Universiti Teknologi MARA
Cawangan Melaka

PCMJ

Progress in Computing and Mathematics Journal

volume 1

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Progress in Computing and Mathematics Journal
College of Computing, Informatics, and Mathematics
Universiti Teknologi MARA Cawangan Melaka, Kampus Jasin
77300, Merlimau, Melaka Bandaraya Bersejarah

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EDITORS

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PREFACE

Welcome to the inaugural volume of the **Progress in Computing and Mathematics Journal (PCMJ)**, a publication proudly presented by the College of Computing, Informatics, and Mathematics at UiTM Cawangan Melaka.

This journal represents a significant step in our commitment to fostering a vibrant research culture, initially providing a crucial platform for our undergraduate students to showcase their intellectual curiosity, dedication to scholarly pursuit, and potential to contribute to the broader academic discourse in the fields of computing and mathematics. However, we envision PCMJ evolving into a beacon for researchers both nationally and internationally. We aspire to cultivate a space where groundbreaking research and innovative ideas converge, fostering collaboration and intellectual exchange among established scholars and emerging talents alike.

The manuscripts featured in this first volume, predominantly authored by our undergraduate students, are a testament to the hard work and dedication of these budding researchers, as well as the guidance and support provided by their faculty mentors. They cover a diverse range of topics, reflecting the breadth and depth of research interests within our college, and set the stage for the high-quality scholarship we aim to attract in future volumes.

As editors, we are honored to have played a role in bringing this journal to fruition. We extend our sincere gratitude to all the authors, reviewers, and members of the editorial board for their invaluable contributions. We also acknowledge the unwavering support of the college administration in making this initiative possible.

We hope that PCMJ will inspire future generations of students and researchers to embrace research and innovation, to push the boundaries of knowledge, and to make their mark on the world of computing and mathematics.

Editors
Progress in Computing and Mathematics Journal (PCMJ)
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UiTM Cawangan Melaka

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ANIMALAR: AN INTERACTIVE TOOL IN LEARNING EDUCATIONAL ANIMAL KINGDOM THROUGH AUGMENTED REALITY

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Article Info

Received: February 2024
Accepted: August 2024
Available Online: October 2024

Abstract

The education of the animal kingdom is the domain of this work. The project's main goal is to solve the issue that younger people, particularly those in primary school, have when learning about animals. The issue is that people do not know enough about the animal realm, and learning about animals is uninteresting. The objectives of this project are to design a 3D environment with variety of animals in it, to develop a mobile application that uses augmented reality in learning animal and to evaluate the usability of the mobile application. The methodology that being used for this project is Agile methodology and the technique being used for augmented reality application is the marker-less technique. Testing was conducted at the Sekolah Kebangsaan Senai Utama to validate the project's functionality and usability through the students and the science teachers. The results of the testing phase revealed it successfully achieve the objectives. In conclusion, this project contributes significantly to the students and the science teachers, providing valuable insights into one of the latest technologies that can be utilize in educational aspect. Moving forward, potential future work that include augmented reality application or other technology that related to it will be improve to ensure it will satisfy and contribute more to the public.

Keywords: Animal Kingdom; Augmented Reality;

PCMJ

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INTRODUCTION

In introduction, project background will be introduced. Furthermore, the problem statements and the objectives of the project will be described. The importance of using

augmented reality in animal kingdom applications for educational purposes is also covered in the introduction.

In the project background, according to Jan Nowatschin (2022), millions of animal species exist, and as scientific knowledge advances, the count fluctuates. Animals constitute over 75% of Earth's species, categorized as vertebrates, animal with a backbone and invertebrates, animal without a backbone. Invertebrates, mainly in the phylum Arthropoda, contrast with vertebrates in Phylum Chordata. Animals can further be classified into mammals, insects, reptiles, and birds.

Society encounters an issue with the lack knowledge of animal in the younger generation. This poses a problem as understanding animals is crucial for them. Study made by Wulandari & Widodo (2020) show that in Table 1 that 47.7% of students have complete understanding of the animal kingdom, 10.4% show incomplete understanding of the animal kingdom, after that misconception is 31.6% and finally, no idea or guessing is 13.3% about animal kingdom. Three categories which is incomplete understanding, misconception and no idea or guessing can contribute to the lack of knowledge in the students in school. Additionally, uninteresting way of learning knowledge about animal can negatively impact individuals' interest in acquiring new knowledge. Study made Saleh & Jing (2020) showed that Malaysian school teachers mostly use one-way communication in their instructional methods, resulting in minimal interaction between students and teachers. This approach, where teachers primarily talk and teach while students simply copy notes, is deemed uninteresting and lacks meaningful interactions, potentially impacting students negatively.

