Penerbit UTHM

© Universiti Tun Hussein Onn Malaysia Publisher's Office

JSCDM

Journal homepage: http://penerbit.uthm.edu.my/ojs/index.php/jscdm

Journal of Soft Computing and Data Mining

Implementation of Augmented Reality in Automotive Mobile Learning Application

Paul Winston George[1], Muhammad Fakri Othman[1*]

[1]Faculty of Computer Science and Information Technology,
Universiti Tun Hussein Onn, Parit Raja 86400, Batu Pahat Johor, MALAYSIA

*Corresponding Author

DOI: https://doi.org/10.30880/jscdm.2022.03.02.002
Received 12 May 2022; Accepted 10 July 2022; Available online 08 August 2022

Abstract: Nowadays, the young generation is the technology generation. Most of the students used technology devices such as smartphones as their mobile-learning tools. Students used their mobile devices to download learning applications for self-learning through devices. However, most of the existing applications do not teach full- learning and no tutorials. One of the example applications is the automotive learning application. Therefore, the AUTOGO application is introduced to help students learn and guide them about automotive subjects. AUTOGO is a mobile learning application using the Augmented Reality approach for Form 4 and 5 students from Kolej Vokasional Kluang (KVK). The methodology chosen for the development process is the Multimedia Mobile Content Development (MMCD) method. The software selected to develop the AUTOGO application are Unity3D and Visual Studio Code with C# language. The result of the beta testing show AUTOGO application is completely functioning as expected. Thus, the application of beta testing scores on the System Usability Scale (SUS) is 93% which means it falls within the acceptance range.

Keywords: Mobile learning, automotive learning, augmented reality

1. Introduction

Mobile technologies are a rapidly growing industry that draws enterprises from all over the world. A mobile application, also referred to as a mobile app and is a type of software designed to run on mobile devices. Users can utilize mobile applications to access the same services available on PCs, but they are lightweight [1], [2]. As a result, there are three sorts of mobile applications which are native applications, web applications, and hybrid applications [3]. Mobile application is a new norm for students to learn subjects through their smartphones as a learning tool.

Many students downloaded the application to learn particular subjects, such as automotive subjects [4], [5]. However, most of the existing applications do not teach full learning about the automotive subject and only cover certain topics [6], [7]. The existing application implemented limited multimedia elements such as text-based and static images. Even the application has a bunch of advertising, so the user felt annoyed when using the existing application [8], [9]. Therefore, the AUTOGO application is designed to highlight the issues. The objectives of this application are to design AUTOGO application in the form of educational purposes, to develop AUTO, an Automotive learning application for Kolej Vokasional Kluang (KVK) students based on the Android platform, and to test AUTOGO, an Automotive learning application for Kolej Vokasional Kluang (KVK) to the target user.

The AUTOGO application is to design a mobile-learning application for Kolej Vokasional Kluang (KVK) students. This application has three main content: Learning content, Augmented Reality (AR) content, and Quiz content. Learning content will cover two chapters for the user to learn the automotive subject [10]. AR content is to scan the image target and view the 3D models. The purpose is to make the users view the actual components. The quiz content is to answer ten

*Corresponding author: fakri@uthm.edu.my

questions for each chapter. This application can access anywhere and anytime. It also has good features, easy to use, and is user-friendly with multimedia elements.

This paper consists of five sections that cover the project development. Section 1 describes the background of the project, such as the problem statement, the objectives that led to the project's development, the objectives achieved, and the scope of the application. Section 2 discusses a systemic analysis of scholarly articles and other sources related to the application development, such as the technology used. Next, Section 3 discusses the phases of the application development using Multimedia Mobile Content Development (MMCD). While in Section 4, discussion of results from beta testing and user acceptance test were presented. Finally, Section 5 discusses the final result of the developed application.

2. Literature Review

2.1 Automotive Handbook

This book is to teach about the automotive subject, and the author is Robert Bosch [2]. The book is in its 10th English edition and has been completely advised and enhanced to include the most current development in automotive technology. Hence, this book is to guide and provide basic principles about automotive subjects. For example, an engine is a big machine in order to move the car, but the engine has divided into six main parts, which most people will know the engine parts such as engine block, cylinder head, piston, crankshaft, camshaft, and valve. Therefore, the parts are crucial, and everyone needs to know these basic parts first. This book will guide users from basic to advance automotive subjects.

