UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF INTERACTIVE SIMULATION-BASED MOBILE APPLICATION ON NEWTON'S LAW OF GRAVITATION IN SECONDARY SCHOOL STANDARD CURRICULUM (KSSM)

ZULHELMI BIN FAUZI

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By

ZULHELMI B FAUZI

Thesis Submitted to the Department of Physics, Universiti Putra Malaysia, in partial Fulfilmentof the Requirements for the Degree of Bachelor of Science in Physics with Education (Honours)

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DEDICATION

This dissertation is dedicated to:

- My supervisor, Dr Muhammad Khairul Adib Muhammad Yusof, has guided and provided advice for me in accomplishing this project.
- My project coordinator, Dr Shuhazlly Mamat @ Mat Nazir, has prepared a seminar and workshop related to the preparation of the thesis.
- My family members and my fellow friends have given the support and help directly and indirectly throughout the thesis writing journey.

ABSTRACT

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The change in the Malaysian education system from the Integrated Secondary School Curriculum to the Standard Secondary School Curriculum in 2017 has brought reformations and additions to the content in Physics forms 4 and 5. There are two new topics introduced which are Gravitation and Quantum Physics. The introduction of this new topic has challenged teachers to produce an effective teaching aid. Furthermore, the world is facing the advancement of information technology that demands the integration of ICT in schools through the Malaysian Education Development Plan (2013 - 2025) based on standards given by the International Association of Educational Technology (ISTE). Therefore, this study aims to develop a science simulation with the concept of ICT technology such as an interactive simulation-based mobile application as a teaching aid. The topic of Gravitation form 4 and the first subtopic, Newton's Universal Law of Gravitation, were chosen as the basis for the development of the simulation. The selection is based on the findings of the first study of the study which is the identification of critical subtopics in the topic of Gravitation. The developed simulations were then tested by 20 Physics teachers from various secondary schools in

Malaysia. This study also aims to assess the level of effectiveness of this simulation through the results of a survey conducted among teachers. This study has contributed ideas to teachers on the parts that need to be focused on teaching the topic of Gravitation, as well as providing effective teaching aids for use in teaching and learning.

ABSTRAK

PEMBANGUNAN APLIKASI MUDAH ALIH BERASASKAN SIMULASI YANG INTERAKTIF MENGENAI HUKUM KEGRAVITIAN NEWTON BAGI KURIKULUM STANDARD SEKOLAH MENENGAH (KSSM)

by

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Februari 2022

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Perubahan dalam sistem pendidikan Malaysia daripada Kurikulum Bersepadu Sekolah Menengah kepada Kurikulum Standard Sekolah Menengah pada 2017 telah membawa pembaharuan dan penambahan isi dalam matapelajaran Fizik tingkatan 4 dan 5. Terdapat dua topik baharu yang diperkenalkan iaitu Kegravitian dan Fizik Kuantum. Pengenalan topik baharu ini telah memberi cabaran kepada guru-guru untuk menghasilkan sebuah bahan bantu mengajar yang berkesan. Tambahan pula, dunia sedang berdepan dengan kepesatan teknologi maklumat yang menuntut pengintegrasian ICT di sekolah melalui Pelan Pembangunan Pendidikan Malaysia (2013 – 2025) berdasarkan piawaian oleh Persatuan Antarabangsa Teknologi Pendidikan (ISTE). Oleh yang demikian, kajian ini bertujuan untuk membangunkan sebuah simulasi sains yang berkonsepkan teknologi ICT seperti aplikasi mudah alih berasaskan simulasi yang interaktif sebagai bahan bantu mengajar. Topik Kegravitian tingkatan 4 dan subtopik pertama iaitu Hukum Kegravitian Semesta Newton telah dipilih sebagai asas kepada

pembangunan simulasi. Pemilihan tersebut adalah berdasarkan hasil dapatan kajian pertama kajian iaitu pengenalpastian subtopik yang kritikal dalam topik Kegravitian. Simulasi yang dibangunkan kemudian diuji cuba oleh 20 orang guru matapelajaran Fizik daripada pelbagai sekolah di Malaysia. Kajian ini juga bertujuan untuk menaksir tahap keberkesanan simulasi ini melalui hasil tinjauan yang dilaksanakan dalam kalangan guru-guru. Kajian ini telah menyumbang idea kepada guru-guru mengenai bahagian yang perlu difokuskan ketika mengajar topik Kegravitian, serta menyediakan bahan bantu mengajar yang berkesan untuk digunakan dalam pengajaran dan pembelajaran.

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I wish to express my sincere gratitude to my research supervisor, Dr Muhammad Khairul Adib Muhammad Yusof, for his valuable guidance, patience, knowledge and positive encouragement that have been shared throughout the completion of my thesis.

I would sincerely like to thank all individuals who have contributed to my research, especially my former supervisor, Prof. Dr Sidek Ab. Aziz and Assoc. Prof. Dr Yap Wing Fen gave moral support, sharing of ideas, and assistance throughout my research journey.

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Finally, thank you to my classmates for giving so much help in completing this thesis, and your help and assistance has been a source of encouragement for me to fight in this challenging pandemic COVID-19 situation.

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LIST OF ABBREVIATIONS

KSSM	Kurikulum Standard Sekolah Menengah
KBSM	Kurikulum Bersepadu Sekolah Menengah
BBM	Bahan Bantu Mengajar
P&P	Pengajaran dan Pembelajaran
MCO	Movement Control Order
UI	User Interface
DSKP	Dokumen Standard Kurikulum dan Pentaksiran
COVID-19	Coronavirus Diseases
IoT	Internet of Things
IR 4.0	Industrial Revolution 4.0
HOTS	High Order Thinking Skill
STEM	Science, Technology, Engineering and Mathematics
SDLC	Software Development Life Cycle
IT	Information Technology
CAD	Computer Aid Design

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Following the passage of time, Malaysian education is on the rise. This can be seen in Malaysia's educational curriculum, from the Integrated Secondary School Curriculum (*Kurikulum Bersepadu Sekolah Menengah*, KBSM) to the Secondary School Standard Curriculum (*Kurikulum Standard Sekolah Menengah,* KSSM) starting from 2017. Not only has the educational framework been adjusted, but all subjects now have a new, more modern, and up-to-date syllabus included in the Curriculum and Assessment Standard Document (*Dokumen Standard Kurikulum dan Pentaksiran,* DSKP). Physics subjects are not left out of this reform, as two new topics, Gravitation and Quantum Physics, have been added, bringing the total number of topics for form 4 and 5 Physics subjects to 12 when it used to be 10. This system's renewal includes adding new topics and updating existing content to ensure it is more up to date and systematic.

The ability of teachers to produce effective teaching and learning (*Pengajaran dan Pembelajaran,* P&P) is a good indicator of interactive P&P (Azmi et al., 2011). Creative and innovative teachers should be prepared in terms of knowledge and skills in P&P, including the ability to relate all aspects in their delivery. Teachers who are creative and innovative in P&P can be role models for other teachers because they use new ideas or adapt existing BBM. The presence of BBM allows the teacher to act as a facilitator, increasing the effectiveness of student-centred learning. However, due to the need for teachers to provide time, energy, and money to provide it, the practice of effective BBM use has not been fully implemented (Kamarudin Husin & Siti Hajar, 1998; Sufean Hussin et al., 2005). Furthermore, the Malaysian

education reform has undoubtedly increased the pressure on teachers to provide the most up-to-date and innovative BBM, especially for Gravitation and Quantum Physics topics.

The use of computer simulation as BBM has a long history with science subjects such as biology, chemistry, and physics. Computer simulations allow students to explore and interact with real-world experiences that cannot be physically felt. Computer simulations can also be used for laboratory simulations that are impractical, expensive, impossible, or too dangerous to perform (Zietsman, 1986; Stieff, 2003); provide an open experience for students (Sadler et al. 1999); provide scientific investigation tools (Dwyer & Lopez, 2001). As a result, the computer simulation can simplify the P&P process for KSSM's new physics topics, Gravitation and Quantum Physics, because these two topics require students' high levels of thinking and imagination.

