UML Diagram E-Learning Application: A Pilot Study

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Abstract: Unified Modelling Language diagrams is a topic in Universiti Tun Hussein Onn Malaysia's Diploma in Information Technology's Object-Oriented Programming course, used to graphically present system entities and or flow, for better understanding of a system during its design. Students were found to have trouble differentiating the purpose of and how to draw the diagrams. This paper proposed a learning application for self-regulated learning of the topic. The application designed using the ADDIE model, developed using Adobe Flash and tested by 10 Diploma in Information Technology students in Universiti Tun Hussein Onn Malaysia. Results of usability survey are generally positive, with rooms for improvement in terms of design and navigation.

Keywords: E-Learning, Object-oriented programming, UML diagram

1. Introduction

Diploma in Information Technology (DAT) students in Universiti Tun Hussein Onn Malaysia (UTHM) are required to take Object-Oriented Programming (OOP) course during the first semester of their second year of study. One of the topics in the OOP course is Unified Modelling Language (UML) diagrams, used to visualize components and or flow of a system to help developer understand it. DAT students in UTHM had trouble drawing UML diagrams based on analysis of OOP course's UML's project and final exam marks for Semester 1 Session 2019/2020. Most did not know the purpose of and how to use the different notations for different diagrams.

Thus, the authors conducted a pilot study to determine the usability of a UML diagrams e-Learning application for DAT students' self-regulated learning, to improve the application based on the results of a small scale testing, in order to test it again on a larger sample size. There are many UML diagrams, but the application will only cover Class, Activity, Use Case and Sequence diagrams as these four diagrams are the ones covered in DAT's OOP's syllabus. The application can be used by students as a beginner-friendly learning tool to easily understand UML diagrams. The application can also be used by educators who teach UML diagrams as a teaching tool.

1.1 UML

UML is a development modelling language used to visualize system design [1]. There are many types of UML diagrams [2]. UML is crucial in developing a system because it shows the clear view path of the system [2]. There are a lot of UML tools available for download. However most tools are intended for professional use and not suitable for students that are just starting to learn [3]. The complex syntax or overloaded features may cause confusion for beginners [4]. Most UML tools available also lack educational aspects [3].

1.2 E-Learning

UML can be learnt through e-learning. [5] defined e-learning as a learning/teaching platform enabled electronically. [6] divided e-learning into two types; offline and online. [7] described e-learning as learner centred because of its interactive, repetitive and self-paced design. The advantages of e-learning are it focus on the needs of individual learners [8], flexible in terms of time and place [9], up to date learning materials [10], and cost-efficient [10] as students can choose from a large range of courses and make the selection depending on their needs. However, there are also some drawbacks. Implementing e-learning as a full-time education method can cause learners to face contemplation, remoteness, as well as lack of interaction with other people [9] because of the lack of a real classroom or classmates. Learners might develop antisocial personality [10] thus may not possess and fully grasp skills needed to deliver received knowledge to others.

2. Materials and Methods

The application created using the ADDIE model (Figure 1) that have five phases; Analysis, Design, Development, Implementation, and Evaluation. ADDIE model chosen as reference because it serves as the foundation for instructional design model that offers a step by step process on how to develop educational products and courses, provides an opportunity to re-evaluate the learning goals and outcomes and can be used for evaluation of strategies that can measure each phase's time and cost easily.
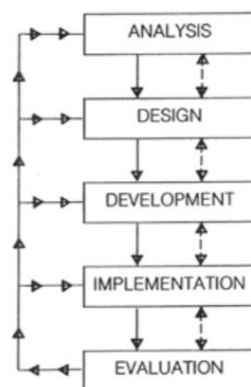
Figure 1: ADDIE Model [11]

2.1 Analysis

A needs analysis conducted based on UTHM's DAT's OOP course session 2019/2020's UML diagrams' project marks (Table 1). Most groups scored 1 which is weak. Total scores from 0 until 2 much higher than score 3 until 4, proof there was a knowledge gap where students were having trouble understanding how to draw UML diagrams as they do not fully understand the purpose of each diagram and its components.