Table 1: The result of the study

Categories	Percentage (%)
Correct understanding	46.7
Incomplete understanding	10.4
Misconception	31.6
No idea or guessing	13.3

Also, A preliminary study involved interviews, focusing on the animal kingdom theme. The interviewee was Miss Kavitha a/p Palan, a middle school science teacher at Sekolah Kebangsaan Senai Utama with 8 years of teaching experience in the subject. This choice was made because science teachers in middle schools possess in-depth knowledge of the animal topic. Thirteen question has been created for the interview.

The project scope of this project consist of target audience, language used, platform, technology and type of animal involve in the project. The target audience for this application is public especially primary school students that took science subject. The platform for this project will be on mobile platform while the language used is English. Furthermore, the technology that will be utilized is Markerless Augmented Reality. The type of animal that covered were both vertebrate and invertebrate, which in the category of mammals, fish insects and cephalopods.

Hence, the project was designed to educate about the animal kingdom using mobile devices and implementing marker-less augmented reality (AR) technology. This approach aims to increase interest in learning about animals by offering an interactive experience that blends real-world surroundings with computer-generated content. Integrating AR elements into the application provides information in an engaging manner, create excitement and increasing interest in learning more about animals.

LITERATURE REVIEW

Animal Kingdom

Animals, or members of the kingdom Animalia, refer to a collection of multicellular eukaryotic organisms that differ significantly from bacteria due to the containment of their deoxyribonucleic acid or DNA within a membrane-bound nucleus (Maiorana, V. C. & Valen,. Leigh M. Van, 2023). Jones (2012) explained the animal kingdom is mainly comprised of multicellular beings such as insects, fish, and mammals, which

acquire sustenance by feeding on other living entities. Furthermore, members of the animal kingdom possess muscles, allowing them mobility, which significantly impacts how organisms acquire nutrients for their growth and reproduction (Maiorana, V. C. & Valen, . Leigh M. Van, 2023).

Zoology

Zoology is a branch of biology that focuses on the study of animal kingdom members and overall animal life. This field encompasses the examination of individual animals, exploring their components down to the molecular level, as well as the investigation of animal populations, entire faunas, and the interconnections among animals, plants, and the non-living environment (Hanson, E. Dorchester, 2023). In addition, according to Wilson (2017), zoology encompasses scientific disciplines such as embryology, cell biology, developmental biology, endocrinology, immunology, biophysics, ecology, genetics, evolutionary biology, and related fields in their connection to animals.

Classification of Animal

Animal kingdom classification is an important system for understanding how all living organisms are related (Austin S., 2023). According to Verma & Prakash (2020), Taxonomy is a way to classification of all living organisms based on distinct characteristics, while systematics, closely associated with taxonomy, deals with the organization and arrangement of these organisms. Based on Figure 1, it shows how the taxonomic hierarchy of animal work. The taxonomic hierarchy consists of several levels, each representing a progressively more specific category.

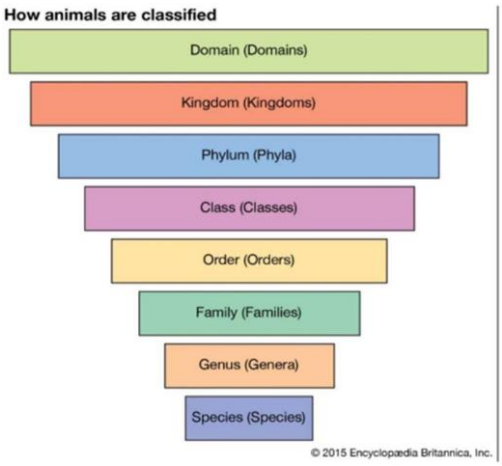

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Figure 1: The hierarchy of Animal Taxonomy

Study made by Austin (2023) indicated that various animal families are categorized based on distinct groups sharing very similar features. Animal families are primarily divided into two main groups, that are vertebrates and invertebrates. According to Anne Helmenstine (2022), vertebrate are animals that have backbones while invertebrate are animals that lacks backbone.

Importance in Learning Knowledge of Animal Kingdom

In gaining an understanding of the natural world through the study of zoology, it looks into animal biology, how and why behind its environments, and ways to sustain their lives alongside humankind (Batool, S. ,2022). The author explained that exploring the animal kingdom through

zoology enhances our comprehension of their biology and underscores their significance in coexisting with humanity. The importance of studying animals can be categorized into two aspects which are social and economic.

