

A Study on the Development of E-Learning System for Java Programming

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Abstract: Learning Java programming can be tedious and difficult for beginners. In addition, traditional teaching methods can be insufficient in acquiring an understanding of the entire Java programming concepts, enhanced coding abilities, and improved problem-solving skills. Lack of resources, files being easily deleted in computers, and poor academic performance were some of the identified problems that led to students' very low competence in Java programming. This paper aims to develop an E-Learning system that would help solve or at least minimize the problems of students in learning Java programming. The expected users of the developed system are the students learning Java programming, the Instructors that will be managing the lessons, and the designated Administrator who will be in-charge in managing the accounts of students and instructors. The proposed E-Learning system for Java programming was evaluated by both the Information Technology (IT) experts and the students as the end-users. The evaluation results in general revealed that the developed E-learning for Java Programming is acceptable among IT experts and end-users.

Keywords: E-Learning, Java programming, Information and Communications Technology (ICT), Coding skills, problem-solving skills

1. Introduction

E-Learning systems refer to the electronically enabled delivery of effective multimedia learning [1]. Information and Communication Technology (ICT) is being utilized to enable access to online learning and instructional resources. Thus, E-Learning can refer to any learning that is enabled electronically and with the use of digital technologies [2]. In addition, E-Learning can be internet-enabled or web-based. It employs electronic technologies to enable access to the educational curriculum outside of a traditional classroom. It can be limited to a single course (or lesson) or a complete program delivered online. E-Learning has been proven to be an effective means of training and teaching courses in which learning is

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done using digital technologies [3][4]. This learning methodology has been adopted by various institutions to take a step ahead and provide advanced learning to their students. In addition, E-Learning systems can supplement the traditional approaches towards learning. Moreover, E-Learning was also being utilized not only by the education sector but also in business, medicine, government, and other sectors.

E-Learning can be implemented in ICT courses [5], and that also includes Java programming [6][7]. Java refers to a concurrent, class-based, and object-oriented general-purpose computer programming language [8]. Java programming was initiated by James Gosling, Mike Sheridan, and Patrick Naughton in June 1991. Java programming has been widely utilized in systems development, particularly in client-server web applications. Learning Java programming can be very difficult for some students due to several factors that include lack of resources, inadequate motivations, inefficient teaching methods, and many more. Students can find it difficult in acquiring an understanding of abstract programming concepts (*e.g.*, control structures, creating algorithms in solving complex problems) [9]. In addition, inadequate comprehension and acquisition of the knowledge of basic concepts and a lack of problem-solving skills and logical reasoning abilities further contribute to students' inability to acquire enhanced Java programming coding skills [10][11].

Teaching Java programming and similar subjects using traditional methods can be insufficient as these subjects require learners to acquire thorough knowledge on the concepts, problem-solving skills, logical reasoning abilities, and coding abilities [12]. The traditional teaching methods using books, presentations, board exercises, and notes can be ineffective as interactions between the teacher and students can be very limited [13]. Learning programming is much more interesting if the teaching strategy is dynamic and includes more interactive and collaborative coding activities. Thus, it is an essential need to provide supplementary learning perspectives to students or change the teaching strategy as a whole [14]. Ideal Java programming learning environment should include live interactions between the teacher and the students, capability to provide immediate feedback with coding activities, coding activities that promotes better motivation that can lead to enhancing students' problem-solving skills, dynamic elements explaining Java programming concepts, and other features that enhance learning [15].

This paper aims to develop an E-Learning system to aid students in learning Java programming. The specific objectives include (1) to design and create a normalized and integrated database that will store data such as student information, lesson, tests, and the scores of the students, (2) to create students' and instructors' account management for the security of the system, (3) to create a module for lessons and test (*i.e.*, can edit and add lessons, can edit and add tests), (4) to create a report module that will display the scores of students and score ratings for the students' learning status, (5) to determine the students' academic performance based on the result of the pre-test and post-test.

The remainder of this paper is organized as follows: Section 2 outlines the review of related literature and systems; Section 3 details the proposed E-Learning system for Java programming; the evaluation results were outlined in Section 4; and Section 5 concludes the study.

