). The database consists of 13 tables, namely (1) demographic, (2) expquestion, (3) historytest, (4) note_tutorial, (5) question, (6) question_answers, (7) question_choices, (8) question_note, (9) question_table, (10) researcher, (11) studentinfo, (12) the survey, and (13) user_questionanswer.

2. User Interface

The user interface is the main component that allows the connection between the LearnJava and the student. This component applies intelligent and adaptive techniques in order to adapt the content and the navigation to the students, learning on the learning materials, that chooses which would be the next task to be shown to the student and in which format the knowledge is going to be learnt. A user interface provides a simple platform to use and easy to understand. The examples of LearnJava user interfaces are shown in Figure 3.18. The whole systems of LearnJava can be accessed through the URLs http://scb.dsprojects.net/. The best browser to run the system is Mozilla Firefox. Refer to Appendix E to view more about LearnJava user interfaces.

The differences in LearnJava system that may not be available in other WBL systems is the "flow button". These buttons consist of two types, namely "anxiety" button and "boredom" button. The "anxiety" button coexists with tutorial questions, and "boredom" button appear along the reference notes. Figure 3.8 shows both of "flow buttons" that will exist throughout the learning process with SCB technique.

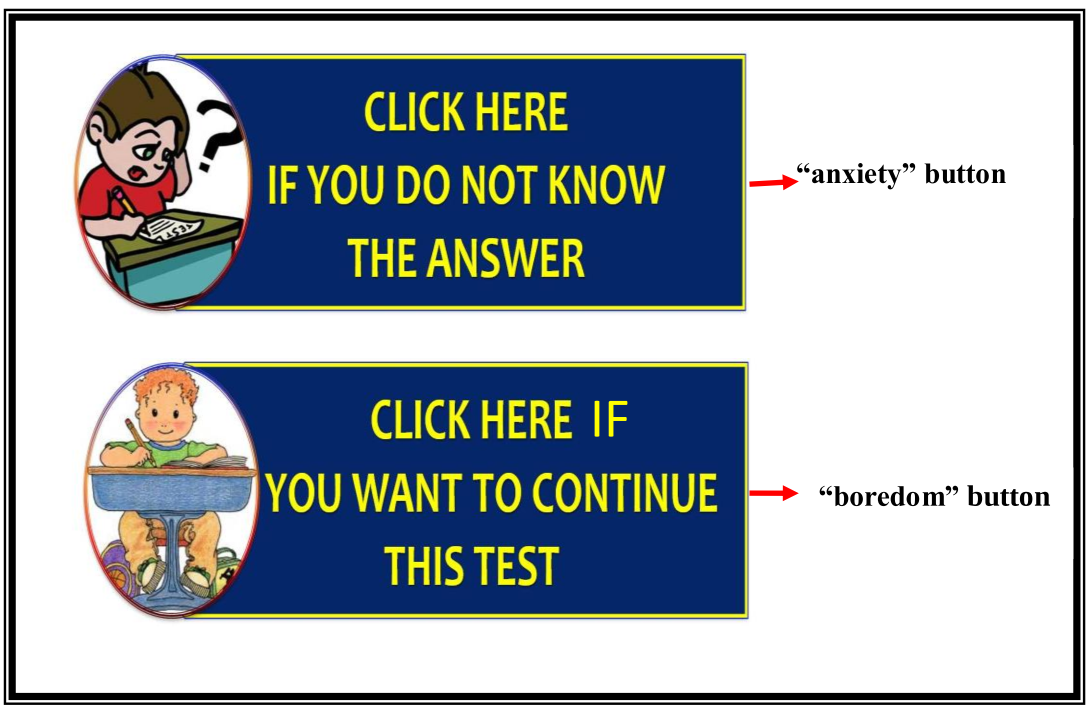

Figure 3.8. The “anxiety” button and “boredom” button.

The "flow buttons" allow students to make their own assessment on their level of skills and knowledge in WBL sessions. In LearnJava, students can evaluate whether a particular topic is too easy or too difficult. If students find that the learning module is too easy, they can choose to move forward to a higher level of difficulty in the learning module. On the other hand, if students find that the learning module is too difficult, they need to click the "anxiety" button. The button will redirect them to the related notes so that they can find the right answer. After the correct answer was found, the student should click on the "boredom" button to return back to the question and answer it. The process of SCB technique is shown in Figure 3.9.

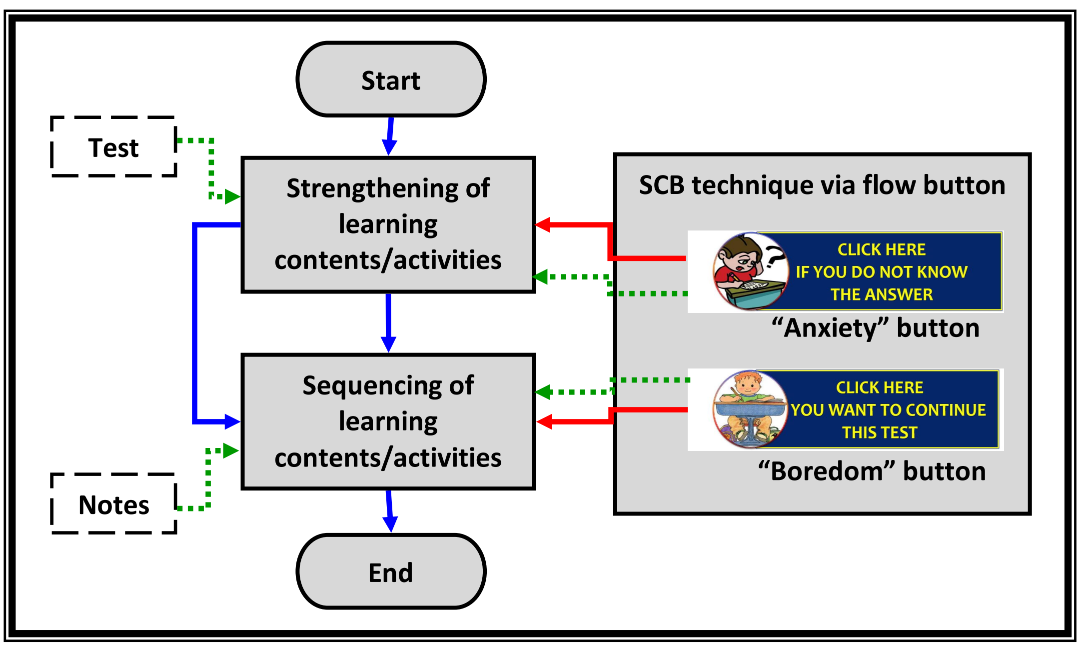

Figure 3.9. The process of SCB technique.

The interaction of "flow buttons" was controlled by a sequencing engine that organizes the learning materials (i.e., the explanation of the theories, concepts, examples, teaching materials, etc). The "flow buttons" helps students to engage in the learning session through adjustment of the learning content based on their current level of skills.

The researcher also outlined some of the rational reason to put the "flow buttons" in different parts of the learning session. Among other things, when a student found that the test questions are too difficult, and students are unsure the answer, the "anxiety" button will help students to browse learning notes related to that question. Students will recall learning modules that have been learned in the past through this learning process. Indirectly, students are able to learn the concepts and explanations related to the module. When students are confident to find the answers, the students will click on the "boredom" button to return back to that question. Students will move forward to the next question with a higher level of complexity.

The core concept of "flow buttons" in LearnJava system was to avoid boredom and anxiety through the learning process. It will maximize student engagement during the learning process.

3. Sequencing engine

It contains a set of rules to perform WBCS functions. It controls the overall communication throughout of the learning process. When the learning materials have been compiled, it will be delivered to students through the user interface. Figure 3.10 shows the flow process in LearnJava with SCB.