Therefore, this research was conducted to create a computer simulation for one of the new physics subject topics, Gravitation. This simulation is aimed to help teachers in P&P by using computer simulation technology as a BBM. Since the topics were recently introduced, the available BBM are limited, especially those tailored to KSSM. Therefore, teachers must work hard to develop effective strategies for information delivery. In addition, this research will also determine the effectiveness of the developed simulations. This is important for improving the simulations created by the user's needs. It is hoped that through the adoption of this simulation, the technology-based BBM can be centralised by the advancement of the modern world.

1.2 Problem Statement

By transforming the national education system from KBSM to KSSM, Malaysia strives to compete internationally in technology, economy, and education. Besides, in accordance with the development of current technology in the world guided by the Industry Revolution 4.0, Malaysian education needs to be aligned with the technology-assisted education system so that efforts to produce competitive future generations can be implemented. Therefore, all parties need to work together to create a P&P strategy using current technology to achieve the aspirations of Education 4.0. The reform of the national education system has brought in several different contents from KBSM. For example, in the form 4 physics subject, there is a new topic under Newton's mechanics: Gravitation. BBM on these new contents is also less to be practised and presented to students.

It is common knowledge that several digital simulation developers have long developed gravity-related simulations. Undoubtedly, all the developed simulations allow users to experience how our solar system works in the presence of gravity. However, these simulations were found to have no improvement over time. Users may experience bugs in the simulations that discourage them from using it. Not only that, but the simulations developed are also not comprehensive and only cover a few theories. Furthermore, some simulations do not follow the fundamental theory of gravity which causes users to experience inaccurate and disengaging learning experiences. Therefore, a study was conducted to address the problems that persisted in the existing simulations.

1.3 Objectives

The objectives of this study are:

1. To identify the most challenging subtopic in the topic Gravitation (Physics KSSM) among Malaysian secondary school teachers.
2. To develop an interactive simulation-based mobile application that aids the teaching and learning the previously identified subtopic.
3. To assess the user experience and efficacy of the developed application among Malaysian secondary school teachers.

1.4 Limitation of Study

Even though the simulation development for BBM appears to be flawless, the researcher encountered certain limitations while researching for this study. One of the study's limitations is the teachers' willingness to respond to the questionnaire. This is due to several factors, including the researcher's ability to obtain face-to-face data. This study was conducted when Malaysia dealt with Coronavirus Diseases (COVID-19) pandemic. The Malaysian government has implemented the Movement Control Order (MCO) to prevent the epidemic from spreading. Therefore, the researcher could only communicate with the respondents via video communication platforms. As a result, the number of teachers involved as respondents is reduced to 20 instead of 30 in the initial plan. Moreover, a lack of manpower in the simulation's development was one of the reasons this study was completed a little later than expected. Furthermore, due to a lack of manpower in the simulation development process, only one topic was focused on Newton's Universal Gravitational Force. This is because developing a comprehensive simulation for all topics will take longer than completing this study.

1.5 Overview of Thesis

Chapter 1 gives the reason for the development of simulation for this study which describes the background of the study. It also explains the problems statement, objectives and limitations of the study. Then, Chapter 2 provides a review of related literature reports relevant to the research and some background information to gain more knowledge about research. This chapter also provides the data and information from the previous research to further strengthen the arguments given in this study. Next, Chapter 3 will discuss the research design, respondents, research periods, data collection procedure, data analysis procedure and study ethic. The result and discussion will be in Chapter 4, where every data is given will be analysed and discussed to answer all of the problems and achieve the research objectives by using the methodology in Chapter 3. Lastly, Chapter 5 will present the conclusion and suggestions for future work of this research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the history, definition, concept theories, model and previous studies on Malaysia's new education system, Curriculum Standard Secondary School (*Kurikulum Standard Sekolah Menengah*, KSSM), teaching aids (*Bahan Bantu Mengajar*, BBM), computer/digital simulation, and simulation development. In addition, this chapter also discusses the mobile application that contains the simulation on gravity and universe from various platforms to get a better understanding for users about this type of simulation. The data gained from this review will help the development of this study.

2.2 Reformation of Malaysia Education System

2.2.1 Industry Revolution 4.0 (IR4.0)

The Fourth Industrial Revolution, commonly referred to as Industry 4.0, is one of the most trending topics in professional and academic fields (Chiarello et al., 2018; Liao et al., 2017). This concept has Smart Manufacturing as its central Element (Kagermann et al., 2013). Industry 4.0 relies on digital technologies to gather data in real-time and analyse it, providing helpful information to the manufacturing system (Lee et al., 2015; Wang et al., 2016). This was made possible by the Internet of Things (IoT), cloud services, big data, and analytics, which gave rise to the industry 4.0 notion of a cyber-physical system. (Wang et al., 2015; Lu, 2017). Industry 4.0 is setting high demand on the education process, as logistics will need highly skilled workers. Industry 4.0 affects governance, business and people, it also involves education. Thus, the name of Education 4.0 came into existence.

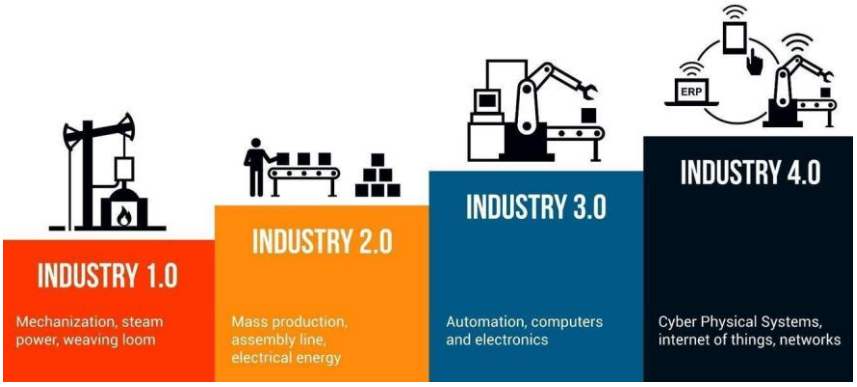


Figure 2.1: Differences of industries phases level

Source: (Mclellan S.,2018)

2.2.2 Education 4.0

Education 4.0 is the implementation of new technology into the current educational system. Education 4.0, in a manner, finishes the wonder of advanced combination in our regular daily existences where individuals and machines are adjusted to take out dissolvable, investigate and find new hypotheses of development (Halili,2019). All institutions must continue to integrate an innovative approach to strengthen the teaching and learning (*Pengajaran dan Pembelajaran*, P&P) process to meet the Industrial Revolution 4.0 demands in education.

The advanced application of technology 4.0 includes 3D printing, augmented reality, virtual reality, cloud computing, hologram, biometrics, multi-touch LCD screen, Internet of Things, artificial intelligence, big data, and QR-code is one of the underpinnings in Education 4.0. The theme also includes four components that must be highlighted. First, the utilisation of multi-tiered collaboration tables and a smart board to improve learning spaces. Second, the use of various pedagogies, including heutagogy, pedagogy, and cybergogy. Third, the use of a fluid and organic curriculum in which all institutions must accept new ideas without being constrained by existing curriculum methods. Fourth is the inclusion of technology developments in the P&P. To achieve this, P&P and incorporating the latest technology must be transformed (Dzulkifli, 2017).