2. Review of Related Literature and Systems

This section outlines some of the well-known E-Learning systems that were already available for learners of Java programming. These include the Codecademy, Khan Academy, and the W3Schools. Codecademy refers to an interactive platform that offers free coding classes (*i.e.*, includes 12 different programming languages such as Python, Cascading Style Sheets (CSS), Java, Go, Javascript, Ruby, Structured Query Language (SQL), C++, C#, Swift, Sass, and HyperText Markup Language (HTML)) [16]. This online freemium system allows students to select their goal/learning objectives and then the system recommends the proper course. It includes lessons and coding activities where the students can

practice their coding skills by trying and running the examples on the console. The home graphical user interface (GUI) of Codecademy website is depicted in Figure 1.



Figure 1. Home GUI of Codecademy

Codecademy can be related to the proposed system as it helps students in learning coding skills in a particular programming course. However, a drag and drop feature is being integrated into the proposed E-Learning system that Codecademy does not have.

Khan Academy is a non-profit educational organization founded by educator Salman Khan in 2006 aiming to create a set of online tools that can freely help students in learning [17]. Short YouTube video lectures were produced by the organization as well as supplementary practice exercises and materials were provided for educators. The organization's interface can be compared to a Google classroom wherein teachers can upload lesson activities, assignments, and exercises. Students can then access the lecture videos and modules to study. Khan Academy is more focused on providing lecture videos and tutorials while the proposed E-Learning system is more focused on enhancing and measuring the students' programming skills. The home GUI of Khan Academy website is depicted in Figure 2.

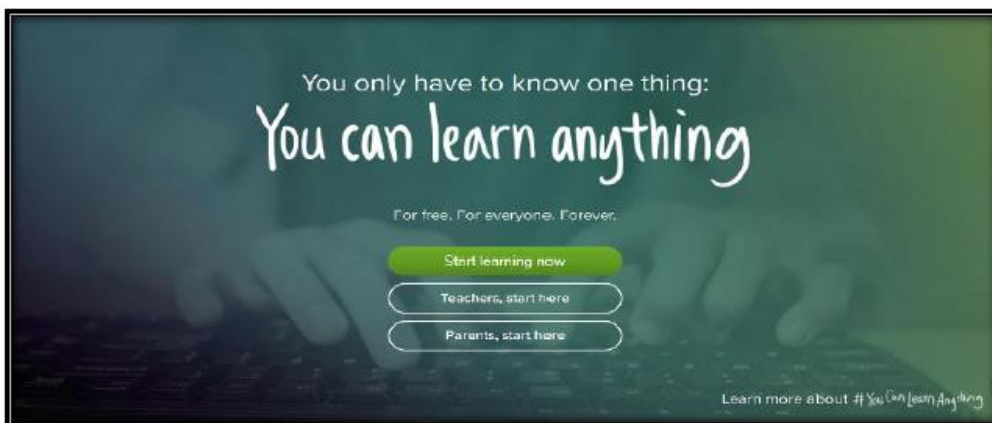


Figure 2. Home GUI of Khan Academy

W3Schools refers to a free educational website that is dedicated to making students learn the various aspects of web technologies [18]. Students may select to learn from a variety of tutorials and references relating to HTML, Extensible Markup Language (XML), Hypertext Preprocessor (PHP), SQL, JQuery, *etc.* Students can learn, test, and train with coding online. It is developed in 1998, deriving its name from the World Wide Web (WWW). In this educational website, students can practice their skills in creating a website. Similar to Codecademy, the students can run a particular program and explore its codes. The main feature in W3Schools is that the tutorials lead to developing a website. The contents of W3Schools

are focused on web design and development in contrast with the proposed E-Learning system that focuses on Java programming. The home GUI of W3Schools website is depicted in Figure 3.