In social aspect, animal kingdom study through zoology able to help the society in creating medicine and provide therapy. One study in 2019, found that the use of therapy dogs improved the efficacy of mental health treatments among adolescents. (Johnson, J., 2020). Furthermore, according to Batool, S. (2022), zoology's contributions to medicine enhance our understanding of human health, facilitate the development of treatments and preventive measures, and promote the well-being of both humans and animals.

In economic aspect, according to Bhatt & Maru (2022), every animal has their importance in modern-era as their have special place in the industries because it are able to produce material or substance that important to humankind such as honeybees and silkworm.

Findings of Interview

From the interview, it was revealed that the animal kingdom topics, such as vertebrates and invertebrates, are extensively covered in textbooks. Miss Kavitha emphasizes the need for more interesting and accessible learning materials. She advocates for augmented reality as an exciting tool for teaching the animal kingdom,

highlighting its potential benefits and approval for school use. Miss Kavitha notes a limited science subject knowledge due to parental influence, stressing teachers' efforts to enhance understanding. Regarding students learning beyond textbooks, she suggests alternative teaching methods. Overall, she believes students can achieve a profound understanding of animals through science education.

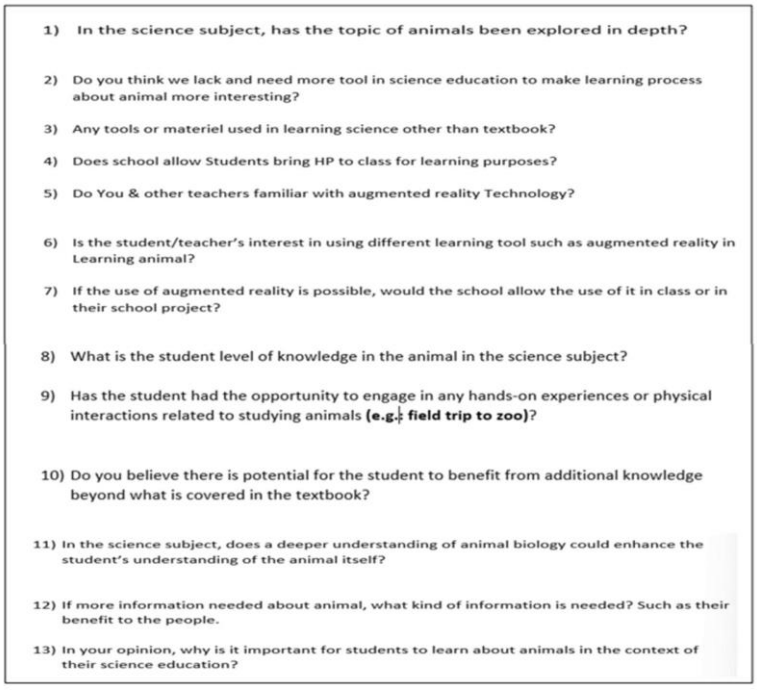
1) In the science subject, has the topic of animals been explored in depth?
2) Do you think we lack and need more tool in science education to make learning process about animal more interesting?
3) Any tools or materiel used in learning science other than textbook?
4) Does school allow Students bring HP to class for learning purposes?
5) Do You & other teachers familiar with augmented reality Technology?
6) Is the student/teacher's interest in using different learning tool such as augmented reality in Learning animal?
7) If the use of augmented reality is possible, would the school allow the use of it in class or in their school project?
8) What is the student level of knowledge in the animal in the science subject?
9) Has the student had the opportunity to engage in any hands-on experiences or physical interactions related to studying animals **(e.g. field trip to zoo)**?
10) Do you believe there is potential for the student to benefit from additional knowledge beyond what is covered in the textbook?
11) In the science subject, does a deeper understanding of animal biology could enhance the student's understanding of the animal itself?
12) If more information needed about animal, what kind of information is needed? Such as their benefit to the people.
13) In your opinion, why is it important for students to learn about animals in the context of their science education?

Figure 2: Interview's questionnaire

People's Lack of Knowledge in Animals

According to Cothran, M. (2020), the author stated that educational platforms, like the Next Generation Science Standards, inadequately address in-depth exploration of natural content, particularly lacking guidance on topics such as animal taxonomy. Interviews reveal students' limited knowledge of animals due to restricted exposure, with hands-on experiences mostly confined to the school setting rather than extended to places like the zoo.