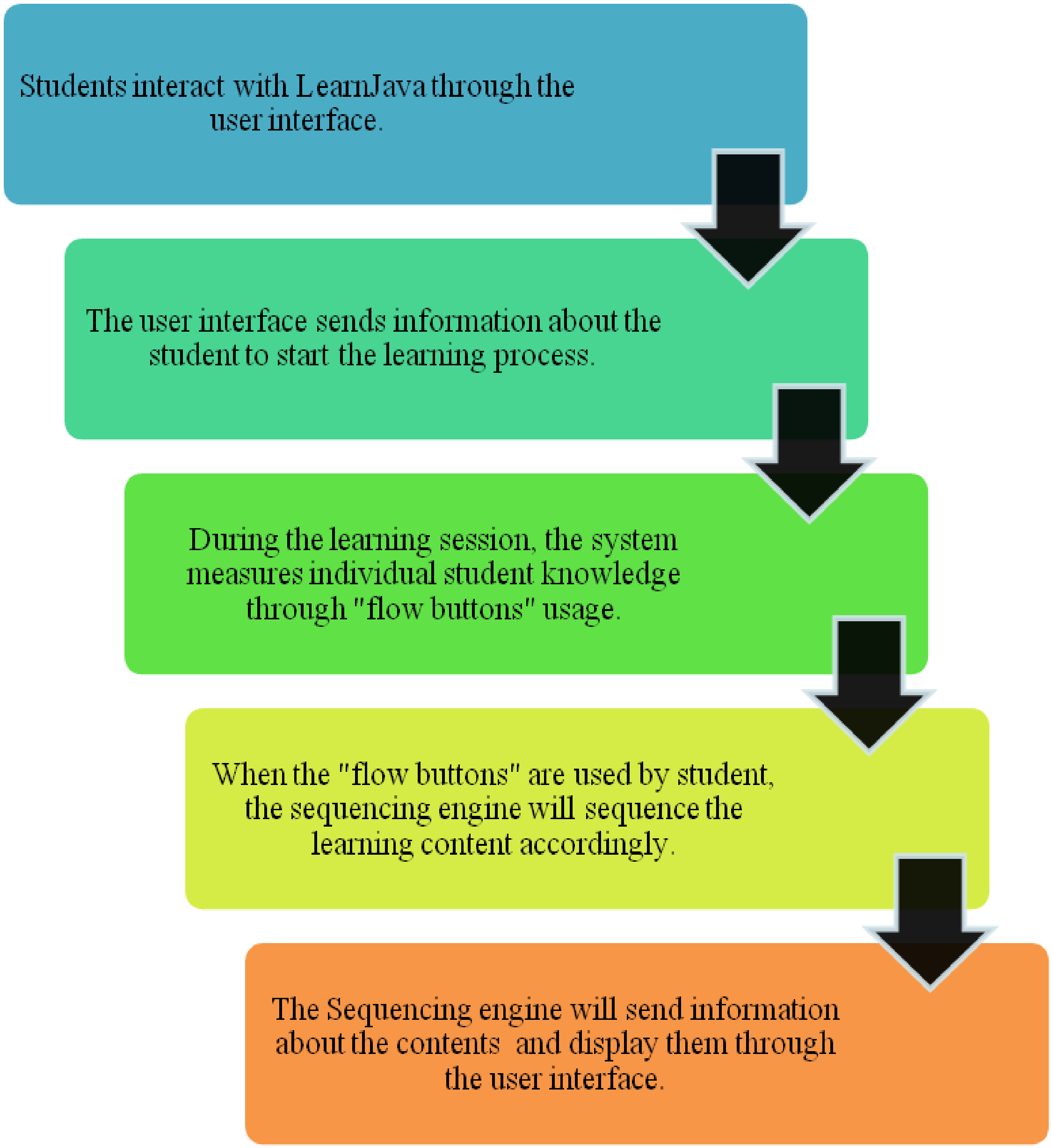

Figure 3.10. The flow of process in LearnJava with SCB.

Refer to Figure 3.13, for the complete rules to deliver sequence of instructions in LearnJava.

3.3.2.2.2. LearnJava: User and WBCS Interactions

As mentioned earlier, LearnJava is a WBCS system that aims to evaluate student engagement during learning process.

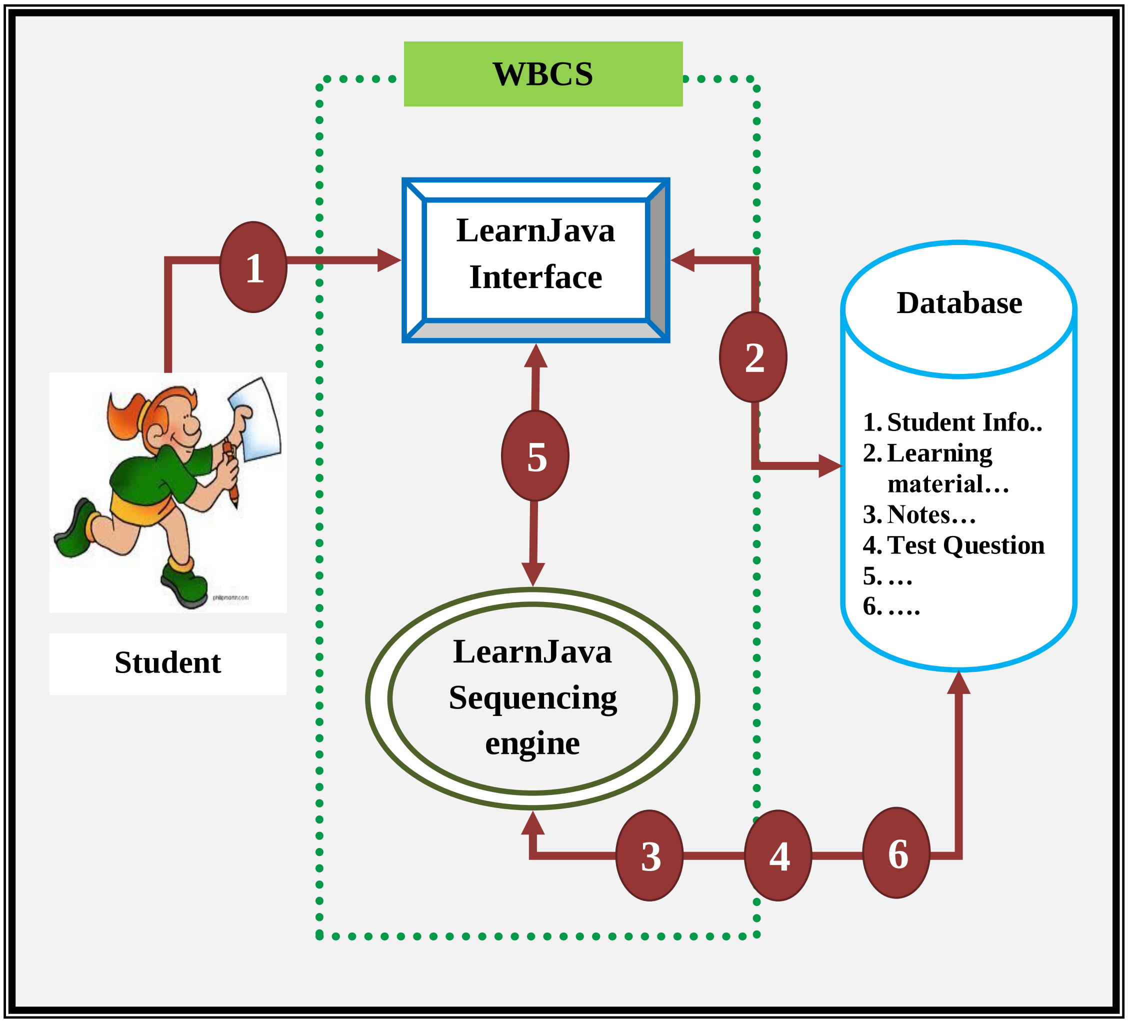

Figure 3.11. The architecture of LearnJava.

Figure 3.11 shows the architecture of LearnJava and its learning process. The description about the diagram is as follow:-.

Process 1 : A student starts a learning session with LearnJava through the user interface.

Process 2 : The LearnJava user interface interacts with database (i.e., student table), either to keep the data or to record the data.

Process 3 : The database (i.e.,: student table) passes the data about the student to sequencing engine.

Process 4 : The sequencing engine checks up the learning materials that linked to the test questions.

Process 5 : The learning materials will be displayed to the student through the LearnJava user interface.

Process 6 : All the student information and their learning interactions will be updated in the database.

Process 3, 4, 5, and 6 will occur repeatedly when the student uses the anxiety's button and the boredom's button during the learning process.

3.3.2.2.3. The Implantation of SCB in LearnJava

The SCB technique has been implemented in the user interface components through "flow buttons". It is a combination between the LearnJava user interfaces and the sequencing engine. The functions of both "flow buttons" are as follow:-

1. The anxiety’s button

The anxiety's button appears together with the test questions. If students do not know or maybe not sure the answers for a test question, the students have to click this button. Next, the students will be directed to the learning content related to the question. This situation is expected to help students to stay away from anxiety and keep them in flow. Overall, the anxiety’s button is for students with low skill and knowledge.

2. The boredom’s button

The boredom's button appears together with the learning contents. If students feel that the learning content is too easy for them, then the students have to click this button. Next, the students have to proceed to the test questions until finished. This situation is expected to help the students to stay away from boredom then keeping students stay in flow. Overall, the boredom's button is for students with high skill and knowledge.

During the learning session, the skills and knowledge of students will be measured by the system. The detailed information about learning process will be known after completion of all sessions. The "flow buttons" usage will be calculated to show the students' engagement.