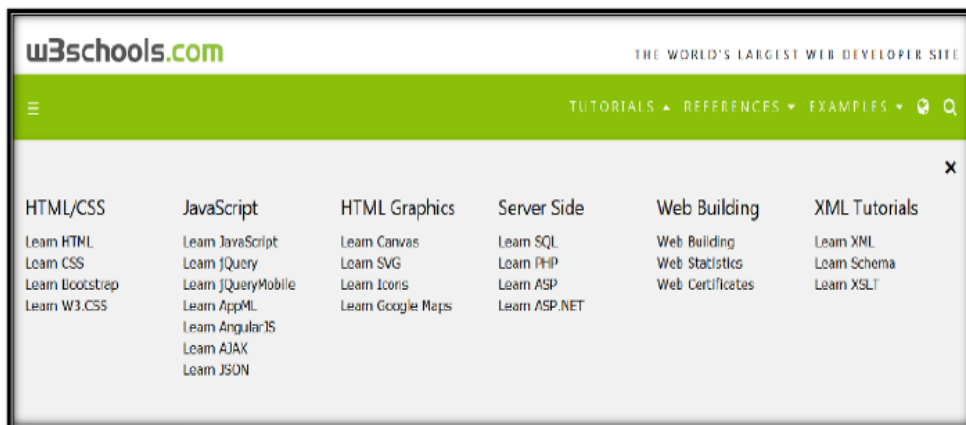


Figure 3. Home GUI of W3Schools

3. Proposed E-Learning for Java Programming

The proposed E-Learning system aims to aid students in their subject “Java Programming”. The developed system also aims to support students in their studies, help them better understand Java programming, and provide a better motivation to learn the subject.

The main problem in learning this subject was the poor performance of students in Java Program coding skills which can be the result of ineffective teaching methods, lack of resources, and poor students’ comprehension in studying Java programming. In this regard, the E-Learning system has been proposed that could possibly address these problems. In the development, Bootstrap template, JavaScript, CSS, HTML, and PHP were utilized. For the database, the MySQL (*i.e.*, combination of “My”, the name of co-founder Michael Widenius's daughter, and “SQL”) is used for data storage. The developed E-Learning system can become a viable solution to the identified problems in relation to Java programming. The students can access the learning resources anywhere and anytime.

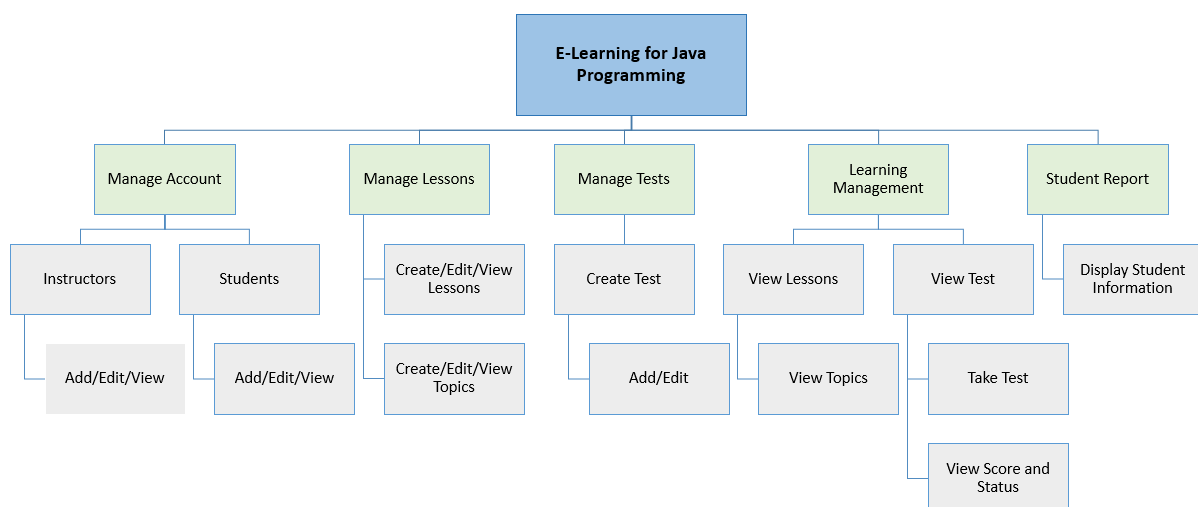


Figure 4. Functional Decomposition Diagram for the Proposed E-Learning System

The functional decomposition diagram (FDD) for the proposed E-Learning system is depicted in Figure 4 highlighting the five main functions: (1) managing account information, (2) managing Lessons,

(3) managing activities, (4) learning management, and (5) Student reports. The system recognizes three user roles, that is, the administrator, Instructors, and the students (*i.e.*, highlighted by the three entities shown in the context diagram depicted in Figure 5). The administrator account is responsible for managing account information of Instructors, Students, and Admin. The Admin registers or creates an account for students, Instructors, and other admins. The log-in screen user interface of the proposed E-Learning system for Java programming is depicted in Figure 6(a).