2.2 Mobile Learning

Mobile learning, or *m-learning*, was defined as "the processes of coming to know through conversations across multiple contexts among people and personal interactive technologies" [11]. The definition of m-learning has evolved in different ways and directions since the first decade of the 2000s. Based on the work by [12], the evolution of these definitions has mainly highlighted m-learning positive characteristics and is quoted in many different types of research; such as *mobility* [13], *access* [14], *immediacy* [15], *situativ*e [16], *ubiquity* [17], *convenience* [18] and *contextuality* [19]. Mobile learning has been regarded as a tool for improving learners' learning and bridging students' learning in class and in the field. Also, nowadays, mobile learning places have changed from classrooms to real-world contexts; in addition, the number of across-context studies is increasing [20]. Furthermore, it is widely regarded as both a formal and informal method for any practice. And the extension to that is that today's mobile learners use mobile devices for mobile learning because it is portable and can be accessed anywhere and anytime [3]. It is also convenient to use the devices without any difficulties.

2.3 Comparative Analysis

The existing applications have highlighted the issues or difficulties encountered by the users. The comparison of existing applications with the same approach to the AUTOGO application is based on three mobile learning applications, which are Automobile Engineering Books Free [4], Automobile Engineering [5], and Car Problem and Repair [6]. These existing applications are available on the Play Store. Table 1 presents a comparative analysis between existing applications and proposed applications.

Table 1 - Comparative analysis between existing applications and proposed applications

Application	Automobile Engineering Books Free	Automobile Engineering	Car Problem and Repair	AUTOGO
Operating System	Android	Android	Android	Android
Open Source	Open	Open	Open	Open
Scope	Worldwide	Students	Worldwide	Students (Kolej Vokasional Kluang)
AR Approach	Not applied	Not applied	Not applied	Applied
Tutorial Method Form	Text and image	Text and Image	Text and image	Text, images & animation
Online / Offline Mode	Online and Offline	Online	Online	Offline
Advertisement	Applied	Applied	Applied	Applied

Table 1 shows the comparison between the existing application with the proposed application. Therefore, these existing applications are not suitable for students with limited multimedia experience, and the user tends to get bored

when using the applications. Hence, the AUTOGO application is developed by implementing the AR approach and using the infographics method with multimedia elements to increase the interaction of this application.

3. Methodology

The methodology selected for the development of the AUTOGO application is the Multimedia Mobile Content Development (MMCD) method [7]. This section discusses in detail the MMCD method, which are five phases, where the phases are to develop the AUTOGO application. This methodology is chosen because the phases are easy to understand and provide all the requirements to develop this application. The phases in the MMCD method are shown in Figure 1.

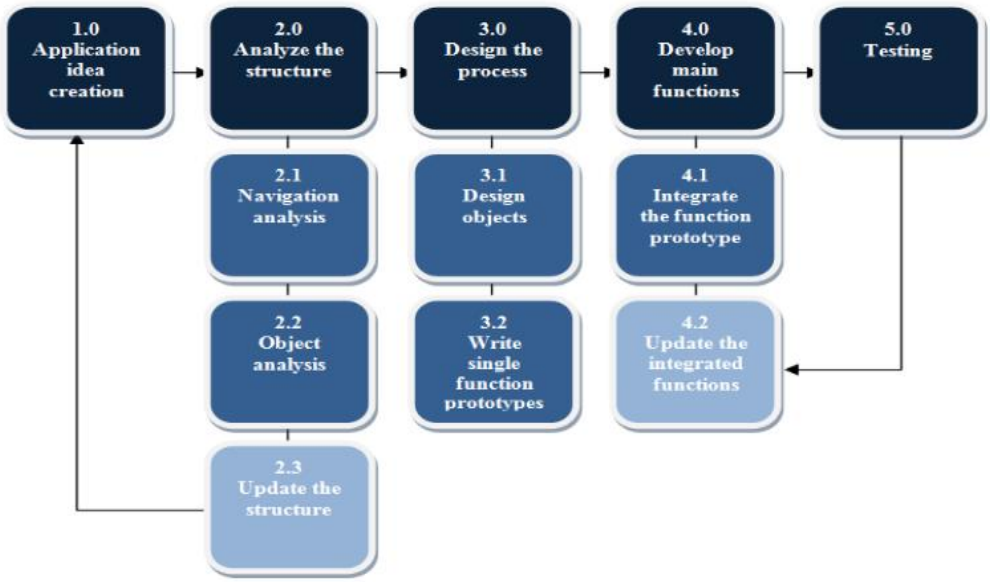

Fig. 1 - Multimedia Mobile Content Development Method [7]