Uninteresting method of learning animal

Ristya Rini (2021) found that rather than relying solely on two-dimensional image-based learning resources, students would gain more from utilizing augmented reality for a more effective exploration of animal varieties and characteristics.

Furthermore, through the interviews that been conducted suggest that students can be inspired to delve deeper into animal studies using engaging methods like augmented reality, expanding their understanding beyond traditional textbooks.

Learning Technology

Applications development must encourage learning motivation, so students are happy to use it. It is important because a strong application, of course, will indirectly shape the character of students in an awareness of learning (Miyake, 18 M., Takeuchi, K., & Toda, Y., 2018). According to Dyhrkopp (2021), In the era of digital living, the use of technology in education is becoming increasingly widespread. The author elucidates the growing prevalence of technology employed in current educational methods, highlighting its commonality in response to the digital age in which people are now immersed. Furthermore, Dyhrkopp (2021) stated that utilizing technology in the classroom can involve play, digital storytelling, games-based learning, blogs, coding, robotics and virtual field trips.

Augmented Reality Technique

Augmented Reality (AR) technology integrates virtual information into the real-world using multimedia, 3D modelling, real-time tracking, intelligent interaction, sensing, and other technical tools. Its core principle involves overlaying computer-generated virtual elements like text, images, 3D models, music, and videos onto the real-world following simulation (Chen et al., 2019). There are two categories of AR which are marker-based AR and marker less AR. The differences between these two rely on the information source for the position of the digital content within the user's view (Boonbrahm et al., 2020). Maker-based AR provides information about a physical object through digital visualizations. While not widely used, it offers diverse applications based on specific needs, utilizing a camera to analyze images, QR codes,

or patterns and displaying relevant information on the screen (Aryel, 2020). The markerless augmented reality technique allows virtual objects to be positioned anywhere in the physical environment without relying on specific markers. Unlike marker-based AR, it depends on the inherent features of the surroundings. Commonly used in smartphones and digital devices, the markerless AR system utilizes the built-in GPS function to locate and interact with available augmented reality resources (JomsriP, 2018).

Design Principle

Design principles are fundamental pieces of advice for designers to make easy-to-use, pleasurable designs. Designers apply them when they select, create and organize elements and features in their work. Design principles represent the accumulated wisdom of researchers and practitioners in design and related fields. When these principles have been applied, designers can predict how users will likely react to their designs (Francis, S., 2020). According to Miler,

J. (2020), AR enhances the real physical world by incorporating digital visuals, sound, and sensory technology. Numerous contemporary apps prioritize AR design to enhance user experiences. The author emphasizes the significance of incorporating elements like digital visuals, sound, and sensory technology in augmented reality design to create a more immersive user experience.

Visual Elements of the Augmented Reality

Visual elements that used in the project are text, picture such as animal biology, static model such as animal kingdom model. Furthermore, animations are implied also in the project to show the movement of the 3D animal and lastly is video and audio, video to show certain info about the animal and audio to increase the 3D environment of animal kingdom in the application.

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Review of Methodology

A methodology is a structured approach used to solve problems or achieve goals, providing specific guidelines for effective activities. In project management, it outlines steps and processes to ensure logical order and role clarity. Common methodologies in multimedia project development include Agile, Waterfall, and Rapid Application Development (RAD). Methodology usage varies by industry, and new variations may emerge as organizations adapt to unique needs. The count of methodologies is not fixed and evolves over time.

Review of Methodology

Reviewing existing apps entails assessing various aspects like technology, techniques, user interaction, accessibility, and design elements of established mobile applications. This analysis offers insights for developers to make informed decisions or enhancements. The application that been reviewed is Google 3d animal, Animal Safari AR and ARLOOPA: AR Camera 3D Scanner. This application been chose because all of those three shares the same thing which is Marker less augmented reality and involve with animal theme in their application.

Figure 3: Google 3d Animal

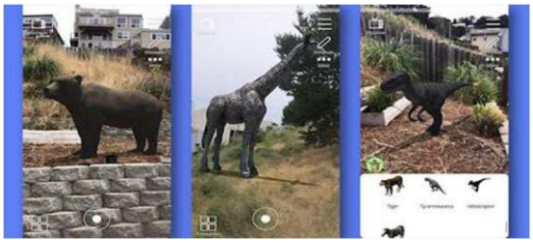

Figure 4: Animal Safari AR

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e-ISSN: 3030-6728
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Figure 5: ARLOOPA: AR Camera 3D Scanner

METHODOLOGY

The methodology used in this project is agile methodology. This project only focuses on four phases of agile which is requirement analysis phase, design phase, development and testing phase.