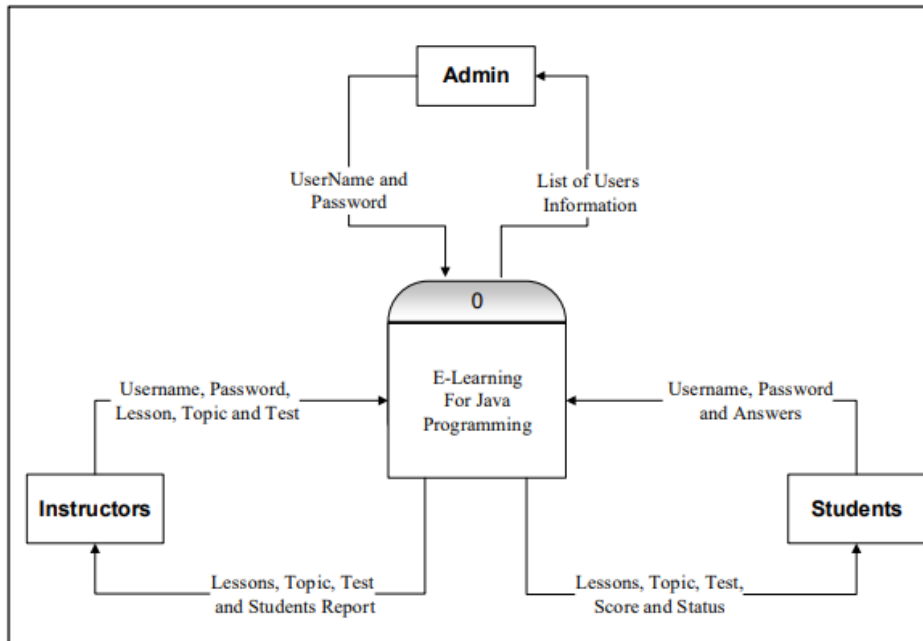
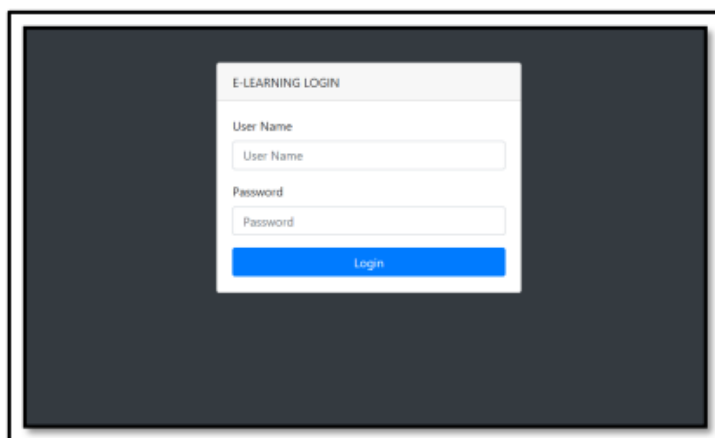


Figure 5. Context Diagram for the Proposed E-Learning System

Manage lessons, Manage Tests, and View Student Reports are the modules being managed by the Instructor. The Instructor will be responsible for providing the lessons, activities, and tests for the students. The Learning Management module can only be viewed and accessed by registered and enrolled students to a specific Instructor. In this module, the students view the lessons to study (*see* Figure 6(b)), take tests, and view the scores in every test being taken. The Instructors are those responsible for teaching Java programming and will be responsible for managing the student accounts being registered by the admin. They can also enroll students in their classes. They will be managing the lessons, activities, and tests. The status reports of each student can also be viewed by the Instructor.



(a) Log-in Screen

The screenshot shows a 'Student Registration' form within an 'E-Learning' application. The form includes the following fields: User Name *, Password *, Student No *, First Name *, Last Name *, Middle Name, Address, Contact, Level *, Course * (with a dropdown menu showing 'IS InfoTech'), and Section *. There are 'Back' and 'Save' buttons at the bottom. A copyright notice 'Copyright © E-Learning 2018' is visible in the footer.

(b) Student Registration

The screenshot shows a 'Lessons' management page in the 'E-Learning' application. It features a table with columns for Lesson, Status, and Actions. A '+ Add' button is located in the top right corner. The table contains four rows of lesson data.