2.2.3 KBSM to KSSM

Integrated Secondary School Curriculum (*Kurikulum Bersepadu Sekolah Menengah*, KBSM) was first implemented in 1989. With the development of advanced technology in the current era, KBSM has been reviewed to ensure our education aligns with the recent development and has been implemented in secondary schools across the country through the instruction of Ikhtisas Circular Letter No. 2/2000 dated 14 January 2020: Implementation Revised Syllabus for Integrated Primary School Curriculum (*Kurikulum Bersepadu Sekolah Rendah*, KBSR) and KBSM. On 23 May 2008, a follow-up Cabinet of Ministers Meeting No.6/2008 was conducted to overhaul Malaysia's education system. A new concept of the curriculum obtained the approval of the Central Curriculum Committee Meeting No. 2/2010 in October 2010 to be implemented in all stages started in form 1. It is known as Secondary School Standard Curriculum (*Kurikulum Standard Sekolah Menengah*, KSSM). After the first cohort of Primary School Standard Curriculum (KSSR) ended, the 198th Education Planning Committee (JPP) meeting on 18th January 2012 decided to implement KSSM in 2017.

To achieve the six aspirations of a student, which is knowledge, thinking skills, leadership skills, bilingual skills, ethic and spirituality, as well as national identity as recommended in the Malaysia Education Blueprint (PPPM) 2013-2025, innovation in the education system need to be done so that learning programs and student achievement can be improved. This innovation implementation based on content, pedagogy and assessment are as follows:

1. The content is restructured and improved to ensure students are provided with relevant knowledge, skills and values with current needs to meet the challenges of the 21st century.
2. Pedagogy emphasises in-depth learning through based P&P that priorities High Order Thinking Skills (HOTS). It also focuses on inquiry-based learning, problem-solving, contextual, collaborative learning, project-based learning and Science, Technology, Engineering and Mathematics (STEM) approaches.
3. Assessment is carried out continuously to ensure the development and achievement of student learning. A summative and formative form is implemented in the P&P assessment. The teacher assesses the capability of the student on mastering the learning standards by referring to performance standards. In addition, actual development and achievement of student mastery level are recorded and reported descriptively to students and their parents.

To ensure the continuity of primary education with secondary education, curriculum transformation is performed on KBSM. The curriculum was strengthened and improved to provide that it is always relevant to the current needs and challenges of the 21st century. To achieve this, the KSSM was introduced, which is in line with the Government Transformation Plan. The differences between KSSM and KBSM are explained in Table 2.1.

Aspect	KBSM	KSSM
Element of Curriculum	Language, Science & Information & Communication Technology, Environmental Sustainability, Moral, Patriotism	Language, Science & Information & Communication Technology, Environmental Sustainability, Moral, Patriotism, Innovation & Creativity, Entrepreneurship, Information & Communication Technology (TMK) and Global Language

Pedagogical Emphasis	Inquiry-based learning, problem-solving, contextual learning, collaborative learning and project-based learning	Inquiry-based learning, problem-solving, contextual learning, collaborative learning and project-based learning, constructivism approach, STEM approach
Assessment	Summative and Formative	Assessments are written in the DSKP as Performance Standards.
Rebranding of Subjects	1.TMK Literacy Program (SMR) 2. Integrated Living Skills 3. Elective Technical Subjects	1. Fundamentals of Computer Science (SMR) 2. Technology Design 3. Professional Elective Subjects
Offering New Subjects	None	● Korean Language ● Semai Language ● Special Vocational Education Subjects
Curriculum Design	1. The Curriculum Framework is based on three areas, ● Communication ● Human & Environment ● Self-Development 2. Based on learning outcomes	1. The Curriculum Framework is based on six areas, ● Communication ● Physical and aesthetics Development ● Humanity ● Self-appearance ● Technology & Science (STEM) ● Spirituality, Attitudes & Values 2. Standard-Based ● Content Standard ● Learning Standard Achievement Standard
Curriculum Documents	Syllabus	Curriculum and Assessment Standards Document (DSKP)
Time Allocation	Minute/week	Hour/week
Curriculum Organization	● Core Subject ● Compulsory Subject ● Additional Subject ● Elective Subject	● Core Subject ● Compulsory Subject ● Additional Subject ● Elective Subject

Table 2.1: The differences between KBSM and KSSM

2.3 Teaching aids

According to J. S. Farrant (1997), the confusion in defining the function of BBM arises from the decreasing frequency of their use during teaching and learning (*Pengajaran dan Pembelajaran*, P&P). To create the most effective BBM, some characteristics that are appropriate to the environment and conditions must be established. Therefore, BBM must explain difficult-to-understand parts, be prominent and visible, use attractive colours and the right size, be durable, be most effective, and be inexpensive (Azmi et al., 2011).These characteristics serve as the foundation for selecting teachers' BBM used during P&P. The characteristics mentioned are also among the factors that influence the use of BBM in P&P. There are several reasons, including management and administration, equipment and location, the importance of use, and preparation and use.

Most physics teachers use this as an excuse for not using BBM, even though BBM can help them from various aspects during P&P. The importance of its application is that it provides a solution to the problem of a lack of energy and time when preparing P&P (Siti Fatimah & Ab. Halim, 2010). Furthermore, it can attract students and increase motivation to pay close attention to the teacher's instruction. This is because BBM can adequately describe the theory that students have learned. Students will then have more fun and will not be bored (Azmi et al., 2011) by the teacher's P&P because each time they present their P&P, it always has something new. This factor is related to BBM as well as the method of delivery. Physics subjects require a wide range of BBM to explain concepts and theories of physics that are difficult to understand or cannot be seen with the naked eye.

2.4 Computer Simulation

2.4.1 Computer Simulation as Teaching aids

Computer simulation is one of the education technologies that help students improve their understanding by representing complex and difficult phenomena physics surround us in digital form. It is a process of creating a real or hypothetical physical system model, running it on a computer, and assessing the results (Fishwick,1995). This form of role-playing is analogous to computer simulation, which is used in synthetic power settings and virtual worlds. Model design, model execution, and model analysis are three significant subfields within the broader job of simulation (Fishwick,1995). To form an analogue of the behaviour of the existing system, the model must compose equations that duplicate the functional relationship within the basic design. The mathematical description or models of an entire system in a computer program was used to create a simulation. Declarative, functional, constraint, spatial and multi-model are all examples of models (Fishwick,1995). After a mathematical model was created, the next step is to run on a computer, which requires a computer program that steps through time while changing the state and event variables in the model.

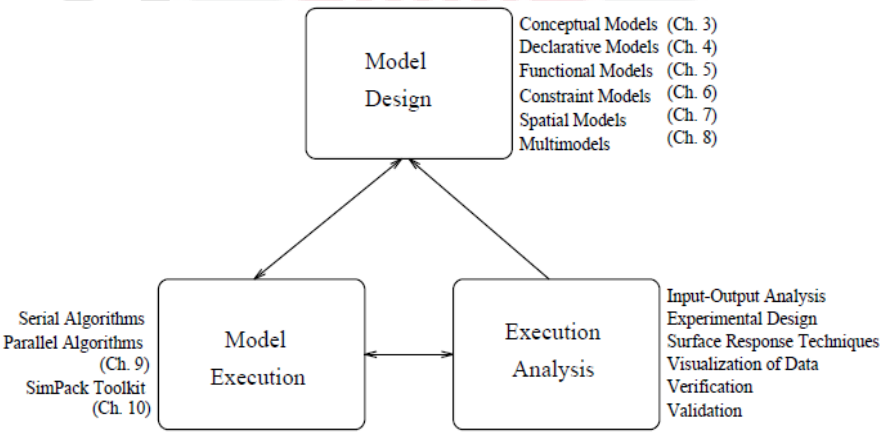


Figure 2.2: Three sub-field of computer simulation

Source: (ExpertsMind, 2009)

2.4.2 Factors Influencing Mobile Learning

Several variables encourage students and instructors to adopt mobile applications. These influencing variables must be considered if mobile learning is to be successful. Systematic literature reviews were performed on how mobile devices were used as P&P tools. As a result, the influential elements were divided into three groups, each of which had numerous subcategories. The characteristics of the gadgets, user expectations, and pedagogical advantage are the three primary categories.