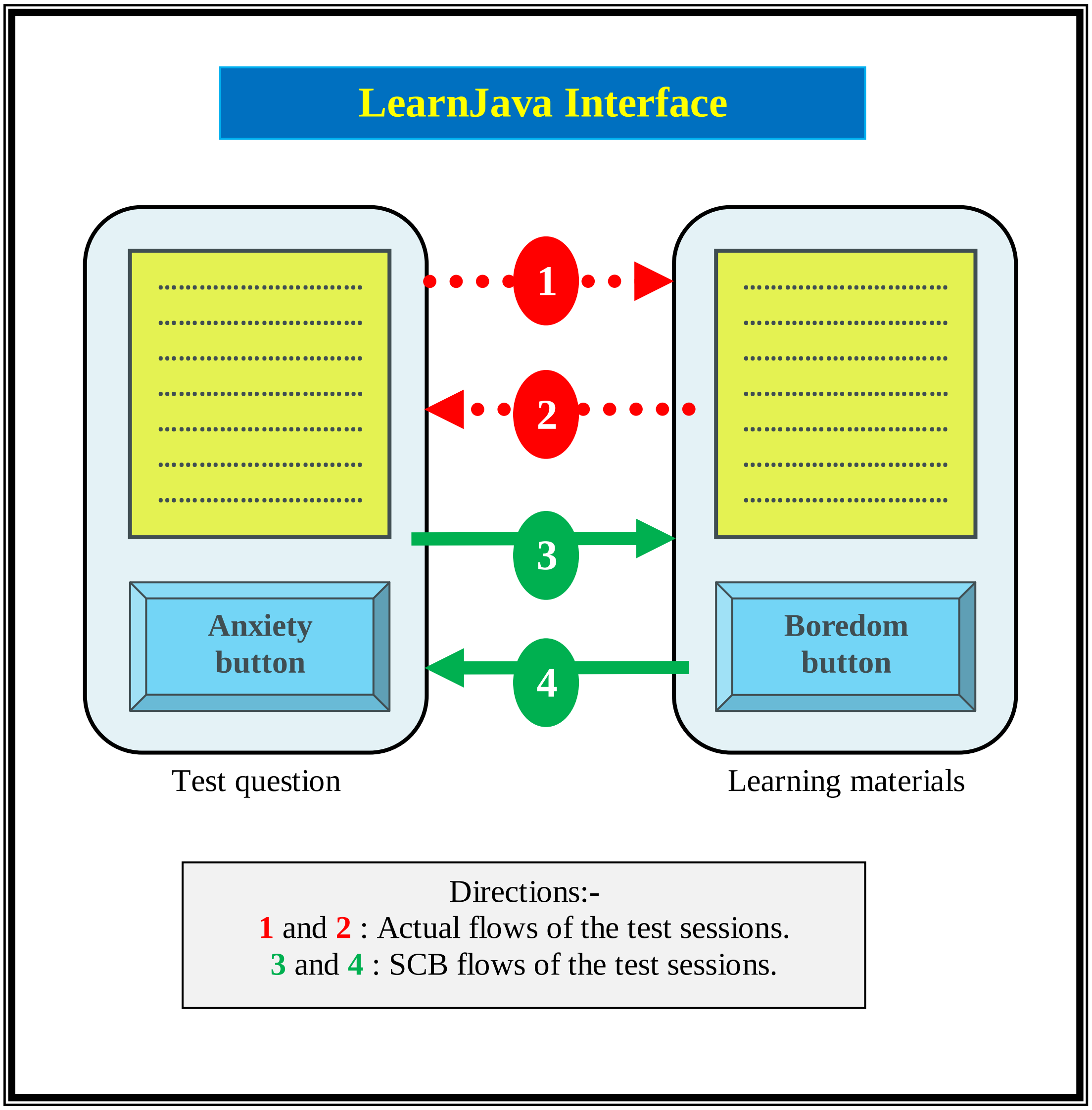

Figure 3.12. The learning process using LearnJava.

Figure 3.12 shows the overview of the learning process using LearnJava. The bold dotted arrows (colour: red) stand for the actual flow of the WBL sessions. However, the bold straight arrows (colour: green) stand for the new flow, especially when the "flow buttons" (i.e., the anxiety 's button and the boredom 's buttons) are created in the LearnJava user interfaces.

3.3.2.2.4. Transforming the Design into Rules

The rules and algorithm for LearnJava system were linked to the "flow buttons" (i.e., the anxiety's button and the boredom's button). An algorithm combined the interaction between WBCS and SCB technique has been programmed, as shown in Figure 3.13. It will occur repeatedly through the "flow buttons".

Show the <test questions>
If <the anxiety's button> is entered then
show the relevant learning materials
If <the boredom's button > is entered then
test <students' knowledge>
If <student's knowledge> is <not enough> then
give responses to students
Show the sequence of learning materials
test <students' knowledge>
If <students' knowledge> is <enough> then
give responses to students
Continue to the next stage of <test questions>
test <students' knowledge>
……………………………………………………..…
……………………………………………………..…
……………………………………………………..…
……………………………………………………..…
……………………………………………………..…

Figure 3.13. The rules and algorithm for LearnJava.

3.3.2.2.5. LearnJava Development and Deployment

The LearnJava's system was developed to show how the SCB technique would be performed. It was developed using Macromedia Dreamweaver as the web development tool, PHP as the programming language, MySQL and APACHE as the database management system, and JOMHosting.NET as the server.

The "flow buttons" were created to avoid confusion among the students. The buttons' implementation was simplified to make students understand the flow of the system. The words printed on the buttons gave the clear meaning and easy to understand. The buttons are marked as: (1) "Click here if you do not know the answer" to represent the situation of "anxiety", and (2) "Click here if you want to continue this test" to represent the situation of "boredom". Overall, the students will go through two different situations when one of the two buttons is pressed. The bold red line in Figure 3.14 and Figure 3.15 displays the "anxiety" button and the "boredom" button screenshots.

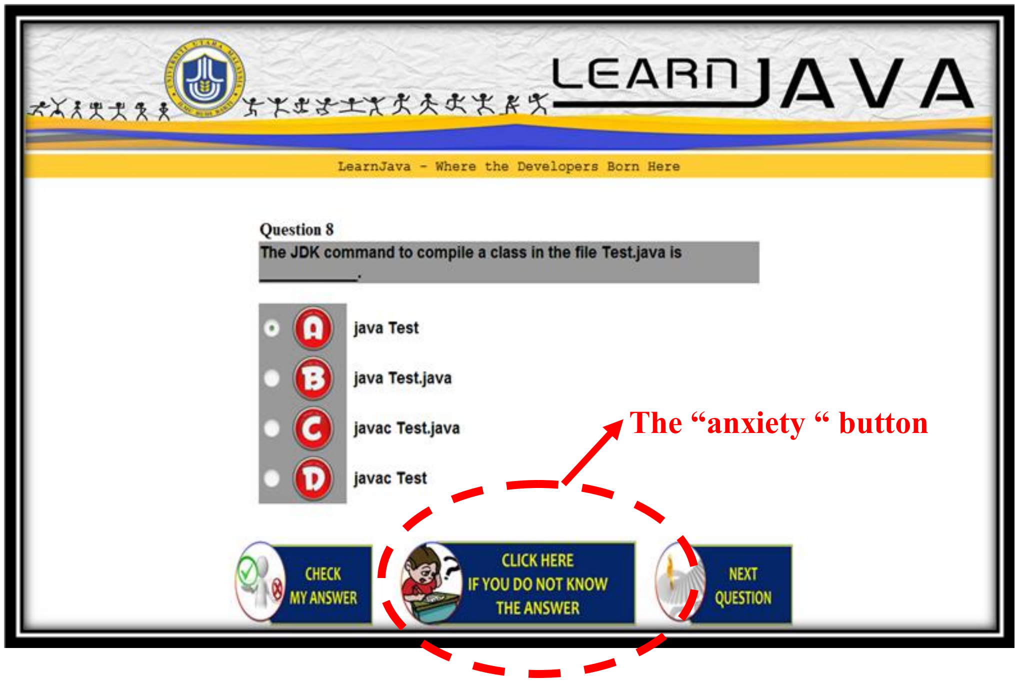

Figure 3.14. Example of screenshot for "anxiety" button.