Agile development, as a project management methodology, prioritizes individuals and interactions over processes and tools. It emphasizes adaptability, teamwork, and continuous improvement in managing projects and developing software. According Sharma et al (2012), agile methodology is having flexibility and able to adapt shifting needs of the user through the iterative process. Furthermore, Edeki (2015) found that, the iterative method has proven to be highly efficient in supporting software developers to enhance their skill in estimating schedules for remaining tasks. Agile methodology has six phases which is started with requirement analysis phase, design phase, development phase, testing phase, deployment phase and review phase. However, this project only involved four phases of Agile.

Figure 6: Agile Methodology

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First phase is requirement, during this phase, essential data for the animal kingdom project was gathered through extensive research on articles and journals. This included information on the younger generation's lack of animal knowledge, the use of augmented reality in learning, and existing applications in this domain. The collected data covered all aspects required for developing the augmented reality application, addressing societal issues related to animals, detailing the development method, and proposing solutions through the application.

Second phase is design phase, in this phase, developer need to create a proper flow of the application design that can be represented through the flowchart, flowchart is a diagram that will show the flow of the application's process. Additionally, the phase involves crafting the application's storyboard, outlining crucial elements as a design guide, Storyboarding is essential before the development of application is started as it help visualize and plan the flow of the project.

Figure 7: Flowchart of AnimalAR: An Interactive Tool in Learning Educational Animal Kingdom Through Augmented Reality

Third phase is development phase, The developer constructed the application using information gathered from the requirement and design phases. This stage focused on creating 3D models and scripting for the augmented reality application. The development utilized the hardware and software identified in the requirement analysis phase.

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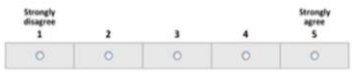
Fourth and final phase is testing phase, the testing phase plays a crucial role in the development process by verifying that the application meets quality standards and project requirements. Engaging the intended users, specifically primary school students from the younger generation, this phase evaluates the augmented reality application's effectiveness in fulfilling project objectives. System Usability Scale or SUS test case was used for the testing. According to Brooke (1995), SUS is a simple, ten-item scale giving a global view of subjective assessments of usability.

Table 2: System Usability Scale Test Case

	Question	Scale
1	I like to use this augmented reality application more often	
2	I find this augmented reality application to be more complicated than it should be	
3	I think the augmented reality application is simple and easy to use.	
4	I need technical support to use this augmented reality application.	
5	I find the augmented reality application functioning smoothly and is well integrated.	
6	I think there are a lot of irregularities in the augmented reality application	
7	I think most people can learn this augmented reality application quickly.	
8	I find this augmented reality application to be time-consuming.	
9	I feel confident while using this augmented reality application	
10	I think there are a lot of things to learn before I can start using this augmented reality application	

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RESULT AND DISCUSSION

In the project's application testing phase, the goal is to systematically assess the augmented reality application's performance using the System Usability Scale (SUS). The testing covers aspects like user satisfaction, efficiency, ease of use, interactivity, and learnability. Primary school students and the science teacher from Sekolah Kebangsaan Senai Utama will act as testers. Once the augmented reality application testing is done, an evaluation form will be provided to gather feedback from both students and teachers.

Table 3: Questionnaire Evaluation Results

No	Questions					
	User Satisfaction	**1**	**2**	**3**	**4**	**5**
1	I like to use this augmented reality application more frequently.	0	0	0	20	10
2	I find the augmented reality application functioning smoothly and various functions are well integrated.	0	0	0	17	13
3	I thought the AR learning tool was very well designed.	0	0	0	16	14
4	I feel confident while using this augmented reality application.	0	0	4	22	8
	Efficiency					
5	I think the navigation through sections in the app is easy.	0	0	0	16	14
6	I believe that I could become productive quickly using this AR learning tool.	0	0	0	23	7
	Ease of Use					
7	I would describe the AR learning tool as very easy to use.	0	0	0	17	13
8	I found it easy to become familiar with the AR learning tool.	0	0	1	19	10
	Interactivity					
9	I find this augmented reality application to be complex than it should be.	9	18	1	2	0
10	I need technical support to use this augmented reality application.	12	17	1	0	0
11	I found there was too much inconsistency in this AR learning tool.	16	14	0	0	0
	Learnability					
12	I think there are a lot of things to learn before I can start using this augmented reality application.	10	19	1	0	0
13	I think i can learn this augmented reality application quickly.	0	0	0	13	17

Table 3 shows the questionnaire for the respondent, the total number of questions is 13 with five different aspects of questionnaire; user satisfaction, efficiency, ease of use, interactivity and learnability. The total acquire of respondents is 30 people which is 28 students and the other two is science teachers.