Table 1: OOP course's project's UML diagrams' evaluation summary

Criterion	Very Weak 0	Weak 1	Fair 2	Good 3	Very Good 4
Use Case					
Use case to use case	4	4	7	0	0
Actor to use case	0	3	1	11	0
Relationship	0	9	6	0	0
Activity					
Activity diagram	1	11	3	0	0
Condition/merge and fork	2	10	3	0	0
Class					
Class diagram -class	0	0	1	12	2
Class diagram -relationship	5	1	8	0	1
Class diagram - visibility	1	0	5	7	2
Sequence					
Sequence diagram	0	12	2	2	0
Sequence diagram - sequence fragment	1	11	1	1	0
Total	14	61	37	33	5

The application's target audience is anyone who is teaching or learning UML diagrams, specifically Class, Use Case, Activity, and Sequence. The application's learning objectives are for the students to 1) understand the purpose of each UML diagram and its components, 2) know how to draw UML diagrams based on given scenarios, and 3) appreciate the importance of UML diagrams.

To realize the the first objective, the application has a Learn section that is separated into four subsections, one for each diagram. The section gives bit-size knowledge about the diagrams to not overwhelm students with too much information at one time. The second objective is achieved based on the examples in the Learn section and the scenarios in the Test section of the application, where students are able understand the difference, in terms of purpose, components, and notations, between the diagrams. The third objective is accomplished when students are able to realise the reason behind the inclusion of UML diagrams in the OOP syllabus, that is its significance in object oriented design, as a result of their knowledge, understanding, and application of the diagrams through the application.

2.2 Design

The application designed to be user-friendly by using simple navigation through menu and navigation buttons and simple layout with a menu on the left-screen side and contents on the right-screen side. The preferable flow of usage is from the Title screen to Learn screen to Test screen and Exit screen, as the authors wanted the students to gain the knowledge and understanding of the diagrams first before applying them during assessment. From the Title screen, students are able to navigate to three different screens. Two of the screens have another four subscreens.

2.3 Develop

Draw.io website used to design and create the graphics. Sound effects edited and downloaded from FL Studio website. Multimedia elements integrated using Adobe Flash CS6 with ActionScript version 3.2 scripting language. Open Broadcast Software (OBS) used for screen recording. Then, the tutorial video created using Windows Video Editor.

When the application launched, user greeted with Title screen (Figure 2) that contains a menu with three buttons; 'Demo', 'Learn' and 'Test'. 'Demo' button goes to Demo screen (Figure 3), 'Learn' button to Learn screen (Figure 4) and 'Test' button to Test screen (Figure 5(a)).
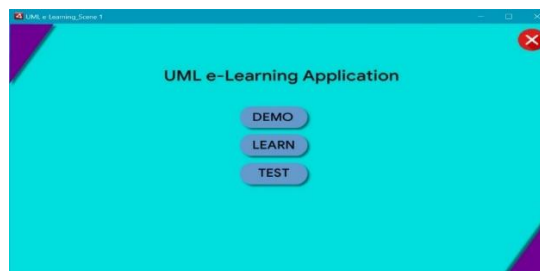
Figure 2: Title screen

Demo screen (Figure 3) shows a video on how to use the application. Home button redirects to Title screen.
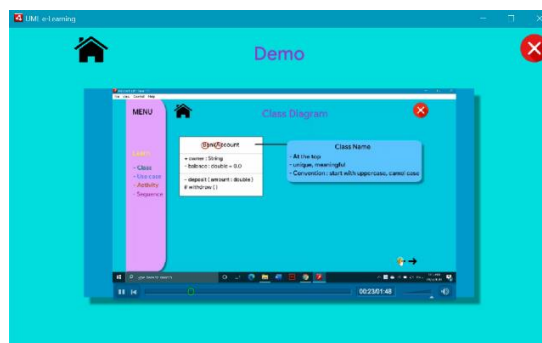
Figure 3: Demo screen