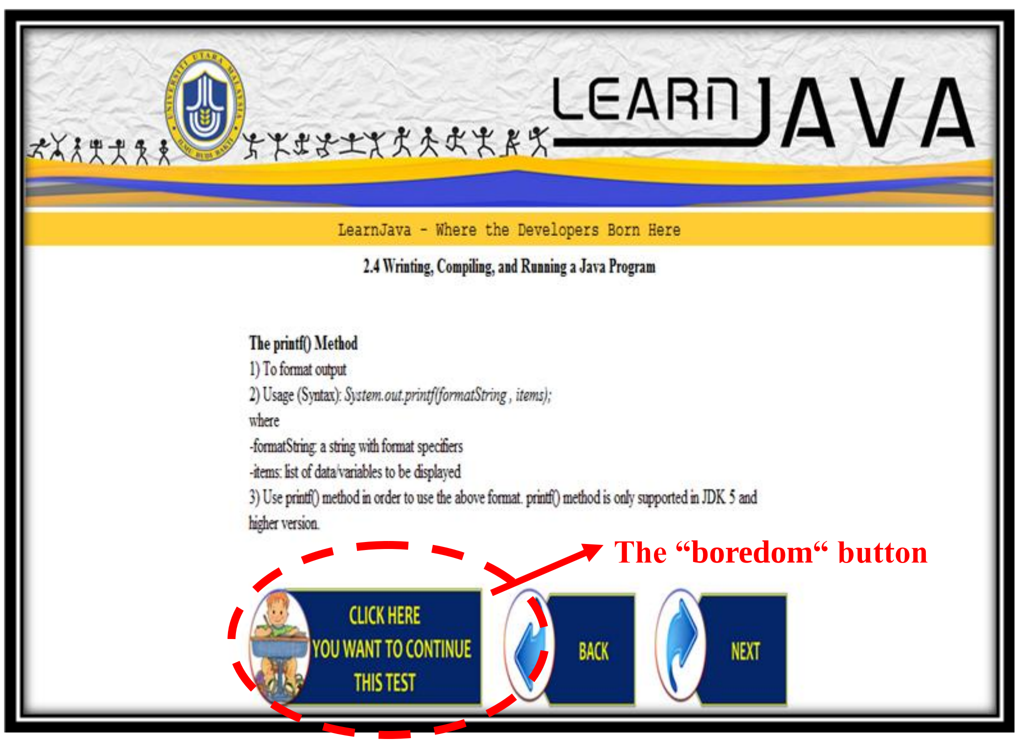

Figure 3.15. Example of screenshot for "boredom" button.

3.3.2.2.6. LearnJava Programming Code

Figure 3.16 shows the examples of code snippets for the main function of LearnJava system. This code was written in Hypertext Preprocessor (PHP). Appendix D describes more examples of code snippets that were used for system development.

```php
<?php ob_start(); ?>
<?php require_once('Connections/learnJavaConnection.php'); ?>
<?php include "config.php" ?>
<?php
mysql_select_db($database_learnJavaConnection, $learnJavaConnection);

$mx = $_SESSION['MM_matricno'];

if($_GET['q']){
    $que = $_GET['q'];
    $query = "SELECT * FROM question WHERE question_id = '$que' ";
    $raw = mysql_query($query)  or die (mysql_error());
    $result = mysql_fetch_array($raw );
    $question = $result['question'];
}else{
    $que = 1;
    $query = "SELECT * FROM question WHERE question_id = '$que' ";
    $raw = mysql_query($query)  or die (mysql_error());
    $result = mysql_fetch_array($raw);
    $question = $result['question'];
}

if($que == 1)
  $_SESSION['MM_start'] = date("Y-m-d H:i:s");
$query = "SELECT * FROM question_table WHERE question_id = '$que' ";
$raw = mysql_query($query)  or die (mysql_error());

$quenext = $que + 1;

if($_GET['bor'] == '1'
  $sql = "INSERT resea
        VALUES ('$mx',
  $row = mysql_query($
}
?>
```

```php
<?php ob_start(); ?>
<?php require_once('Connections/learnJavaConnection.php'); ?>
<?php include "config.php" ?>
<?php
  mysql_select_db($database_learnJavaConnection, $learnJavaConnection);

  $mx = $_SESSION['MM_matricno'];

  $query = "SELECT name,lastlogindate FROM studentinfo WHERE matricno = '$mx' ";
  $raw = mysql_query($query)  or die (mysql_error());
  $result = mysql_fetch_array($raw );
  $name = $result['name'];
  $lastlogin = $result['lastlogindate'];
?>
```

Figure 3.16. Examples of code snippets in LearnJava system.

3.3.2.3. Usability Test

A usability test is a technique used to evaluate systems that have been developed. It has been conducted to evaluate the usability and reliability of LearnJava system. It aims to measure the suitability of the system to be used as a learning tool. Through it, the researcher will know problems in the LearnJava interface as a WBL system. Besides, it also to analyze the usability of LearnJava based on certain criteria as outlined by the WBL usability questionnaire.

3.3.2.3.1. Methods

A usability test was performed using two evaluation methods, namely: (1) heuristics, and (2) a formal evaluation. The purpose of the heuristic evaluation method was to find the problem in LearnJava interface, then to identify the suitability of the system development. The formal evaluation method was to analyze the usability of the system based on some specific criteria on usability testing questionnaires.

3.3.2.3.2. Participants

The usability assessment for LearnJava has been done not only by the experts in the development of a system, but ordinary individuals who know how to use computers. It is to identify any usability problems, collect quantitative data identifying the user performance (e.g.:- time on task and error rate), and determining user's satisfaction when they use the system. Next, the problems related to the design of the system were identified, and improvements were done before the system is used by primary users. To ensure that the system was successful, a usability test was conducted. This test involves two experts in usability evaluation, a web-based system instructor, and five students.

3.3.2.3.3. Instruments

The usability evaluators were given a usability evaluation form to record all the problems that arise on the system. In addition, their comments on the system were recorded. The usability evaluation form was confirmed through a number of studies. It was designed to test the usability for WBL system (Zaharias & Poylymenakou, 2009).

Refer to Appendix A: Materials for the Usability Evaluation for the usability evaluation form.

3.3.2.3.4. Procedure

All the usability evaluators were given a sheet that comprised: (1) guidelines to perform usability test, and (2) usability report. The evaluators performed the usability tests independently at their own convenience, within the allocated time. The evaluators were asked to navigate the LearnJava interfaces carefully. The usability problems were identified and recorded in the report. The evaluators were asked to answer a usability questionnaire for e-learning.

3.3.2.3.5. Result

The responses from the usability tests were analyzed. There were no major usability problems in system development. The evaluators' comments had been reviewed, and appropriate actions that relevant, had been taken for improvement.

3.3.3. Phase III : Evaluation

This section explains an experimental study to understand the student's engagement when they use LearnJava for learning Java programming. Therefore, two version of LearnJava system were used; they are LearnJava with SCB and LearnJava without SCB (i.e., non-SCB will be used in the rest of this report) to measure engagement among students. Both of the systems were different in terms of navigation style and control over the learning sequence. For this reason, the researcher predicts dissimilarity in the engagement levels that students could experience from the two different systems.

3.3.3.1. Evaluation of Student Engagement

Evaluation of student engagement in using the LearnJava with SCB and non-SCB is the major part of this phase. The respondents for this study were both undergraduate and postgraduate students who enrolled in IT programs at School of Computing, UUM. This study was conducted following within-subject design; an experimental design in which the participants were exposed to two situations namely treatment group (i.e., LearnJava with SCB) and control group (i.e., LearnJava without SCB). The purpose of the treatment and control group are comparing the effects between two groups. Basically, it is an experimental design for clinical tests. In some sense, this design of experiment is common in investigating the effects of certain technique or objects in pharmaceutical field (health science). However, it also can be used in computer behavioral study.

Both learning systems were divided into several sections in the learning process that students must undergo. At the end of each section, students will be asked about their level of engagement through their experiences using a set of questionnaires. Further, when the students completed all the learning tasks, they were given a long a version of questionnaire known as Learning Experience Questionnaire. It consisted of twelve questionnaires. Each question measured standard dimensions of engagement as adapted from Park, Parsons and Ryu (2010). The instrument was primarily developed by Webster, Trevino and Ryan (1993). It intended to measure the engagement during learning process.

Figure 3.17 shows the overall procedure for conducting the experiment.