3.1 Structure Analysis

This subtopic will mainly focus on the output of the first two phases of the project methodology, i.e., the structure analysis. To deliver the analysis, two subject matters from Kolej Vokasional Kluang (KVK) and a subject matter expert (SME) are involved. The SME has provided a module named Automotive Car Book as guidance or reference to develop the AUTOGO application. From the study, two main functional requirements are decided, i.e., User Interaction Support and Autonomous System Activity (see Table 2 for details of functional requirements). On top of the functional requirements, the system should comply with non-functional requirements, which are in terms of usability, implementation, legal, culture, and performance.

Table 2 - Functional Requirement

User Interaction Support	Autonomous System Activity
• The system should be able to click the continue button to begin the application	• The system should automatically calculate the scores and display the scores while answering each question
• The system should be able to access the main menu interface	
• The system should be able to click the buttons in the application	• The system should automatically decrease the time allocated to answer each question
• The system should be able to navigate the application smoothly	
• The system should allow the user to learn the automotive subject through notes in the application	• The system should automatically display the 3D Models when scanning the image target.
• The system should allow the AR camera to scan the image target to display the 3D model in the application	
• The system should distribute ten questions in the quiz section for each chapter	

Meanwhile, Figure 2 shows the content structure of the AUTOGO application, which is divided into goals, content, and activity. There are three contents with their respective activities.