#	Lesson	Status	Actions
1	INTRODUCTION TO JAVA	Published	
2	GETTING TO KNOW YOUR PROGRAMMING ENVIRONMENT	Published	
3	PROGRAMMING FUNDAMENTALS	Published	
4	CONTROL STRUCTURES	Unpublished	

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(c) List of Lessons

Figure 6. Screen Shots of the E-Learning System User Interface

This E-Learning system can be used by the Instructors as their teaching guide and supplementary strategy to contribute to improving and strengthening students' academic competencies in a more convenient way. Through this proposed E-Learning system, the Instructors are enabled to monitor the learning of students in Java Programming. The Instructors will be allowed to add items for the test in every lesson but it would only randomly display 10 items per test. After the student answered the test, the system calculates and displays the score (*i.e.*, the number of correct answers) and rated Excellent (if the score is 9 or 10), Very Good (if the score is 7 or 8), Good (if the score is 5 or 6), Fair (if the score is 3 or 4) and Poor (if the score is 0-2). The students are allowed to retake the test and the number of retakes will be recorded. The tests will be in multiple-choice and identification of terms. The questions will be selected randomly based on the learning competencies of the Java programming subject.

The students will be the main recipients of this E-Learning system wherein they can study, review, and test their Java programming knowledge through a series of lessons, activities, and evaluation tests provided in the system. Vital resources in relation to learning Java programming can be provided by the E-Learning system where learning becomes meaningful based on students' pace and direction. Learning materials based on each students' learning pace can be retrieved by students. The students are given an option to do advanced study or to re-study Java programming concepts that they think are difficult for them to grasp. In addition, having a drag and drop feature for some of the coding tests make the learning experience fun and meaningful. The students may use their School Identification (ID) numbers as their usernames to be easily remembered and identified (*see* Figure 6(c)). They will be allowed to view the lessons, study, and take the tests soon after. Their scores will be made available for them to monitor their progress in learning Java programming.

4. Results and Discussion

This section highlights the results of the analysis on the performance of the proposed system. In Table 1, the comparison of the features of the proposed E-Learning system with the already existing and popular learning platforms has been presented. The main feature being added is the drag and drop capability that aims to ease the students in performing coding activities. The proposed E-Learning system will also include lessons, coding, activities, and tests to evaluate the students' learning progress. However, unlike the Khan Academy, there are no provided lecture videos and tutorials.

Table 1. Comparison of E-Learning Features

Features	Codeacademy	Khan Academy	W3Schools	Proposed System
Video	×	√	×	×
Coding	√	×	√	√
Drag and Drop	×	×	×	√
Activities	√	×	√	√
Lessons	√	√	√	√

The graph in Figure 6 shows the evaluation results for the proposed E-Learning system by Information Technology (IT) Experts and students. The evaluation questionnaire had a Rating Scale of 5 (Very High), 4 (High), 3 (Moderate), 2 (Low), and 1 (Very Low). As depicted on the graph, most of the criteria were rated as Moderate that includes Auditability, Accuracy, Completeness, Communication and Commonality, Conciseness, Consistency, Observability, Operability, Self- documentation, Simplicity, Traceability, Training, Controllability, Data commonality, Decomposability, Error

Tolerance, Execution Efficiency, Expandability, Generality, Instrumentation, and Modularity. Software System Independence, Hardware Independence, and Modularity were rated “High” and the lowest criterion rated was Security. In this regard, it can be said that the developed E-Learning system for Java programming can be acceptable.