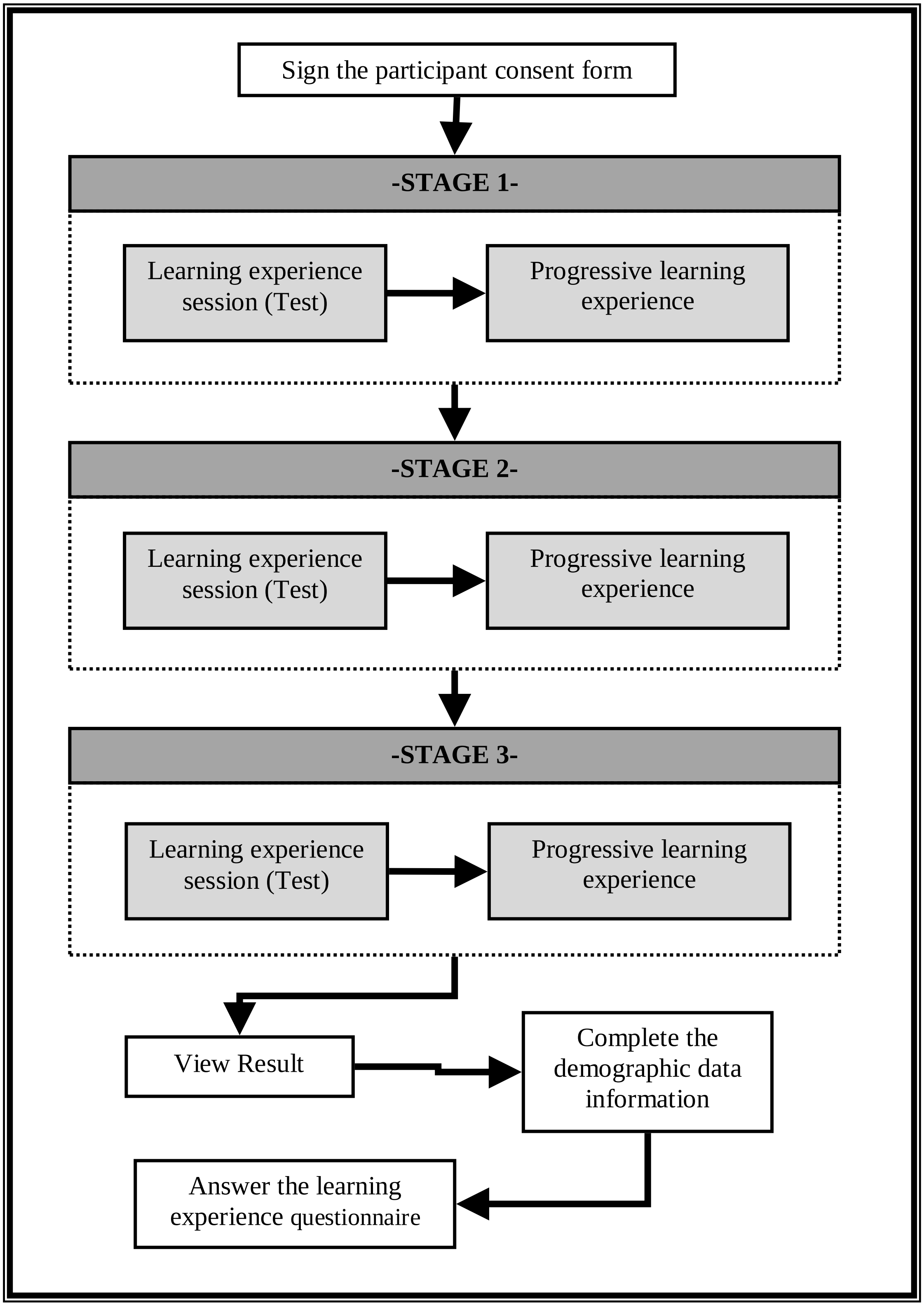

Figure 3.17. The procedure for conducting the experiment.

3.3.3.1.1. The Experiment

1. Participants

A total of 52 students from School of Computing, Universiti Utara Malaysia participated in this study. From this number, 25 students were male and 27 students were female. All students successfully completed all the tasks. These data were used for the analysis of LearnJava system usage, to assess the level of individual engagement in the domain studies. The students were required to use both systems, namely LearnJava with SCB and LearnJava without SCB. The students were invited through students' mailing list of the school. All of the students were contacted via email.

2. Apparatus

The apparatus used for this experiment consisted of three main components: - (1) two web-based learning system; namely the LearnJava with SCB and LearnJava without SCB, (2) a progressive learning experience questionnaire for three stages (1 stage = 4 questions), and (3) a set of learning experience questionnaire (12 questions).

The two types of the systems used in this study known as LearnJava with SCB technique, and LearnJava without SCB technique. It was hosted in a server and accessible via https://scb.dsprojects.net for learning system with SCB, and https://noscb.dsprojects.net for learning system without SCB. For the purpose of this experimental study, the content from chapter 1 and chapter 2 of the Java introductory programming were used. This is to manage the participants' time effectively and to ensure that the students will not withdraw from the study due to high workload. The effectiveness of SCB technique can be evaluated more systematic. Figure 3.18 shows an example of interface for both of the learning systems.

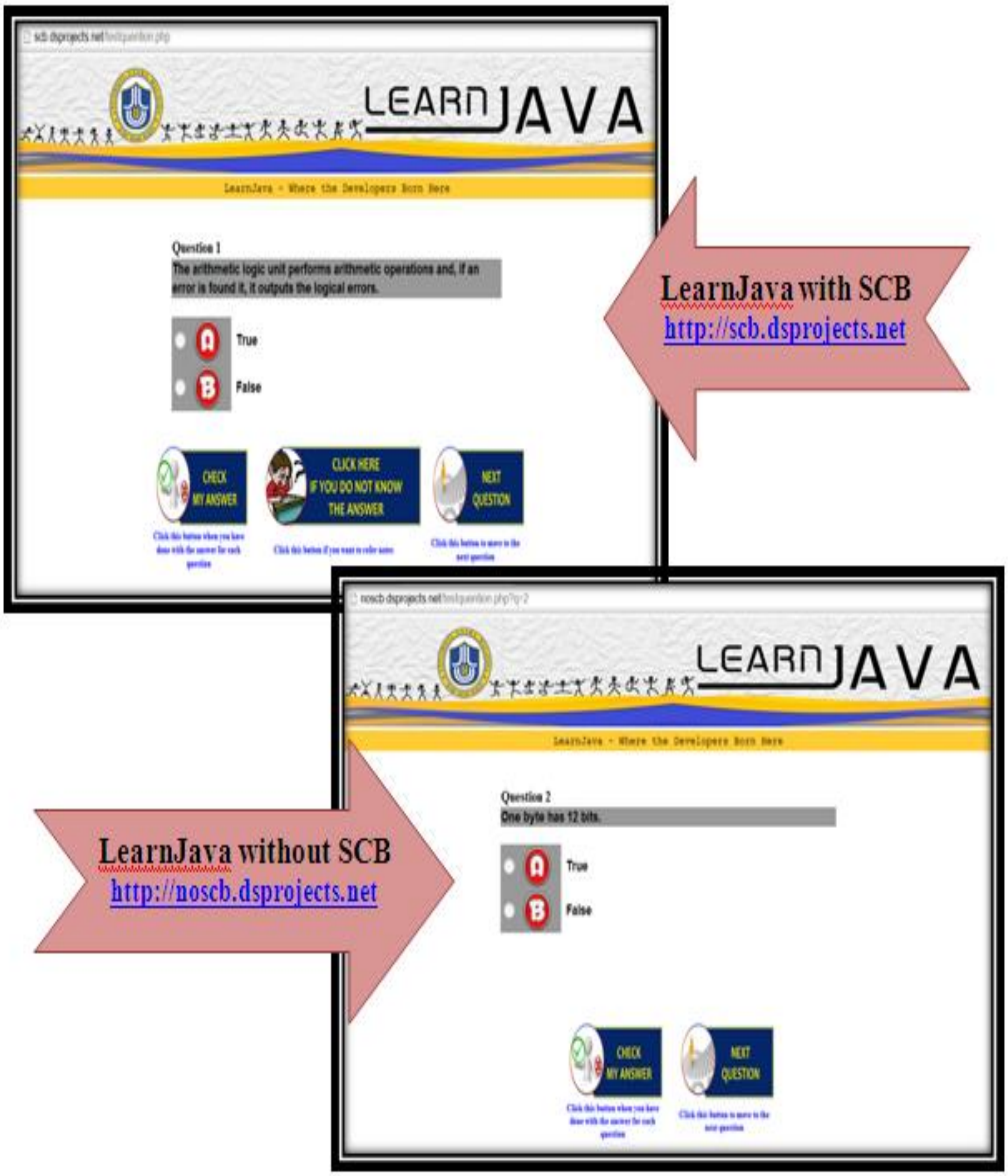

Figure 3.18. The interface for both LearnJava systems.

There are two sets of instruments that were used to review student engagement, namely as Progressive Learning Experience that consists of four questions that repeated in three stages, and a set of Learning Experience Questionnaire that consisted of twelve questions. All the questionnaires were grouped into four dimensions of engagement based on flow theory proposed by Csikzenmihalyi (1990). There are control, focus attention, curiosity, and intrinsic interests. It was used to measure students' engagement during the learning processes. As mentioned earlier, the questionnaire was adopted by Park, Parsons and Ryu (2010) that was initially designed by Webster, Trevino and Ryan (1993). It used a 5-points Likert-scale, 1= Strongly disagree and 5= strongly agree.

Table 3.21 and 3.22 show the questionnaires that were used during the experimental study and their corresponding dimensions.

Table 3.21

Progressive Learning Experience Information.