Learn screen (Figure 4) shows a menu with four options on the left-side; 'Class', 'Use case', 'Activity', and 'Sequence'. When user click one of the four options, they will be directed to the respective Learn screen. By default, Class diagram's Learn screen showed first. Next and Previous buttons used to navigate through Learn screens.
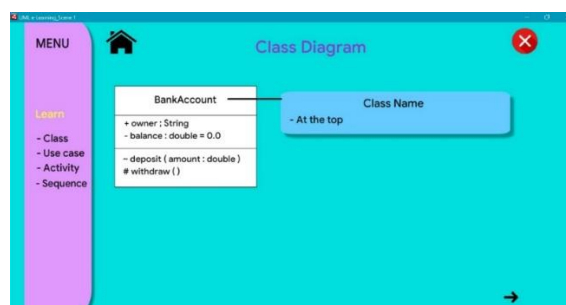

Figure 4: Learn screen

Test screen (Figure 5) shows a menu with four options on the left-side; 'Class', 'Use case', 'Activity', and 'Sequence'. When user click one of the four options, they will be directed to the

respective Test screen. By default, Class diagram's Test screen showed first. Test screen test knowledge of UML diagrams using multiple choice questions (Figure 5(a)) and drag-and-drop (Figure 5(b)).
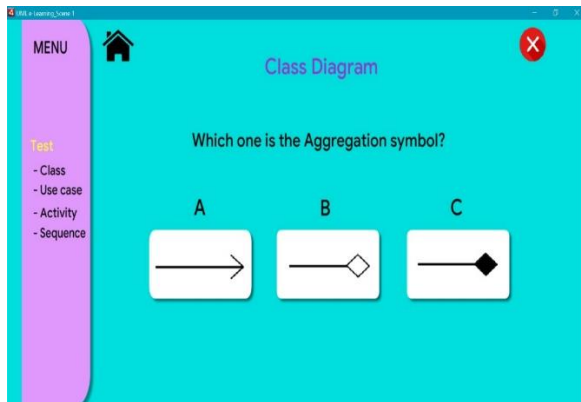

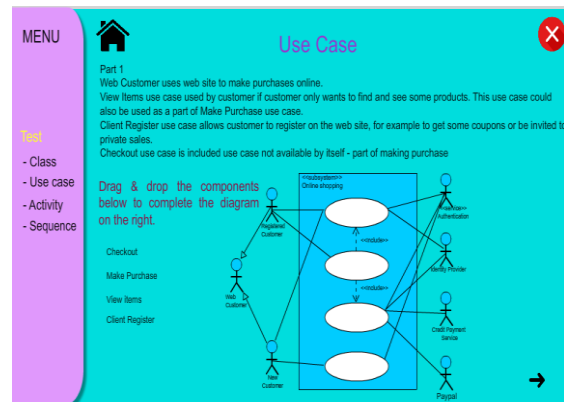**Figure 5(a) : Multiple choice question's test screen**

Figure 5(b): Drag and Drop's test screen

Score screen (Figure 6) shown after Test completed. It shows scores for both parts of Test; objectives and drag and drop. Each part separated into four scores, one for each diagram.
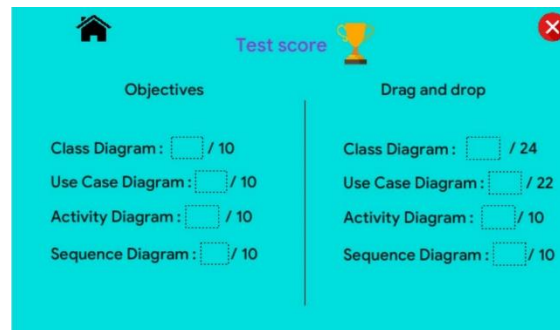

Figure 6: Score screen

Exit button appears on all screens. When user click it, a popup appears (Figure 7), asking for confirmation. If user selects Yes, the application closes, else they stay on the same screen.

Figure 7: Exit screen

2.4 Implement

The application file given to testers through WhatsApp to be downloaded and opened using Flash player or Internet Explorer browser. After using the application, they filled a feedback survey.

2.5 Evaluate

After using the application, testers filled a feedback survey modified from [12]. Survey divided into three parts. Part A is the demographics of respondents. Part B consists of a usability questionnaire with 25 five-point Likert scale items ranging from strongly disagree to strongly agree divided into seven sections; interface, contents, navigation, usability, reliability, effectiveness and satisfaction. Part C has

two open-ended questions. Analysis of survey determined the usability and positive aspects of, and areas for improvements for the application.