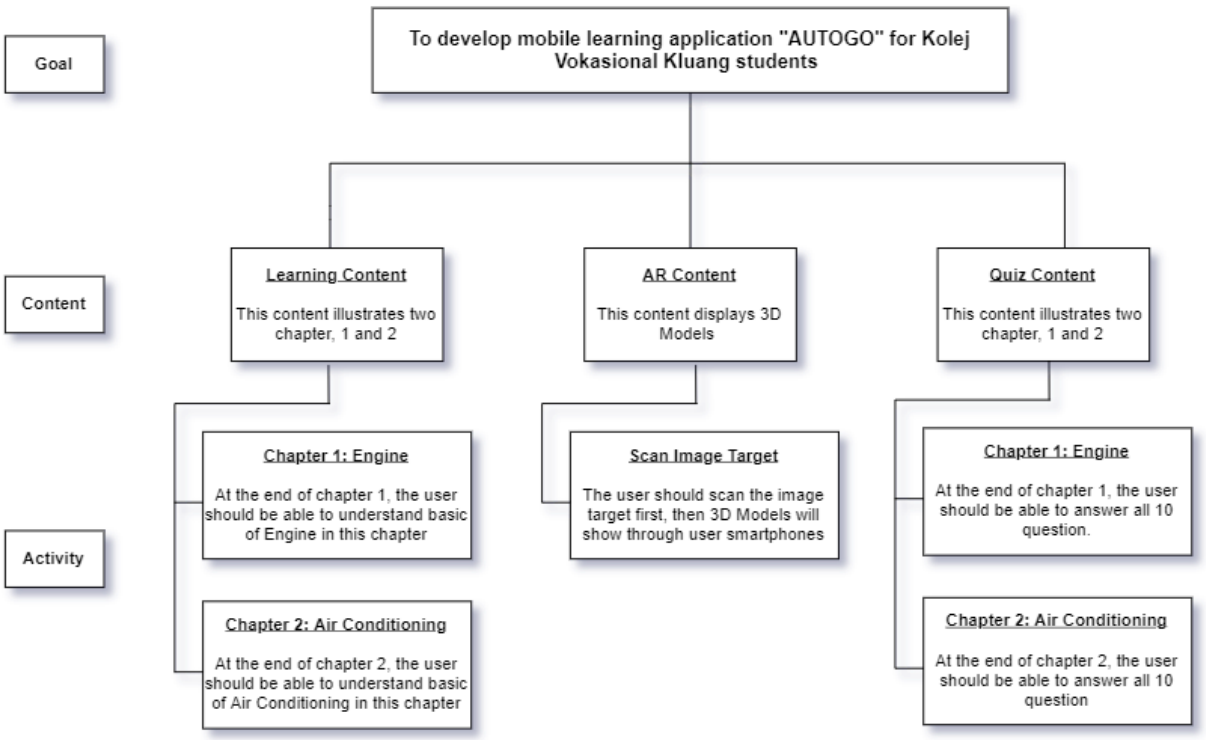

Fig. 2 - Content structure

AUTOGO application is developed on the Android mobile platform and as mobile learning tool [8]. Besides, the existing mobile learning application does not teach full learning about a particular subject. Therefore, the user does not feel interested in using the learning application. The AUTOGO application has Augmented Reality content. Most mobile learning does not have AR content in the current application. The AR function is to scan the image target and then 3D model display on their screen.

3.2 Design and Implementation

The home interface consists of a continue button and the logo of the application. Clicking the continue button will bring us to the next AUTOGO interface. In the main menu, the user is able to choose whether to pick Learning, AR camera, or quit the application. In learning, the user can find various notes on the selected topic, as in Figure 2(c). When clicking on the AR camera, it basically will show the AR Interface, where it will display various 3D models of items (from selected topics).

Other than that, interfaces for quizzes are also implemented to support the application to be more practical and easy to use. The quizzes consist of a question, answer, timer and score. Score-text is to display the score when the user answer question right. The timer is to display 20 seconds for the user to answer 1 question.

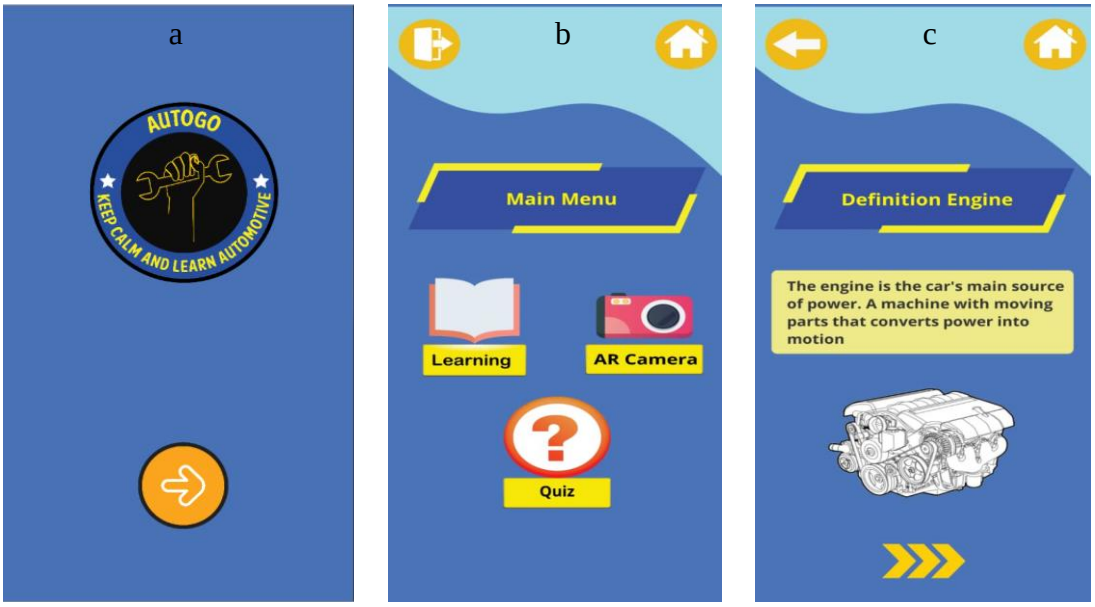

Fig. 2 - (a) Home Interface; (b) Main Menu Interface; (c) *Content* Interface

In this phase, all the assets are designed and also utilized in Unity 3D for integration. Visual Studio Code software is used with C# language to develop the AUTOGO application. Following application analysis, application design is conducted to specify the workflow of the AUTOGO application. However, due to the limitation of the paper, it is not to be discussed here in detail. Next, all necessary assets are designed using Adobe Illustrator, such as buttons, logos, interfaces, and images, followed by all the application interfaces. The main interfaces can be seen in Figure 3 below. Figure 3 shows one of the example scenes along with the coding for changing scene transition.