2.4.2.1 Features of Devices

The gadgets' features were further divided into three categories: usability, technical, and functional (Economides and Nikolaou, n.d.). Firstly, mobile learning tools are tiny, light, and portable in terms of use (Ahonen, Pehkonen, Syvanen and Turunen, 2004; Cavus and Ibrahim, 2009). These characteristics let students feel more at ease because studying is no longer limited to the classroom with cumbersome backpacks stuffed with books and other learning resources. As a result of this flexibility, the process of imparting information becomes more flexible and may be done at any time and in any location. Next, functionally, Cavus and Ibrahim (2009), Eteokleous and Ktoridou (2009), and Cohen (2010) all claim that the gadgets may offer immediate and spontaneous information. There are occasions when students require direct access to certain information. Examples are quick solutions to particular queries, such as definitions, formulas, and equations. The gadgets will assist students in swiftly searching for such material. Continuity is another essential feature where mobile learning is a teaching method that allows students to access learning materials from any location. The ability to continue learning without regard to time or place is a critical factor influencing how learners are motivated to utilise mobile apps (Lan and Sie, 2010). Because of their location, learners' access to information and learning materials does not always come to a halt. Learners may

access and interact in several places and situations.

2.4.2.2 User's Expectation

Naismith and Corlett (2006) reviewed numerous successful mobile learning initiatives and found five important success factors.

Ownership is one of the five critical variables stated in the research. Learners will become more motivated, more engaged in communication, and learn much better if they own or treat the learning tool (Luckin, Brewster, Pearce, Siddons-Corby and du Boulay, 2004; Attewell and Webster, 2005).

Next, when comparing mobile devices to other computer devices (such as laptops and PCs), the former, of course, provides a sense of privacy to the learners. Learners have access to a private virtual environment through mobile applications, making them feel protected and motivated. Learners will interact with the gadget for various reasons if they have a sense of privacy. Learners can independently access and download material from other students (BenMoussa, 2003; Zhang, 2003; Virvou and Alepis, 2005).

Thirdly, researchers emphasise the necessity of giving students more control over their education. If learners are encouraged to take a more active part in their learning, they are more likely to pay attention to learning events (Watts, 1997; Selfe, 1999). Mobile learning allows learners to be at the centre of the learning process, taking an active part from goal setting through evaluation (Makoe, 2010). They are more likely to create learning methods to help their learning growth and build motivation once they are actively involved with the activity. Unlike other forms of digital media, a mobile device may be carried around at all times and provides users with a great deal of flexibility over how and when they use it.

In addition, today's learners' high mobility necessitates flexible learning. Mobile learning expands the range of possibilities for learning independent of location or time. Learners have the flexibility to exist in areas other than those of their professors, to study at their speed and on their own time, as long as they have the necessary hardware and network infrastructure (Cavus and Al-Momani, 2011).

Moreover, in most nations, life-long learning has become a crucial national objective due to contemporary economic and social development and the transition to a knowledge-based society. Mobile learning is considered one technology that can help people learn for the rest of their lives. HandLeR (n.d.) and a related study (Ketamo, 2002) at Tampere University of Technology (Finland) investigated life-long learning using mobile devices.

Lastly, games are thought to have a significant impact on mobile applications. According to Prensky (2007), computer games may be utilised entirely for learning, not simply for enjoyment or basic refresher of school subjects. Learners acquire all of the abilities included in each game level, feel interested and driven, and are unaware that they are learning. Prensky claims that when students play the game, they experience a thrill and engagement that they do not typically experience when ‘learning' in school. As a result, these digital games have become a replacement for a world of learning in which everything students learn is outdated and plain uninteresting.

2.4.2.3 Pedagogical Advantages

The researchers cited several empirical studies that show mobile devices can help with the instructional techniques or strategies listed below.

Firstly, collaborative learning requires social inclusion. The students collaborate to achieve a shared objective. Mobile devices encourage inclusiveness and provide for additional possibilities for involvement due to their accessibility, and as a result, learning becomes more successful. Many academics advocate for the use of mobile technology to increase students' participation in the learning process (Virvou and Alepis, 2005)

Secondly, blended learning, which blends classroom teaching with mobile learning, may improve and optimise the effectiveness of both face-to-face and online learning techniques (Ocak, 2010; Uzunboylu, Cavus, and Ercag, 2009; Bonk and Graham, 2006; Uzunboylu, Cavus, and Ercag, 2009). After a class session with their lecturer, the students can use their mobile devices to complete their assignments and projects.

Next, Cavus and Uzunboylu (2009) and Sharples, Taylor, and Vavoula (2005) use mobile technology to create an interactive learning environment. Mobile devices serve as interactive agents that enable different levels of interaction and engagement with technology, allowing learning to take place.

In addition, the gadgets' mobility allows for learning that is not restricted to educational settings. The tools strengthen the link between school and other daily activities (Sharples, 2003). This suggests that education may extend outside the classroom, with essential elements of learning brought into the school and diverse parts of the visit improved for learning purposes

(Chen, Kao, Sheu, and Chiang, 2002; Lonsdale, Baber, Sharples, Byrne, Arvanitis, Brundell, and Beale, 2004).

Lastly, one example of how mobile learning promotes Problem-Based Learning is the SNOWMOBILE project in Norway (Smrdal and Gregory, 2005). Students from the University of Oslo's School of Medicine experimented with PDAs and smartphones in medical teaching. In issue-based learning, students actively seek and work with content they believe is required to answer the teacher's challenge.

2.5 Simulation Development

2.5.1 Software Development Life Cycle

Leau et al. (2012) described the Software Development Life Cycle (SDLC) as a method for developing and managing software. The essential aspect of software development is the software development life cycle. It illustrates the stages of software development that must be completed. It usually involves several steps, ranging from fundamental development analysis through software testing and assessment after effect. It also includes the models and methods used by software development teams to create software systems. The methods serve as a framework for planning and managing the whole development process.

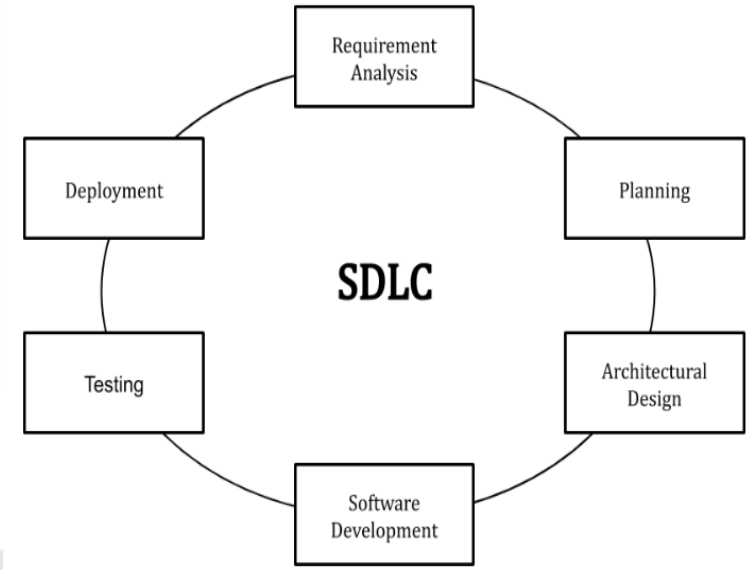


Figure 2.3: Software Development Life Cycle

Source: (Nambukara O. A.,2020)

A software program or information system is created to complete a particular set of tasks. The system's duties frequently produce well-defined results that need extensive calculation and processing. Managing the whole development process to ensure that the end product has a high level of integrity and robustness and user acceptability is a time-consuming and challenging task. To accomplish the qualities above of a successful system, a systematic development approach that focuses on comprehending the breadth and complexity of the whole development

process is required. There are many types of SDLC, such as the Waterfall Model, V-Model, Spiral Model and Agile Model. Still, a kind of SDLC methodology is suitable for developers for this project, the Agile Model.