3. Results and Discussion

The survey respondents consist of 11 DAT students (six males and five females). Results from the questionnaire summarized in Table 2.

Table 2: Summarization of questionnaire responses

	Question	1	2	3	4	5
	Section 1: Interface					
1	Pleasant and attractive	0.0	0.0	0.0	45.5	54.5
2	Easy to understand	0.0	0.0	0.0	45.5	54.5
3	Fonts easy to read	0.0	0.0	0.0	63.6	36.4
	Section 2: Content					
4	Organized	0.0	0.0	9.1	45.5	45.5
5	Easy to understand language	0.0	0.0	9.1	27.3	63.6
6	Appropriate terminologies	0.0	0.0	9.1	45.5	45.5
7	Same words, concepts or actions refer the same thing	0.0	0.0	9.1	63.6	27.3
8	Attractive and clear	0.0	0.0	0.0	45.5	54.5
9	Free from irrelevant material	0.0	0.0	18.2	45.5	36.4
	Section 3: Navigation					
10	Simple and is placed together	0.0	0.0	0.0	63.6	36.4
11	Layout remains the same when navigating	0.0	0.0	27.3	27.3	45.5
12	Every screen has required navigation	0.0	0.0	9.1	45.5	45.5
	Section 4: Usability					
13	Easy to learn how to use	0.0	0.0	0.0	36.4	63.6
14	Easy to remember how to use	0.0	0.0	0.0	45.5	54.5
15	Easy to become skilful to control	0.0	0.0	0.0	36.4	63.6
16	Requires fewest step to accomplish desired instruction	0.0	0.0	0.0	81.8	18.2
17	Can be used without written instructions	0.0	0.0	0.0	54.5	45.5
18	Can be used by novice and expert users	0.0	0.0	0.0	54.5	45.5
	Section 5: Reliability					
19	Any technical problem never observed	0.0	9.1	27.3	36.4	27.3
20	Speed is good and reliable	0.0	0.0	0.0	63.3	36.4
	Section 6: Effectiveness					
21	Help users to become more effective and productive	0.0	0.0	18.2	45.5	36.4
22	Give users control over learning activities	0.0	0.0	9.1	54.5	36.4
23	Encourage student-teacher interaction	0.0	0.0	16.7	41.7	41.7
	Section 7: Satisfaction					
24	Satisfied and fun to use the application	0.0	0.0	18.2	18.2	63.6
25	Application works the way user want it to work	0.0	9.1	9.1	27.3	54.5

1- Strongly Disagree (%)
2- Disagree (%)
3- Neutral (%)
4- Agree (%)
5- Strongly Agree (%)

Most of respondents' opinion was positive for all items. The interface is the "first thing that I like", "attractive", "beautiful", "user friendly", "easy to use", "easy to understand" and "all the colour match". The Learn section is "easy to learn" and "easy to understand". The Test section "makes me understand

more", "makes you get better at UML" and "fun and attractive". When asked for suggestions for improvement, the responses was "nothing" as it is "perfect" and "good as it is". A respondent suggested that "developer make another course that i can learn easily".

However, interface design should be "more attractive" and "more interactive". Test section can "provide question followed by group of diagrams". There are also issues with items 19 and 25. These two items are related as if any technical problem observed, application would not work the way user want it to. Since no respondents mentioned anything about technical error, the authors cannot respond to why a respondent disagree with the two items.

From the results attained, it can be seen that both the Learn and Test sections received both praise and criticism. It is important to note that both sections contributed to an increase in understanding of UML diagrams, which is the problem that the study was trying to alleviate. However, to increase the possibility of usage by students, the application must enhance its interface and question design.

4. Conclusion

This paper proposed simplifying teaching and learning of UML diagrams using an e-learning approach. Testing generally showed positive results with improvements needed in terms of interface and question design, as well as navigation, to improve reliability and satisfaction. This project has marketability value if the contents of the Learn section improved by adding the learning objectives of each diagram, scope of the application expanded by adding other UML diagrams, and design of Test section enhanced to make it more attractive. The application could then be marketed in the Play Store or App Store. Educators can use the learning application as a teaching aid and students can use it to self-assess understanding of UML diagrams.

Acknowledgement

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