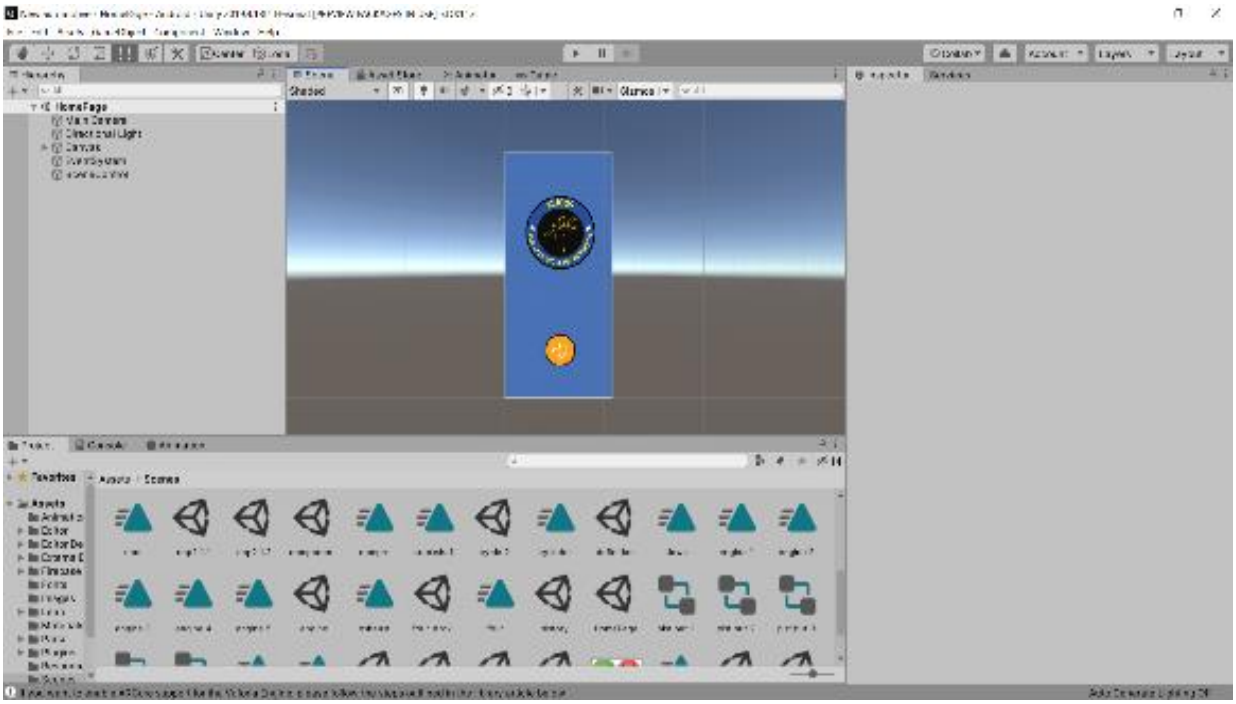

Fig. 3 - Sample of scene

3.3 Testing

The goal of this phase is to test the AUTOGO application and identify whether the application works as per expected. There are two testings involved, i.e., alpha testing and beta testing. The alpha testing is to evaluate the functionality of the buttons. The alpha testing is tabulated in Table 3.

Table 3 - Alpha testing

Test	Expected Result	Actual Result	Corrective Action
Continue Button	Navigates to AUTOGO scene	Works well as expected	Not needed
Quit Button	Exit the application	Works well as expected	Not needed
Main Menu Button	Navigates to Menu scene	Works well as expected	Not needed
Back Button	Navigates to previous scenes	Works well as expected	Not needed
Home Button	Navigates to Menu scene	Works well as expected	Not needed
Learning Button	Navigates to the Content scene	Works well as expected	Not needed
AR Button	Navigates to AR scene	Works well as expected	Not needed
Quiz Button	Navigates to Quiz Scene	Works well as expected	Not needed

Target users conduct beta testing. The testing is conducted with 12 students from Kolej Vokasional Kluang (KVK). After using the application, the students are given a set of close-ended questionnaires to provide their feedback. The options are using the Likert Scale in the questionnaires.