Figure 2.4: Agile model cycle

Source: (Javatpoint, 2019)

The phrase agile refers to moving swiftly (Balaji, 2012). The gile approach requires a flexible workforce that can adjust to changing requirements. Rapid release of valuable software ensures customer happiness. Changes in conditions are welcome, mainly if they occur late in the development process. Working software is supplied regularly (weeks, not months). Customer satisfaction is the essential concept achieved by providing modest and helpful software in a timely and consistent manner.

Advantages	Disadvantages
1. The flexibility to adapt to changing project needs is the essential feature of the agile methodology. 2. Because there is face-to-face connection	1. If the projects are small, utilising the agile approach is undoubtedly beneficial, but if the project is vast, judging the effort and time necessary for the project

and continual feedback from the client, there is no guessing between the development team and the customer.	in the software development life cycle becomes challenging. 2. Only experienced developers are better equipped to make the judgments required for agile development, leaving little room for novice programmers unless they are coupled with senior resources.

Table 2.2: Advantages and disadvantages of Agile model

2.5.2 Unity

Figure 2.5: Unity software logo

Source: (Unity, n.d.)

Unity is a game engine developed in 2005 by Unity Technology in Denmark. Nicholas Francis, David Helgason and Joachim Ante were the backbones of Unity's development. Craighead et al. (2010) further described Unity uses a proprietary graphics engine in conjunction with the Nvidia PhysX physics engine and Mono, an open-source adaptation of Microsoft's Microsoft's. NET libraries. There are many advantages to using Unity as the project's engine, such as community, documentation, easy difficulty level, cost, physics and rendering and multi-platform distribution.

Craighead et al. (2010) also described Unity as a simple game engine compared to other game engines that adopt the concept of 'drag and drop'. Contents are organised in a tree and dragged and dropped into an environment. Each object in the atmosphere has its tree, to which it may be assigned numerous scripts written in C#, a Javascript-like language, or Boo, as well as physics and rendering properties. Script developers have complete control of the Mono API. Scripts can provide interactive actions to objects, build user interfaces, or manage data. Next, physics is essential in developing a game because physics is the backbone that provides properties to objects such as mass, velocity, momentum, energy and others. In Unity, physics properties are stimulated by Nvidia's PhysX engine, which is widely used in any simulation, including AAA commercial games. Shader and texture assignment are two rendering characteristics that impact visible objects. Unity's proprietary rendering engine employs a reduced shader language compiled into DirectX 9 or OpenGL 2.0 shaders depending on the target platform. Finally, the editor for the Unity engine runs on the OSX operating system. However, Unity apps may be built for OSX, Windows, Android, or a Web-Player that runs in a web browser through a plugin, similar to Adobe Flash. The distribution of Unity-created apps is unrestricted. Because Unity-created applications are not modifications of current games, the end-user does not need to possess a copy of anything. The developer can just release complete binaries as they see fit.

J. K. Hass (2014) realised that gaming engines might be utilised for non-game applications. For example, develop mobile applications, prototype an idea, create digital simulation, create an interactive art installation or use them for data visualisation. This ability of non-game uses makes Unity popular among developers because they no longer need to use different software when it is complete and capable of doing many projects. For example, a computer-aided design (CAD) application is nearly difficult to make a quality game, while Unity can do design as CAD and even more. This is also the main reason Unity is used in this project.

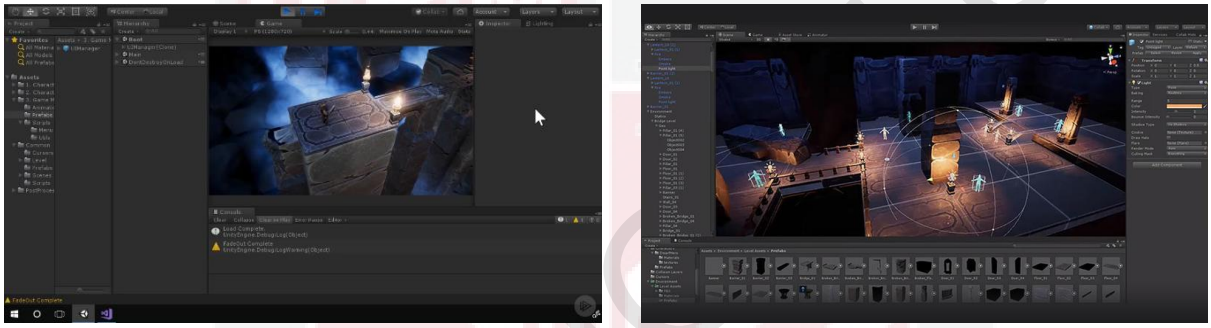


Figure 2.6: Interface of Unity

Source: (Unity, n.d.)

2.6 Mobile Application Review

2.6.1 Gravity Simulator

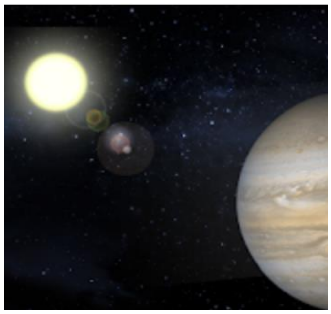


Figure 2.7: Gravity Simulator logo

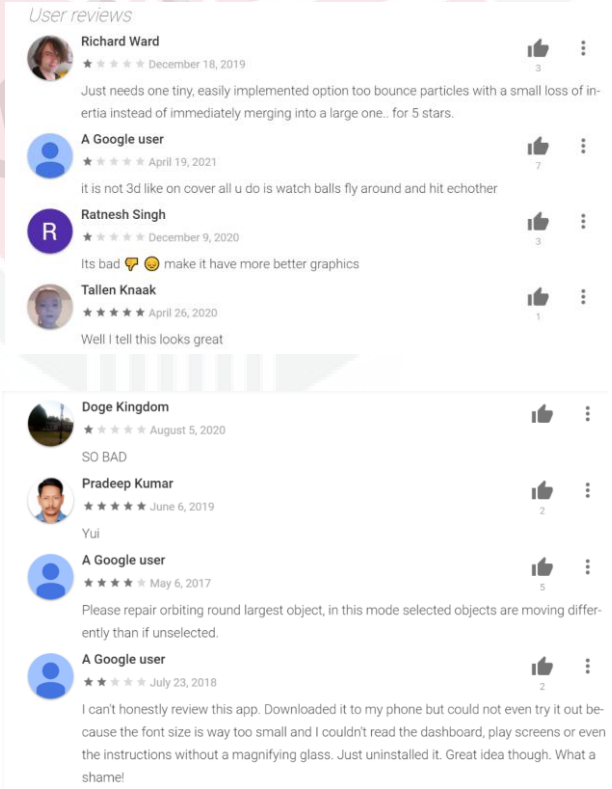
Source	Google Play
Platform/OS	Android
Developer	DPoisn LLC
Licenses	Free-To-Play
Rating	2.7 / 5
User Review	