Progressive Learning Experience		
Dimensions of learning experience	**Questionnaire**	
Control	Q1	LearnJava allowed me to control the whole learning process.
Attention focus	Q2	When using LearnJava, I was totally absorbed in what I was doing.
Curiosity	Q3	Interacting with LearnJava made me curious.
Intrinsic interests	Q4	LearnJava was fun for me to use.

Table 3.22

Learning Experience Questionnaire Information.

Learning Experience Questionnaire		
Dimensions of learning experience	**Questionnaire**	
Control	Q1	When using LearnJava, I felt in control over everything.
	Q2	I felt that I had no control over my learning process with LearnJava.
	Q3	LearnJava allowed me to control the whole learning process.
Attention focus	Q4	When using LearnJava, I thought about other things.
	Q5	When using LearnJava, I was aware of distractions.
	Q6	When using LearnJava, I was totally absorbed in what I was doing.
Curiosity	Q7	Using LearnJava excited my curiosity.
	Q8	Interacting with LearnJava made me curious.
	Q9	Using LearnJava aroused my imagination.
Intrinsic interests	Q10	Using LearnJava bored me.
	Q11	Using LearnJava was intrinsically interesting.
	Q12	LearnJava was fun for me to use.

Control refers to the situation where a student feels in control of learning activities. In this situation, the student is able to control the interaction between themselves with LearnJava to remain focus in the learning track. In the context of WBL, the control is a critical component which influences the motivation, performance, and attitude toward learning. In fact, the study also revealed some examples on self control for any form of available activities during WBL process led to the better academic achievement (Kopcha & Sullivan, 2008).

Attention focus refers to a situation where a student is absorbed in WBL activities. It actually measures the level of attention given by the students during the learning process (Saadé & Bahri, 2005). This will generate a more positive attitude towards learning through exploration extensively in the education system. Indirectly, curiosity always exists for students to pursue learning process and achieve optimal engagement. In this study, the researcher attempts to understand the effectiveness of LearnJava system to attract students to go through the learning process.

Intrinsic interest refers to the situation where a student feels fun to go through the learning process. It implies that the learning medium attracted the interest of students to encourage them to explore the learning domain. The researchers in the WBL recognize that proper design of the system can helped stimulating of students' interest in learning (Krause & Coates, 2008).

3. Procedure

As mentioned before, the participants who had taken part during this study consists of 26 students in Bachelor of Information and Technology with Honors, and 26 students in Master of Science Information Technology. The experiments were performed separately for both programs of study. The participants will go through two learning processes (i.e., LearnJava with SCB, and LearnJava without SCB). The learning process conducted in online mode. The participants were given forty-five minutes for each of the learning sessions.

Each student was given with an information sheet about the research explaining how the experiment will be conducted. Next, the students signed a consent form before participating in this study.

The next step, the students learn at their own pace. After finished answering the first five questions, the students should answer the progressive learning experience that consists of 4 questions. Indirectly, the students have completed the first stage of the experiment. Students went through three stages of learning consisting of 15 questions and 4 questionnaires for each stage.

After completion of all the tasks, the students can view their result for their learning session. Next, the students should complete the student demographic data followed by a set of learning experience questionnaire for twelve questions.

3.3.3.2. Validation

The raw data obtained from the study were stored in the database. A data screening procedure was performed to ensure the precision and the reliability of the data. The process of data analysis was performed using IBM SPSS Statistics 20.

Among the tests were reliability test (i.e., Cronbach's alpha coefficient) and Wilcoxon Sign Rank Test. During the data analysis process, all the tests for this research were carried out using non parametric data tests. The non parametric data tests performed to calculate the mean and the mean ranks to assess the differences between two samples instead of the means and standard deviations (Sheskin, 2007) for small sample size. Appendix F shows the raw data of this research.

3.4 Summary of Chapter 3

This chapter discusses the development of WBL system called LearnJava covering its' components, architecture, and how the system works. LearnJava was developed by embedding SCB (Katuk, 2012). The usability test was carried out by individuals who have experienced in information technology and web development system. The evaluation suggested that LearnJava can be used as a learning tool for basic programming. Evaluation on students' engagement when they use LearnJava was conducted on 52 respondents. It aims to test the effectiveness of this system in achieving engagement throughout WBCS learning process. The results of this evaluation are explained in the next chapter.

CHAPTER FOUR

RESULTS AND FINDING

4.1 Overview of Chapter 4

This chapter presents the findings obtained from the experimental study. The findings were analyzed using statistical package IBM SPSS Statistics 20. The data are presented in tables, diagrams, charts and descriptions.

4.2 Pre-processing Data

The researcher used non-parametric statistical tests because the number of samples (respondents) was small. The non-parametric statistical tests were performed to identify student engagement level when they use two types of WBCS; (1) SCB and (2) non-SCB.

4.3 Student Demographic Data

Table 4.1 shows the participants' demographic information in a form of descriptive analysis. A total of 52 students who enrolled in Information Technology programs at SOC, UUM were participated in the experiment study. From this total, twenty six of students were undergraduate (14 males and 12 females) and the others were postgraduate students (11 males and 15 females).

Table 4.1

Student Demographic Information.

Demographic data information		Postgraduate student		Undergraduate student	
		Total	%	Total	%
Gender	Male	11	42.3	14	53.8
	Female	15	57.7	12	46.2
Age	17-20	-	-	25	96.2
	21-25	7	26.9	1	3.8
	26-30	17	65.4	-	-
	31-35	2	7.7	-	-
	>40	-	-	-	-
Year of study	First year	13	50.0	26	100
	Second year	10	38.5	-	-
	Third year	3	11.5	-	-
	Final year	-	-	-	-
English	First language	5	19.2	-	-
	Second language	21	80.8	26	100
Computer experience	Less than a year	-	-	-	-
	2 to 3 years	-	-	-	-
	More than 3 years	26	100	26	100
	Never used the computer	-	-	-	-
E-learning experience	Yes	26	100	26	100
	No	-	-	-	-
	Not sure	-	-	-	-
Working experience	Less than a year	3	11.5	-	-
	2 to 3 years	1	3.8	-	-
	More than 3 years	13	50.0	-	-
	Do not have any experience	9	34.6	26	100

There were 7 students aged between 21 to 25 years old, 17 students aged between 26 to 30 years old, and 2 students aged between 31 to 35 years old for the postgraduate students. For undergraduate students, the majority of students were aged between 21 to 25 years old with the total percentage 96.2%. Analysis of the student demographic data showed that the average age of the students was 22.86.

All the undergraduate students were in their first semester. Meanwhile, for the postgraduate students, 13 of them were in their first year study, 10 of the students were in their second years, and the other 3 students were in their third year. 19.25% of the postgraduate students used English as their first language. The remaining 80.8% students reported English as their second language. All undergraduate students were non-English speakers. All the students had more than three years of experience in using computers. The students also had more than three years experience using the web as a major medium in learning process.

The student demographic data showed all the undergraduate students did not have any working experience before further study in degree level. However, for the postgraduate students, there were three students had less than a year in working areas, only one student had a two-to-three years experience, and the others did not have any working experience yet.

4.4 Learning Experience and Engagement

Learning experience was measured in four dimensions, namely: (1) control, (2) focus attention, (3) curiosity, and (4) intrinsic interest. These dimensions of flow represented the level of engagement student had in WBCS.

Before the major statistical analysis performed, the reliability of the data was tested. The results show that students' engagement data were relatively high in their internal consistency with Cronbach's Alpha Coefficient is 0.816 indicates that the data are internally consistent. Next, the means and mean ranks for each item of the questionnaire for the two groups (SCB and without SCB) were calculated and described in Table 4.2.

To understand whether SCB in LearnJava was effective to increase students engagement; a series of Wilcoxon Sign Rank Tests were performed. It aims to determine the difference in students' engagement level when they use both systems for learning. The research hypothesized that "Students' engagement level was similar in both LearnJava with SCB and non-SCB". Table 4.2 shows the results of the Wilcoxon signed rank test analysis to compare students' engagement level in both SCB and non-SCB.

Table 4.2

The means and mean ranks for SCB-non-SCB.

Dimensions of learning experience	Mean for SCB (n=52)	Mean for Non-SCB (n=52)	Negative Mean Rank	Positive Mean Rank	Test Statistics
Control	3.77	2.93	25.87	8.30	Z=-5.539, p<0.05, Significant
Attention Focus	3.84	2.83	25.05	24.60	Z=-4.879, p<0.05, Significant
Curiosity	4.07	2.97	27.08	13.33	Z=-4.807, p<0.05, Significant
Intrinsic interest	3.88	2.87	24.59	9.25	Z=-5.140, p<0.05, Significant
Total	3.89	2.90	6.72	30.64	Z=-5.725, p<0.05, Significant

The overall engagement were much higher in LearnJava with SCB (mean = 3.89) compared to LearnJava without SCB (mean = 2.90). Further, curiosity received the highest ratings, while control received the lowest ratings. On the other hand, attention focus, received the lowest rating in non-SCB. Similarly as in SCB, curiosity received the highest ratings in non-SCB.