4. Result and Discussion

This section discusses the results obtained from beta testing and user acceptance tests using the System Usability Scale (SUS). A set questionnaire that contains nine close-ended questions was created using Google Forms and distributed to the target users. The form is filled by form 4 and form 5 students from Kolej Vokasional Kluang (KVK) after using the application. Figures 4 and 5 show the result of beta testing. Most respondents provide positive feedback that the AUTOGO application is functioning well. However, a few users responded with low scores related to user friendly due to the font being small and hard to read. Therefore, it should improve on the user-friendly application.

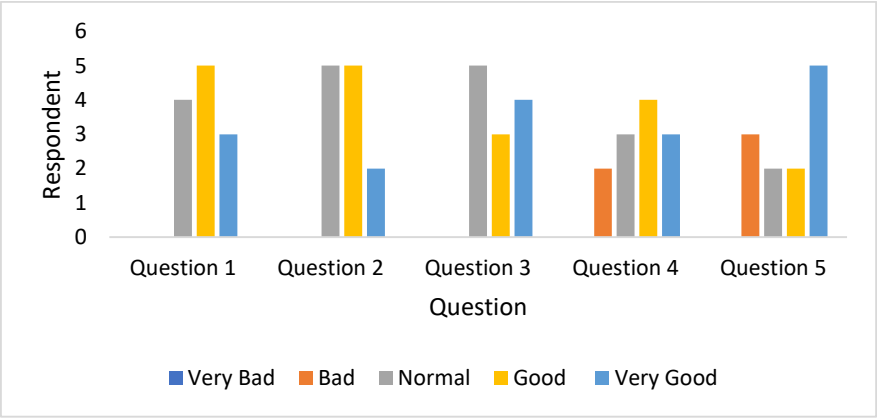

Fig. 4 - User acceptance level analysis of questions 1 to 5

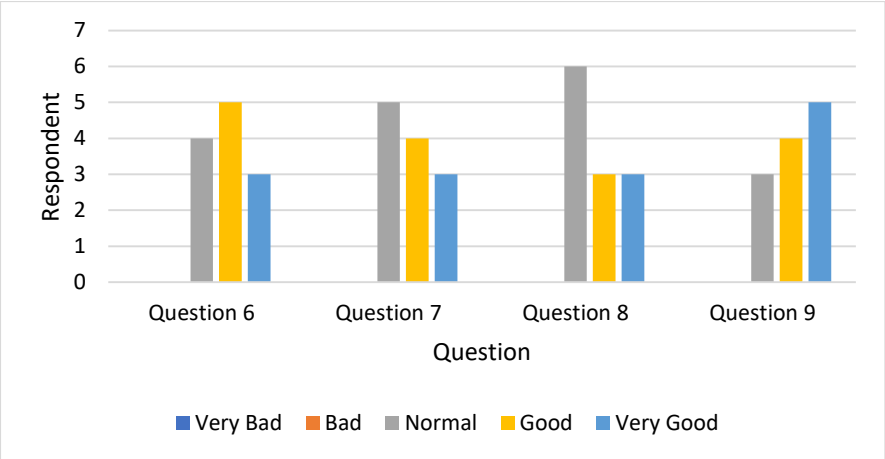

Fig. 5 - User acceptance level analysis of questions 6 to 9

This section is to gather data from the questionnaires that were measured using the System Usability Scale (SUS). The total respondents' scores are calculated as shown in Table 4.