Table 2.3: Information on Gravity Simulator

2.6.2 Pocket Galaxy-3D Gravity Sandbox Space Game Free

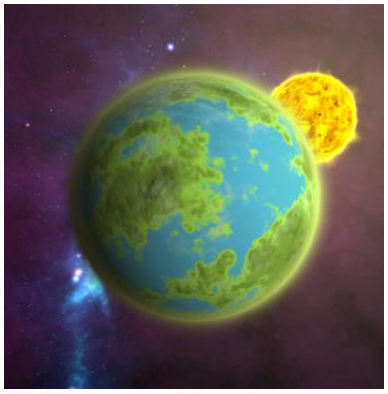


Figure 2.8: Pocket Galaxy-3D Gravity Sandbox Space Game Free logo

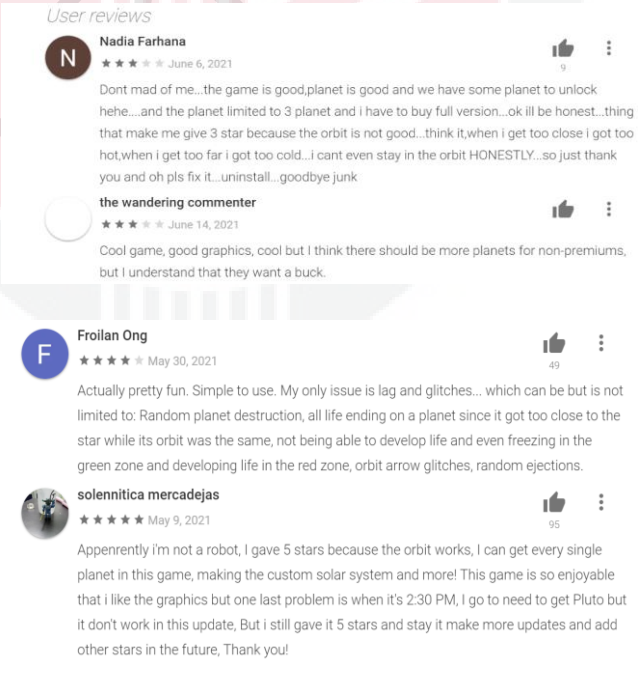
Source	Google Play
Platform/OS	Android
Developer	PocketLabs
Licenses	Free-To-Play, paid content
Rating	4.5 / 5
User Review	

Table 2.4: Information on Pocket Galaxy-3D Gravity Sandbox Space Game Free

2.6.3 Orbit-Playing with Gravity

Figure 2.9: Orbit-Playing with Galaxy logo

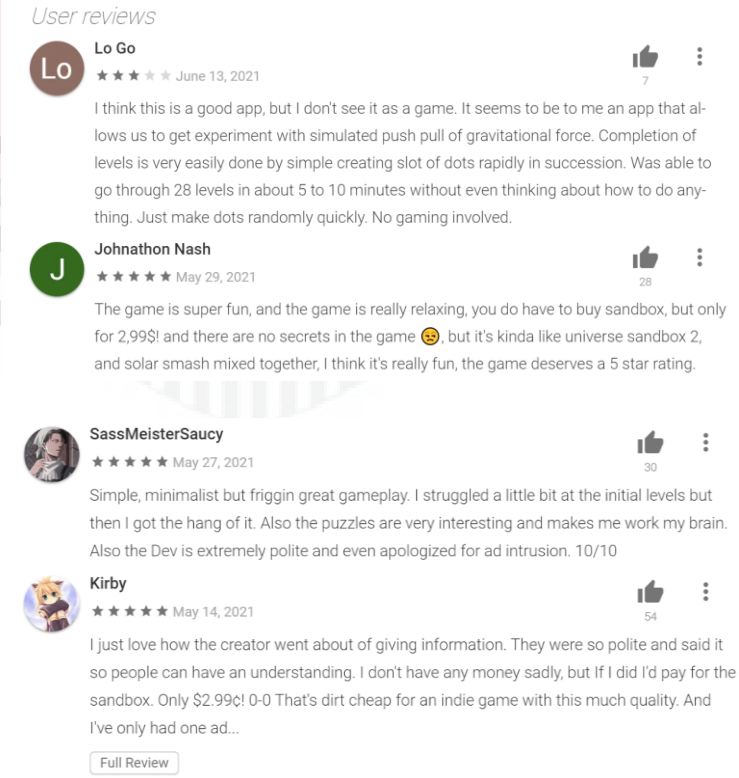
Source	Google Play
Platform/OS	Android
Developer	HIGHKEY Games
Licences	Free-To-Play, paid content
Rating	4.4 / 5
User Review	

Table 2.5: Information on Orbit-Playing with Galax

2.6.4 Space & Gravity Simulator 3D: Galaxy Orbits Free

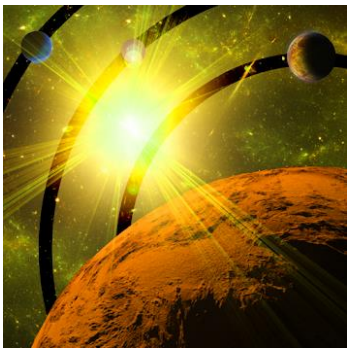


Figure 2.10: Space & Gravity Simulator 3D: Galaxy Orbits Free Logo

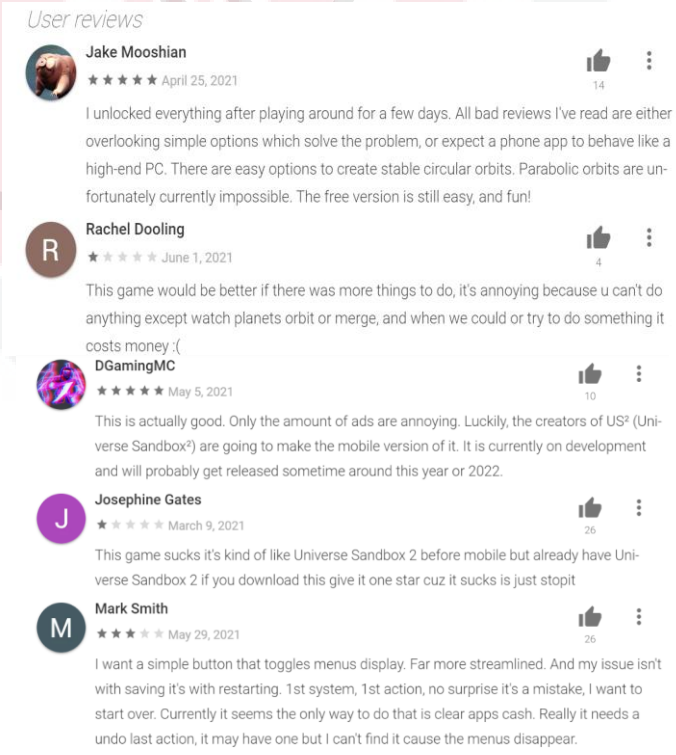
Source	Google Play
Platform/OS	Android
Developer	Magicware Games
Licences	Free-To-Play, paid content
Rating	4.2 / 5
User Review	

Table 2.6: Information on Space & Gravity Simulator 3D: Galaxy Orbits Free

2.6.5 Summary of Reviews

A perfect application arguably does not exist as each has its benefits, drawbacks and goals. The applications reviewed in table 2.3 to table 2.6 provide the gravity simulations and contents. There are three main issues on all of the applications above, which are bugs, graphic quality and licenses. Firstly, there are many errors between all applications, which are bugs. In the field of information technology (IT), a bug is an error, fault, or flaw in a computer programmed or hardware system. A bug causes a system to behave unexpectedly or produces unexpected results. In a nutshell, it's any behaviour or impact that a program or system produces that is not intended to create. The most frequent bug that was reported in the applications was button unresponsiveness. This caused some of the features to be dysfunctional. Secondly, another downside of the applications above is the graphic quality. Some users criticise the standard type of graphic on specific applications above, but the quality of the graphic depends on the smartphone's hardware capability. The development of low graphic applications' development ensures every user can experience the application even though using a low specification smartphone. Developers should create another option of graphic quality to satisfy the user with a high specification smartphone. Lastly, specific applications have in-game content licenses, even the application is free for download. According to some reviews, the price for the content is unreasonable, which argue that it is "worthless to spend on the game".