In terms of control, attention focus, and intrinsic interest, non-SCB received much lower scores than SCB. Generally, it can be said that the engagement in LearnJava with SCB was far better than non-SCB. The Wilcoxon Sign Rank tests confirmed that engagement was significantly difference in both types of system.

Students' engagement was also measured from the perspective how they progressing. These instruments measured four dimensions as explain in Section 3.2.3.1.1.

Table 4.3

The means for SCB-non-SCB (Progressive Learning Experience by stages).

Dimensions of learning experience	**Means for SCB (n=52)**			**Means for Non-SCB (n=52)**		
	Stage 1	**Stage 2**	**Stage 3**	**Stage 1**	**Stage 2**	**Stage 3**
Control	4.42	4.37	4.42	2.88	2.94	2.96
Attention focus	3.52	4.48	3.87	2.67	2.69	2.67
Curiosity	4.48	4.58	4.62	2.85	2.83	2.85
Intrinsic interest	4.06	4.33	4.54	2.87	2.81	2.81
Overall experience	4.12	4.44	4.36	2.82	2.82	2.82

A series of Wilcoxon Sign Rank test was also used to determine the differences in the learning process in the three stages. Table 4.3 describes the means for learning process via SCB technique and non-SCB technique for the four dimensions of learning experience. The overall mean score for stage 1, stage 2, and stage 3 shows how students' engagement was progressing. With SCB, engagement was improved during the second stage, however, it's was a little bit decreasing in Stage 3. On the other hand, engagement in the non-SCB showed a constant level for the three stages (mean=2.82). Table 4.4 illustrates the means and mean ranks for the engagement in three stages for both SCB and non-SCB learning process. The test statistics column showed the learning experience for both types of systems are significance in three stages of learning scores.

Table 4.4

The means and mean ranks for the learning experience in the three stages.

Stages of the test	Mean for SCB (n=52)	Mean for Non-SCB (n=52)	Negative Mean Rank	Positive Mean Rank	Test Statistics
Stage 1	4.12	2.82	24.14	15.45	Z=-4.585, p<0.05, Significant
Stage 2	4.44	2.82	24.52	10.86	Z=-4.157, p<0.05, Significant
Stage 3	4.36	2.82	23.84	15.75	Z=-4.197, p<0.05, Significant

The changing patterns of learning process described in a line chart in Figure 4.1. The line chart shows that there are two types of changes in WBL experience. Firstly, the learning experience with SCB technique appears a positive change though not stable from the beginning to the end of the WBL process. In contrast, the non-SCB learning process shows the horizontal in all three stages of the learning process.

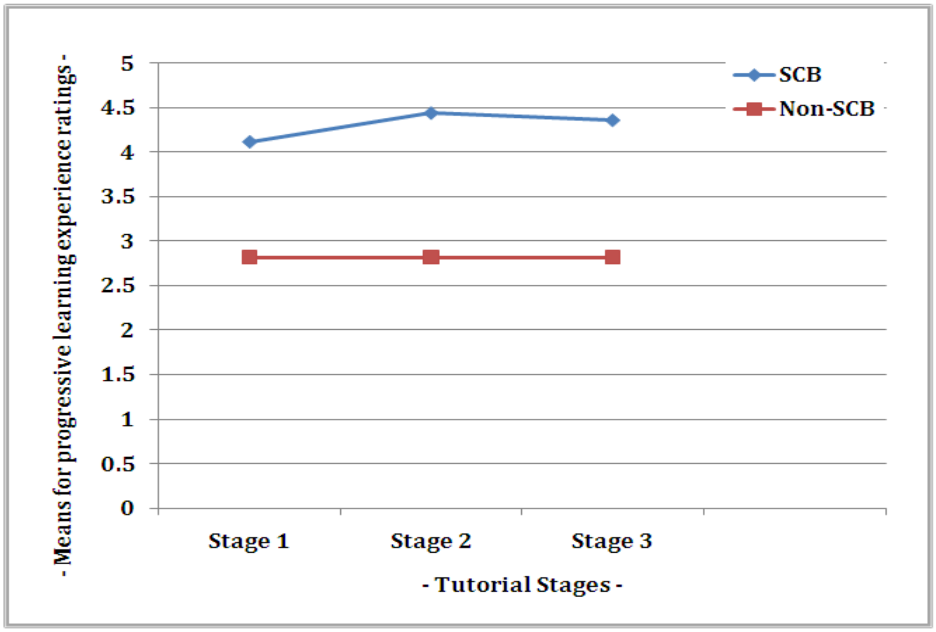

Figure 4.1. Progressive Learning Experience ratings for three stages.

4.5 SCB Button Usage

The "flow buttons" usage was analyzed. This is illustrated in the bar graph in Figure 4.2. Based on Figure 4.2, the analysis shows that 90.38% of the students used the "flow buttons", which consists of "anxiety" and "boredom" buttons. From the total, eighteen of the students were postgraduate and twenty-six were undergraduate students. Two postgraduate students only used "boredom" button, a postgraduate students used "anxiety button" during learning process, and five postgraduate students did not use "flow buttons" at all during their learning process.

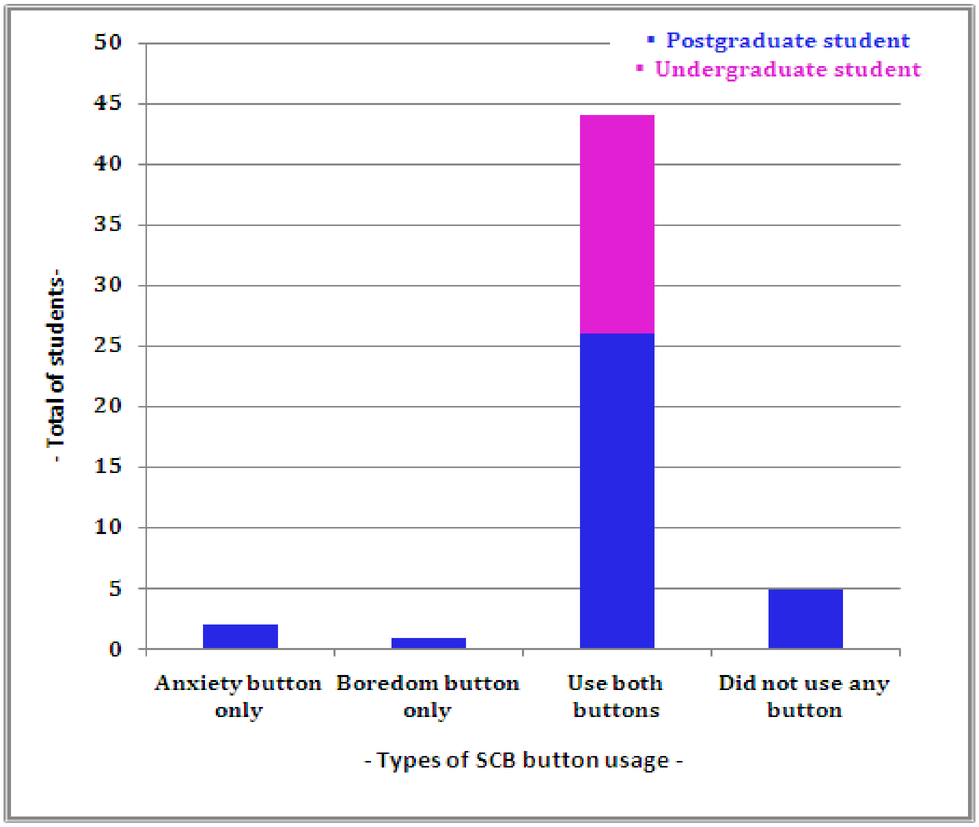

Figure 4.2. Types of SCB button usage.

Based on Figure 4.2 suggested that "flow buttons" were used more by undergraduate students compared to postgraduate students.

4.6 Non-SCB Notes Usage

Figure 4.3 shows the analysis on notes usage among students in non-SCB group. This system was used as alternative control system, only for purposes of comparison to measure the level of student engagement. Therefore, "flow buttons" were not used in this system. The analysis of data only focuses on notes usage. Based on Figure 4.3, the analysis shows that only twelve students used notes outside the learning process. The other forty students did not used notes as references outside the learning process. So, it can be concluded here that the "non-SCB note usage" were used more by undergraduate students compared to postgraduate students.