Table 4 - Respondent's scores based on Likert points

No.	Question	Likert Points					Marks
		1	2	3	4	5	
1.	Did you enjoy using the application?	0	0	4	5	3	47
2.	What do you think about the logo? Is it nice?	0	0	5	5	2	45
3.	What do you think about the color of this application? Is it suitable for this application	0	0	5	3	4	47
4.	What do you think about the font for this application? Is it suitable for this application	0	2	3	4	3	48
5.	Is the application user-friendly?	0	3	2	2	5	45
6.	How about the features of this application? Is it okay?	0	0	4	5	3	47
7.	Are the button icon suits the application?	0	0	5	4	3	46
8.	What is your level of expectation when using this application?	0	0	6	3	3	45
9.	Are you satisfied with this application?	0	0	3	4	5	50
						TOTAL	420

Based on Table 4, the result obtained a total of 420 marks based on the Likert scale points. To calculate the outcome, we used the SUS formula:

$$Y = \frac{P}{Q} \times 100 \quad (1)$$

where:

P is the total scores of respondents for each question.
Q is the maximum total of respondents' scores
R is the percentage score

Therefore,

$$Y = \frac{420}{450}\, x\, 100 = 93\%$$

Based on the SUS scoring table [10] (refer to Figure 6), 93% of acceptance is within the *acceptable* range. Before that, there are a few issues that need to amend the application's error: the font is too small and hard to read. Overall, the AUTOGO application is accepted, and the students from Kolej Vokasional Kluang can use the application as a learning tool.

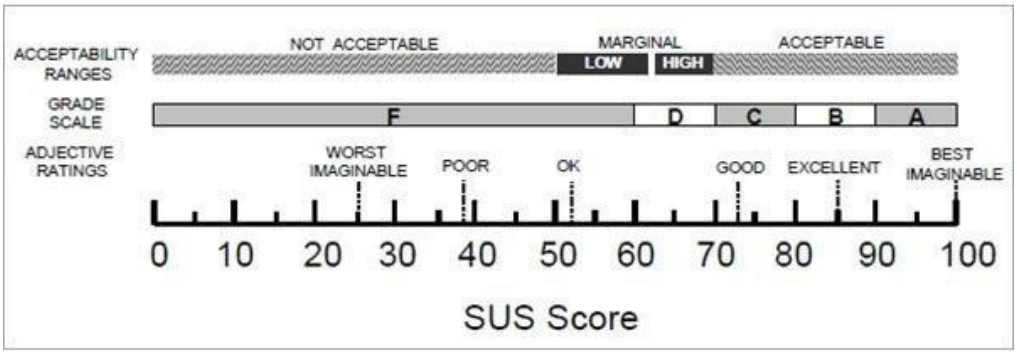

Fig. 5 - System Usability Scale (SUS) [10]

5. Conclusion

In conclusion, AUTOGO has been successfully developed as an automotive mobile learning application. This application aims to provide a mobile learning application for students from Kolej Vokasional Kluang to learn the automotive subject. The objective of developing the AUTOGO application is completed, which is to design the application in the form of educational purposes, develop it in the Android mobile platform and test out the application by the students from Kolej Vokasional Kluang. Thus, the advantage of the AUTOGO application is that the application has good multimedia elements, such as text, graphics, and animation. The learning content is easy to understand because it implements the infographics method so that the user will not feel bored when using the application. Next, the functionality of the AUTOGO has well-supported. All the buttons, text, graphics, images, and 3D Models are displayed correctly. The application is very flexible, which means it is portable application and convenient to use this application. However, the AUTOGO application has limitations when conducting beta testing. The first limitation is that the application's fonts are small and hard to read. Hence, a slider function was implemented in the application, but the user did not notice there was a slider button that could slider the content. Lastly, the interface does not fit the screen. Therefore, the user hardly reads the content when conducting beta testing. The issues were highlighted and amended in the application. Moreover, a few suggestions can enhance the AUTOGO application in the future. The suggestions are to provide more modules, implement a database for the user's high score and implement a video element for a better version in the future. I hope this application will assist the students in learning conveniently. Hence, students can use this application as their reference to better understand the subject.

Acknowledgment

The authors would like to thank the Faculty of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia, for supporting this project.