2.7 Summary

The reform of the education system will make our country's education more competitive at international levels, and students will acquire high quality and up-to-date education. With this reform, some new topics are included in the physics subject, Gravitation and Quantum Physics. These two topics are new challenges for teachers in terms of difficulty to prepare effective BBM. Therefore, a digital simulation was developed for the topic Gravitation that makes a smartphone a platform for teachers' use as a BBM in P&P. This is because smartphones have a variety of functions and benefits and are one of the platforms close to students and teachers. Each application containing gravity simulation has been analysed, and the differences or advantages of each application has been recorded to be used for references and improvements to the simulation developed.

CHAPTER 3

METHODOLOGY

1.1 Introduction

This chapter describes the method and technique used in collecting and analysing data throughout this research. This research aims to develop a simulation-based mobile application as a teaching aid (*Bahan Bantu Mengajar*, BBM) for the most challenging subtopic in the topic Gravitation (Physics KSSM) and assess the user experience and efficacy of the developed application among Malaysian secondary school teachers. To achieve these objectives, this chapter covers research designs, respondents and location, research periods, the role of researchers, data collection procedures, data analysis procedures, and study ethics.

1.2 Research Design

This study uses a Cross-Sectional Survey Design, a non-experimental descriptive research method for answering the survey's questions. This quantitative study was conducted on randomly selected samples to identify the most challenging subtopic in Gravitation (Physics KSSM) among Malaysian secondary school teachers. The study also assesses the user experience and efficacy of the developed simulation among Malaysian secondary school teachers.

This study is a quantitative study using instruments for collecting data to identify the influence between research variables (Gay & Airasian, 2003; Creswell, 2005). It identified the most challenging subtopic in the topic of Gravitation (Physics KSSM) among Malaysian secondary school teachers. It assessed the user experience and efficacy of the developed application among Malaysian secondary school teachers to produce numeric data analysed using statistics.

According to Creswell (2005), survey design explains quantitative or numeric trends, attitudes, or opinions of a population with a review of one population sample. Review of survey study using data quantitatively by performing data analysis descriptively.

In addition, this design uses instruments with scores (nominal, ordinal, ratio and interval) (Othman Talib, 2013). This study uses two sets of standard questionnaires. The first set aimed to identify the most challenging subtopic in the topic of Gravitation (Physics KSSM) among Malaysian secondary school teachers. The questionnaire was given before the simulation development began to get rough data on critical parts to achieve that. Then, the second set of questionnaires was distributed to assess the user experience and efficacy of the developed application among Malaysian secondary school teachers after the development of the simulation was completed. Sekaran (2000) states that, by using instruments, data collection becomes efficient as it saves time and is cost-effective.

In addition, Creswell (2003) suggests that survey review is helpful when there is minor literature about the title or population studied. The quantitative method used in this study explains how a variable impact another variable (Creswell, 2014) and determine the relationship between variables (Fraenkel, Wallen & Hyun, 2011). The researcher has collected quantitative data to understand the research problems (Creswell, Clark, Gutman & Hanson, 2003).

Next, demographic aspects focus on gender, age, race, professional qualification, academic qualification, and teaching experience. This survey was performed among the teachers of the secondary schools in Malaysia. This design is also selected for saving cost, energy and time to conduct the study.

1.3 Respondents

This research gathered 20 Malaysian secondary school teachers who teach physics subjects as the survey respondents, in line with the research problems. These selected respondents are ideal for achieving the objective to develop a simulation-based mobile application as a BBM for the most challenging subtopic in the topic gravitation and to assess the user experience and efficacy of the developed application among Malaysian secondary school teachers with the reason of;

a. Respondents are identified to have similarities from specific criteria of teaching Physics subjects.
b. Respondents are secondary school teachers in Malaysia who often communicate with researchers because they have organised joint education activities.
c. Respondents and researchers collaborate closely and facilitate researcher development in study data collection activities.
d. Data collected is more precise in various respects as there is an equality of researchers and research respondents.
e. Respondents are identified as experienced and knowledgeable on the subjects being studied by researchers as they are directly involved in the teaching process of physics in schools.

The research respondents are based on mutual agreement, and each of them is from different schools to avoid unintentional biases and influences among respondents. The agreement also allows for documents, video and voice recording sharing during the interviews and observations. Furthermore, the documents of the research respondents will be analysed to be used as research material, including materials in the process of conducting teaching for teachers. Therefore, this matter must be approved by the research respondents.

1.4 Location

The research location should be determined to consider the research's needs and ensure that the environment of the selected research location does not limit what is to be studied (Creswell, 2014). The location chosen for this research is any secondary school in Malaysia used by physics teachers to conduct teaching and learning processes. There was no specific selection of secondary schools in Malaysia because;

a. The research required a large number of respondents, and each secondary school only has a few physics subject teachers due to the limited science stream classes, not more than four classes.
b. The research required respondents who were indifferent schools to avoid any data provided being influenced by other respondents.
c. The research requires respondents' opinions from different schools (SMK, SMJK, SMA, SMS, MRSM).

1.5 Research Periods

The study period was approximately four months. The duration of this study is quite long to ensure friendly relationships between the respondents and the researcher were established that consequently avoided mental pressure on the respondents in undergoing the surveys and interviews. Bogden and Biklen (2007) said an extended period would improve the comfort aspect of the respondents and encourage them to share with the researcher's knowledge experience. The long period allows researchers to explore and understand the broad and in-depth implementation of the teaching of physics subject curriculum to obtain a detailed picture.

1.6 Role of Researcher

In this study, the researcher has done a research plan for four months by identifying current problems in education, analysing previous studies and formulating a methodology to be used. Next, the researcher selects the study respondents as the data source, determines the duration and location of the research, analyses the data and concludes the study findings. Researchers distribute and guide teachers throughout the data collection process. Lastly, researchers also develop, test and perform simulation improvements based on respondents' feedback.

1.7 Data Collection & Analysis Procedure

This is a quantitative study that collects data from respondents via a questionnaire. The questionnaire is divided into two sections: before simulation development (pre-test) and after simulation development (post-test). A 4-points Likert scale (1) Strongly Disagree to (4) Strongly Agree was used in both sets of questions. The questionnaire's response scale is shown in table X.X.

Optional answer	Point
Strongly Disagree	1
Disagree	2
Agree	3
Strongly Agree	4

Table 3.1: 4-points Likert scale

The teachers were given a set of questionnaires to fill out before the development of the simulation began. This set of questions contains the items required to answer the study's first objective, which is to identify the most challenging subtopic in the topic of Gravitation among Malaysian secondary school teachers. This set of questions is divided into three sections. Every section represents three subtopics in the topic of Gravitation and four primary constructs: BBM, activities or exercises, and applications. Each construct has its items. This questionnaire contained 16 items for each section where all items were negative. Each item will provide information and identify the most important topics through the overall average mean value. If the respondents have a high score, the topic's difficulty level is critical. These findings will then be used to develop the simulation's core content. The first questionnaire is available in attachment A.

After the simulation testing, the second set of questionnaires to the teachers was distributed. This set of questions contains the items required to answer the study's third objective, which is to evaluate the user experience and efficacy of the developed application among Malaysian secondary school teachers. This set of questions includes items that discuss the characteristics found as constructs in simulations, such as flexibility, content, user interface, and media. There are 17 items in this set of questions, and all items in this questionnaire are positive. Each item will provide information and identify the most critical topics through the overall average mean value. If the respondents get a high score, the topic's difficulty level is critical. These findings will then be used to develop the simulation's core content. The second questionnaire is available in attachment B.

SPSS computer software was used to analyse data from both sets of questionnaires. A normality test will be performed before obtaining the mean value to ensure that the data obtained from

the respondents is not ruined. Then, a descriptive analysis was performed for each respondent to understand the sample profile better. Each item was analysed by calculating the average mean value and categorising levels using a mean scale interpretation table, such as table 3.2.