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To calculate the System Usability Scale (SUS) Score, the following formula is applied. For odd-numbered questions, the score is subtracted by 1, and for even-numbered questions, the score is subtracted from 5. This process is essential in obtaining a comprehensive assessment of the usability of the system, taking into account both positive and negative responses across the questionnaire's set of questions.

$$\boldsymbol{SUS\ score} = (\boldsymbol{X} + \boldsymbol{Y}) * \mathbf{2.5}$$

```
=((B2-1)+(5-C2)+(D2-1)+(5-E2)+(F2-1)+(5-G2)+(H2-1)+(5-I2)+(J2-1)+(5-K2)+(L2-1)
+(5-M2)+(N2-1))*2.5
```

Figure 3: Formula Code for the SUS Score in Google Sheet

The SUS score is calculated using Google Sheets, where columns labelled with alphabet sequences like (B2-1) represent odd-numbered questions, requiring a subtraction of 1 from their scores while columns like (5-C2) presented as even-numbered questions where the score of those questions has to be subtracted from 5. This pattern continues until (5-M2) and (N2-1), which mark the final odd and even-numbered questions. After that, the total of number score from the questions will be multiply by 2.5.

1. I	2. I	3. I	4. I	5. I	6. I	7. I	8. I	9. I	10.	11.	12.	13.	SUS Score
4	5	4	5	5	5	4	4	1	2	1	2	4	57.5
4	4	4	4	4	4	4	4	1	1	2	2	5	70
4	4	5	4	5	4	5	4	2	2	2	2	4	75
4	4	4	4	4	4	4	4	2	2	1	2	4	65
4	4	4	4	4	4	4	4	2	3	2	2	4	65
5	4	5	5	5	5	5	5	2	2	2	3	5	70
4	5	5	4	4	4	5	4	2	2	2	2	5	72.5
4	5	4	4	5	4	4	4	2	2	2	2	4	67.5
4	5	5	4	4	4	4	5	2	2	2	2	4	65
5	4	5	4	5	4	5	4	2	1	1	2	4	77.5
5	5	4	5	4	4	4	4	2	2	1	2	5	65
4	4	5	4	5	4	4	4	2	1	2	2	5	77.5
5	5	4	4	4	5	4	5	2	1	1	2	5	65
4	4	5	4	5	5	4	4	1	2	2	2	4	67.5
4	5	5	4	5	4	4	5	4	1	1	1	5	77.5
5	4	5	4	5	4	5	5	2	1	1	2	5	77.5
5	4	4	5	4	4	4	4	1	1	2	2	5	75
5	4	5	5	4	4	5	4	1	2	1	1	4	70
4	4	5	5	4	4	5	5	1	1	2	2	5	70
4	5	5	4	5	4	5	4	1	2	1	1	5	72.5
4	5	4	5	4	4	5	5	2	2	1	1	4	62.5
4	4	4	5	4	5	5	4	1	1	2	2	5	67.5
5	4	5	4	4	5	4	5	4	1	1	1	4	75
5	4	4	5	4	5	4	5	2	2	1	2	5	62.5
5	5	4	4	5	4	5	4	2	2	1	1	5	75
4	5	4	4	5	4	4	5	2	2	2	1	5	70
4	4	4	4	4	4	5	4	2	2	1	1	5	72.5
4	4	4	4	5	4	4	4	1	1	1	1	4	70
4	5	5	4	4	4	4	3	2	2	1	1	4	70
4	5	4	4	4	4	5	4	3	1	2	2	5	75
													70.0833

Figure 8: Calculation of SUS Score

Figure 4 shows the spread sheet of questionnaire and the score of each questionnaire from the respondents. At the far right of each row is the SUS score and the final row at the is the average value needs to be identified through the total

of SUS score. The total average SUS Score that been calculated is 70.0833.

A SUS score of 70.0833 suggests favourable usability for the application. Users who have tested the application perceive it as user-friendly and easily navigable. Additionally, there is potential for improvement in the application.

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eISSN 3030-6728