References

[1] Budiu, R. (2013). Mobile: Native Apps, Web Apps, and Hybrid Apps. The Effects of Brief Mindfulness Intervention on Acute Pain Experience: An Examination of Individual Difference. [Accessed: Oct. 10, 2020]
[2] Bosch Robert, (2019). Automotive Handbook. John Wiley and Sons Ltd. [Accessed: July. 1, 2021]
[3] Bauer, P., Kolb, C., & Bastian, J. (2020). Mobile learning in higher education. Proceedings of the 16th International Conference Mobile Learning 2020, ML 2020. https://doi.org/10.29121/granthaalayah.v5.i4(se).2017.1942. [Accessed: Oct. 11, 2020]
[4] "Automobile Engineering Books Free -Apps on Google Play." Play Store, 3-Feb-2020. [Online]. Available: https://play.google.com/store/apps/details?id=com.drk.automobileengineeringbooksfree&hl=en&gl=US [Accessed: Feb. 25, 2020]
[5] "Automobile Engineering -Apps on Google Play." Play Store, 11-Apr-2014. [Online]. Available: https://play.google.com/store/apps/details?id=com.faadooengineering.free_automobileengineering&hl=en&gl=US [Accessed: Feb. 25, 2020]
[6] "Car Problem and Repair and -Apps on Google Play." Play Store, 23-Apr-2017. [Online]. Available: https://play.google.com/store/apps/details?id=com.andromo.dev498527.app570067&hl=en&gl=US [Accessed: Feb. 25, 2020]
[7] Saifudin, W. S. N. S., Salam, S., & Abdullah, M. H. L. (2021). Multimedia Mobile Content Development Framework and Methodology for Developing M-Learning Applications. [Accessed: Jun. 5, 2021]
[8] Kang, H., & Cho, J. (2015). Case study on efficient Android programming education using multi-Android development tools. Indian Journal of Science and Technology. https://doi.org/10.17485/ijst/2015/v8i19/75984 [Accessed: July. 2, 2021]
[9] Antonczak, L. (2021). Mobile Technology. Pacific Journal of Technology Enhanced Learning. https://doi.org/10.24135/pjtel.v3i1.98 [Accessed: July. 2, 2021]
[10] A. Bangor, P.T. Kortum, and J.T. Miller, 2018, Journal of Usability Studies, 4(3), 114-123 [Accessed: Nov. 5, 2020]
[11] Sharples, M., Taylor, J., & Vavoula, G. (2007). A theory of learning for the mobile age. In R. Andrews, & C. Haythornthwaite (Eds.), The sage handbook of Elearning research, (pp. 221–247). London: Sage.
[12] Baran, E. (2014). A review of research on mobile learning in teacher education. Educational Technology & Society, 17(4), 17–32.
[13] Sharples, M. (2013). Shared orchestration within and beyond the classroom. Computers and Education, 69(2013), 504–506.
[14] Parsons, D., & Ryu, H. (2006). A framework for assessing the quality of mobile learning. In R. Dawson, E. Georgiadou, P. Lincar, M. Ross & G. Staples (Eds.), Learning and Teaching Issues in Software. Quality, Proceedings of the 11th International Conference for Process Improvement, Research and Education (17–27), Southampton, UK.

[15] Kynäslahti, H. (2003). In search of elements of mobility in the context of education. In H. Kynäslahti & P. Seppälä (Eds.), Mobile learning (pp. 41–48). Helsinki, Finland: IT Press.
[16] Cheon, J., Lee, S., Crooks, S., & Song, J. (2012). An investigation of mobile learning readiness in higher education based on the theory of planned behavior. Computers & Education, 59, 1054–1064.
[17] Kukulska-Hulme, A., Sharples, M., Milrad, M., Arnedillo-Sánchez, I., & Vavoula, G. (2009). Innovation in mobile learning: AEuropean perspective. International Journal of Mobile and Blended Learning, (1), 13–35.
[18] Kynäslahti, H. (2003). In search of elements of mobility in the context of education. In H. Kynäslahti & P. Seppälä (Eds.), Mobile learning (pp. 41–48). Helsinki, Finland: IT Press.
[19] Kearney, M., Schuck, S., Burden, K., & Aubusson, P. (2012). Viewing mobile learning from a pedagogical perspective. Research in Learning Technology, 20(1), 1–17.
[20] Lai, C.-L. (2020), Trends of mobile learning: A review of the top 100 highly cited papers. Br J Educ Technol, 51: 721-742. https://doi.org/10.1111/bjet.12884