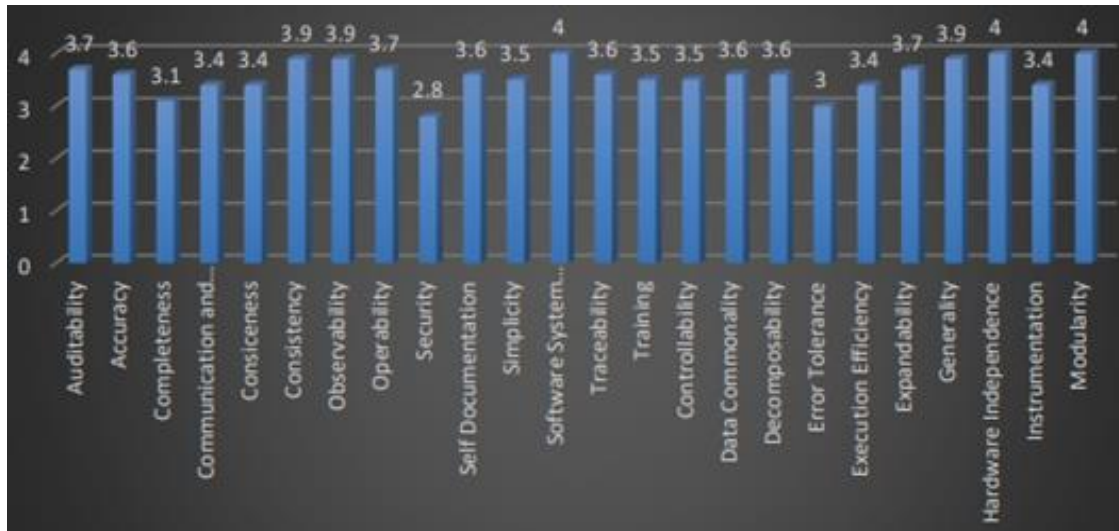


Figure 6. Evaluation Results

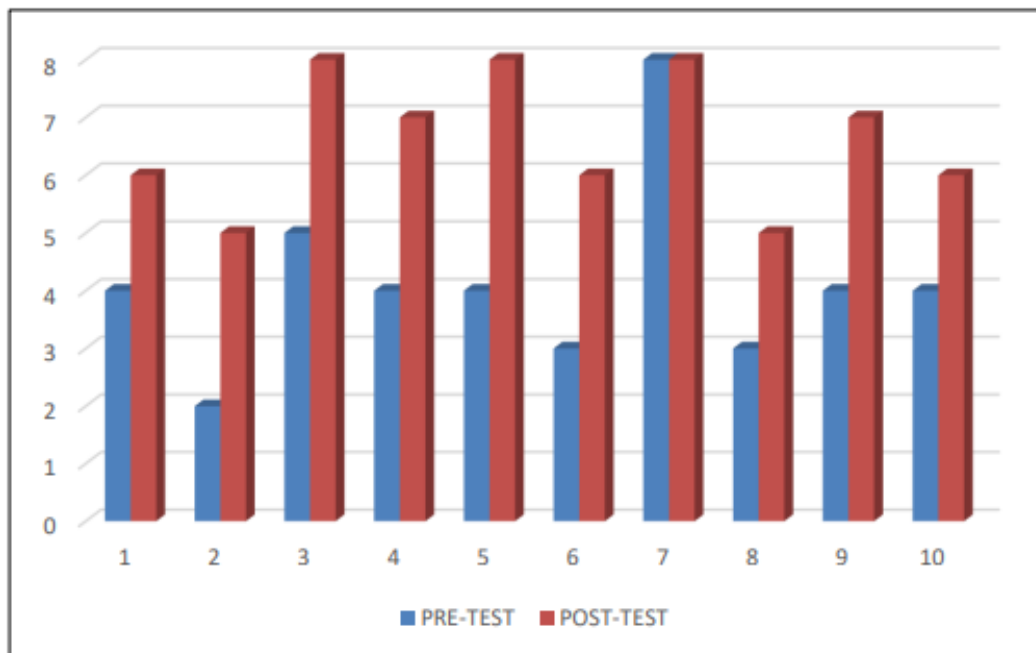


Figure 9. Pre-Test and Post Test Result (Graph Representation)

Moreover, the student’s performance in the pre-test and post-test depicted in Figure 9 indicates a strong improvement in the students’ learning and coding skills in Java programming. The pre-test and post-test were taken by ten randomly selected IT students. Thus, significant improvement in the students learning in Java programming can be achieved through the proposed E-Learning system.

5. Conclusion and Future Directions

The proposed E-Learning system for Java programming aiming to develop the students' learning and coding skills in Java programming has shown significant results to the students' academic performance. The E-Learning system has three main user roles, that is, the Admin, the Instructors, and the students who are the main beneficiaries. The system employs five main features which include managing account information, managing lessons, managing activities, learning management, and student reports. Based on the evaluation, the end-users (*i.e.*, comprised of both IT experts and the students) have rated the E-Learning system as acceptable. In addition, the system shows significant improvement in the students' learning and coding skills as they have performed pre-test and post-test.

In the future, the features of the system will be refined and integrated lessons will be updated to include the current long-term support (LTS) versions of Java. In addition, the E-Learning system will be analyzed to not only cater to Java programming but will also include other programming courses.

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