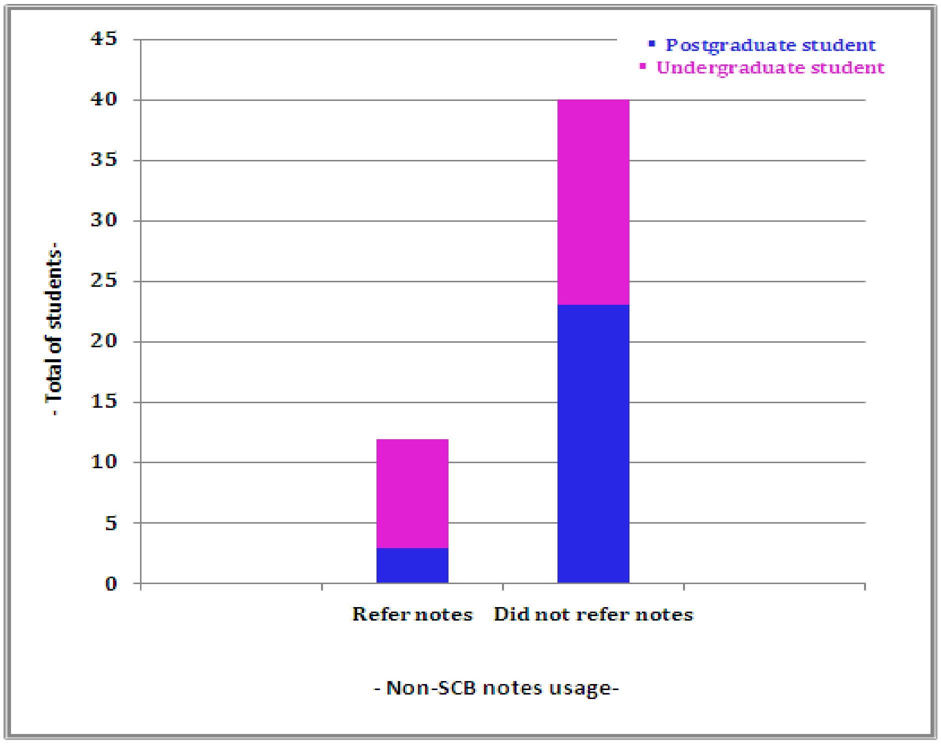

Figure 4.3. The notes usage during non-SCB learning process.

4.7 Summary of Chapter 4

This chapter describes a comparative study on student engagement when they used LearnJava with SCB and non-SCB learning. The results compare their engagement based on the four dimensions of learning experience (i.e., control, attention focus, curiosity, and intrinsic interest). Analysis was performed to see how engagement was progressing in three stages. Further the overall engagement was measured at the end of student interactions with LearnJava. This study suggested that SCB promotes better engagement compared to non-SCB.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Overview of Chapter 5

This chapter summarizes the overall contributions of this study and suggests recommendations and suggestions for future study.

5.2 Review of the Research Objectives

The main purpose of this study was to review students' engagement in WBCS. A WBCS named LearnJava was developed as the main tool for the experiment. As mentioned in Section 1.1, the research aimed to develop a WBCS for learning Java basic programming. A method known as SCB was embedded in the system as a way to improve engagement in web-based environment. Finally, the research aimed to evaluate students' engagement in WBCS with SCB and also without SCB technique. The last objective was to understand how engagement was progressing.

The research questions are as followed:-

1. How to incorporate SCB technique in WBCS design for learning Java programming?
2. Does SCB technique improve student engagement in WBCS for learning Java programming?
3. Does engagement change in WBCS for learning Java programming?

As mentioned before, the goal of WBCS is to provide students with customized learning paths (Brusilovsky, 2004). In identifying the optimal learning path for an individual student, the sequencing techniques take into account a few student's parameters such as background of knowledge, learning objectives and preferences (Chen, 2008). The optimal learning path in WBCS is dynamically generated based on the individual learning requirements. In other words, WBCS handles students individually by providing them with individualized learning sequences. In this research, the sequence of learning contents of a particular domain of knowledge is dynamically generated based on individual prior knowledge. It will be specifically referred to as a WBCS system in this research. Thus, the researcher developed LearnJava system that is embedded with SCB technique in WBCS to improve engagement. The basic idea combined SCB technique in LearnJava to allow students to adapt the difficulty of learning activities to fulfill the current level of their knowledge. The balance in skill and challenge will consequently improve student engagement. The development of the system and description about WBCS with SCB technique were described in Chapter 3. The process answered the first research question.

The findings of this research suggested that SCB technique was effective to improve engagement within WBCS. The stage of optimal engagement is assumed to be achieved only when one is in a condition where the skill and challenge is equivalent, the manipulation of students' skill and challenge appears to be one of the solutions. From analysis data, the students who had used LearnJava system with SCB showed higher mean scores in all dimensions of engagement compared to the student who used

LearnJava system without SCB. This had suggested improvement in students' engagement, especially in focus attention and curiosity. Besides, the usage of flow buttons was more than 80%. This showed an inclusion of the SCBs' manipulation into the design of the WBCS could assist students in achieving an optimal learning experience. The technique gave benefits to students because of its ability to engage students in the learning environments. The results offered conclusive answer for the second research question.

The outcomes showed changes in students' engagement during learning process with SCB technique. The line graph suggested that engagement is progressing positively with SCB. The means value for three stages in the dimensions of learning experience indicated the SCB learning process displays the improvement from the beginning to the end of the WBL (means for stage 1 = 4.12, stage 2 = 4.44, and stage 3 = 4.36). On the other hand, the non-SCB learning process showed a constant engagement. There are some aspects were identified as the reason of changes in student engagement when using WBCS. For the first, the study aims to investigate whether or not the two types of WBL systems (i.e., SCB and non-SCB) would give different engagement among students. If this is the case, how they are different would be consequently examined. In order to examine students' engagements better, the research adopted states of learning experiences based on the flow theory Csikszentmihalyi; (i) anxiety (i.e., students with lower skills and higher challenge), and (ii) boredom (i.e., students with higher skills and lower challenge). Figure 3.1 depicts how these states can be represented in relation to challenges and skills. In this research, the optimal learning experience would be represented by students who were in flow while using WBL. In addition, the research aims to investigate if there is any difference in terms of the learning outcomes of students who had used SCB and non-SCB. This study answered the third research question.

5.3 Summary of the Thesis

Student engagement in a particularly subject is an important factor to measure the effectiveness of WBL systems. LearnJava system was developed to diversify the existing teaching medium, where this system aims to provide for a learning tool for basic programming.

Chapter 1 described the motivation for writing the research, the research questions, and objectives.

Chapter 2 presented literature review on WBL. A literature review was made on past WBL research as references for the development of this research.

Chapter 3 elaborated the development of LearnJava, the main tool used to conduct the research in this thesis. This system is a medium for teaching and learning basic Java programming, a common introductory course at the university level. Two usability experts and three other persons who have experience in programming and systems development evaluated the LearnJava usability. The results from the usability evaluation demonstrated that the tool was usable.

Chapter 4 explained the results on evaluation of student engagement in LearnJava system. It was conducted to understand the effectiveness of the SCB technique in increasing student engagement throughout the learning process. The alternative system, LearnJava without SCB technique was used for comparison. The SCB technique significantly improved students' engagement within WBCS environment.

Chapter 5 summarized up the overall contributions of this study and expressed the recommendations and suggestions for future study.

5.4 Implications of the Project

This section concluded the implications of the study towards students, instructors, and WBL process.

1. Student

Students were given the opportunity to adapt the learning process independently without supervision. It aims to promote independent learning where this process allows students knowing their level of skills and knowledge in turn motivate then to improve weaknesses. It can indirectly increase student engagement in the learning process.

2. Instructor

LearnJava with SCB technique proved that the ability of an individual through learning process is different between one with other students. The style of learning presentation and the structuring of teaching methods presented by an instructor is important to ensure that every student can master the subject. The level of student engagement during learning sessions is important to achieve meaningful learning process.

3. WBL process

During the system development process, the researchers studied the current development of learning technologies that provide opportunities for students to adapt the learning method presented according to their needs. Combination between one technique with others should be studied in details. Level of student engagement is the most important measure of a successful system.

5.5 Limitations of the Findings

The research of the research should be used with consideration of the following limitations:-

1. The sample size used for this research was fifty-two students enrolled in Information Technology's programs at Universiti Utara Malaysia. The results may not be able to generalize the population of students undergo programming course.
2. The experimental studies were conducted in online mode and at the participant’s own convenience. The speed of network was not controlled and unknown. Hence, this factor may affect student engagement within web-based learning environment.
3. The final results of the research should consider the domain of learning (i.e., learning Java programming) used in the experiment. This domain of learning is considered procedural knowledge. Other domains may produce different results.

5.6 Recommendation for Future Work

The study on engagement and SCB technique can be further extended to include variety levels of student's background. The researcher aims to repeat the study among students from other programs as well as from other university. Besides, the domain of the analysis was limited to learn Java programming. The technique could be used and implemented in other domain of learning.

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