Mean	Level
1 – 1.75	Low
1.76 – 2.50	Moderate
2.51 – 3.25	High
3.26 – 4.00	Very High

Table 3.2: Mean scale interpretation table

1.8 Summary

This chapter discusses research designs, populations and sampling, measuring instruments, pilot studies, data collecting processes and data analysing procedures. A pilot study is conducted on every variable to determine the construct of the research and produce parsimony. SPSS Analysis version 26.0 is used to determine the validity and reliability of the instrument in the study, and descriptive statistical analysis is used to analyse demographic parts data. Based on the information obtained, this study is expected to achieve both objectives: to identify the most challenging subtopic in the topic of Gravitation (Physics KSSM) among Malaysian secondary school teachers and assess the user experience and efficacy of the developed application among Malaysia secondary school teachers.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

Three main objectives need to be achieved in this study which is, 1) to identify the most challenging subtopic in the topic of Gravitation (Physics KSSM) among Malaysian secondary school teachers, 2) to develop an interactive simulation-based mobile application that aids the teaching and learning of the previously identified subtopic and 3) to assess the user experience and efficacy of the developed simulation among Malaysian secondary school teachers. This chapter will elaborate on the findings derived from data analysis using SPSS software version 26.0 and show the developed simulation. Among the contents of the findings of this study include a sample study profile and descriptive analysis of the study constructs.

4.2 Sample Profile

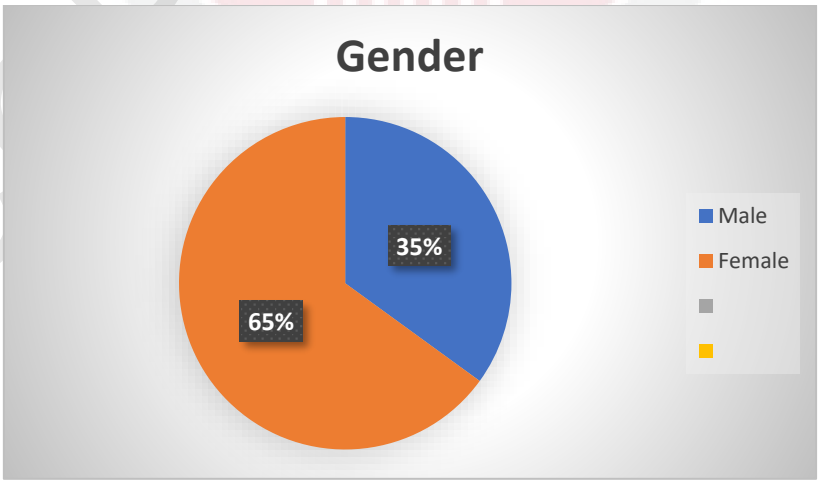


Figure 4.1: Respondent's gender

Figure 4.1 shows, this study involved 20 physics teachers from different schools. A total of 7 (35.0%) male teachers and 13 (65.0%) female physics subject teachers were involved in this study.

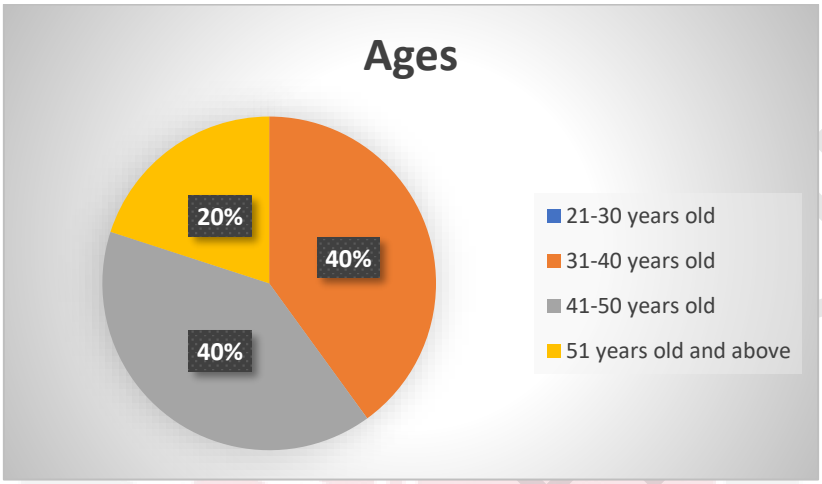


Figure 4.2: Respondent's age

Figure 4.2 shows the number of teachers who participated in the age group of 31 to 40 is 8 (40.0%), same as the number of teachers in the age group of 41 to 50 years, 8 (40.0%) while 4 (20.0%) teachers are aged 51 years and above and 0 (0.0%) teachers are aged 21 to 30 years old.

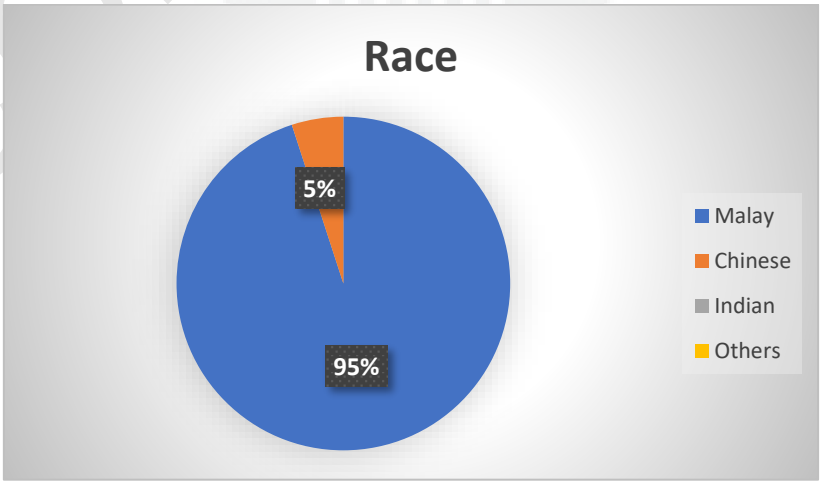


Figure 4.3: Respondent's race

Figure 4.3 shows Malay teachers are dominant at 19 (95.0%) while 1 (5%) is Chinese teachers. There is no any involvement of Indian or others teachers.

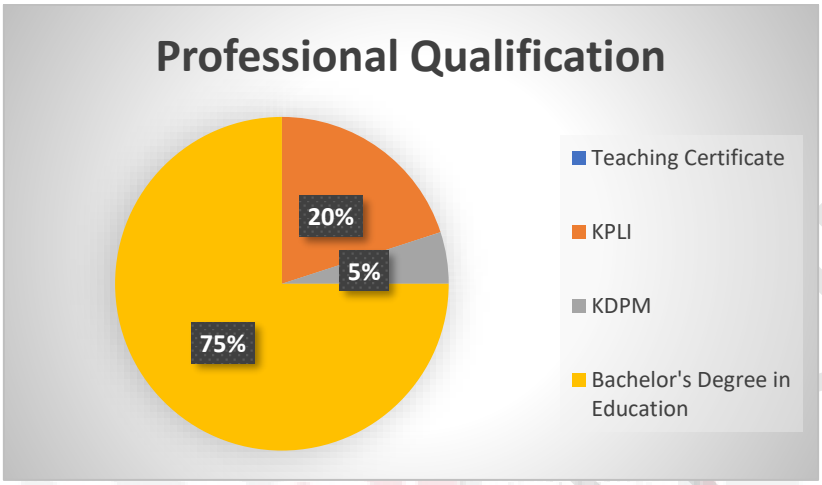


Figure 4.4: Professional Qualification

Figure 4.4 shows all 20 (100.0%) teachers are holding different professional qualifications, which is 15 (75.0%) Bachelor's Degree of Education, 4 (20.0%) *Kursus Perguruan Lepasan Ijazah*, KPLI and 1 (5.0%) *Kursus Perguruan Diploma Malaysia*, KPDM.

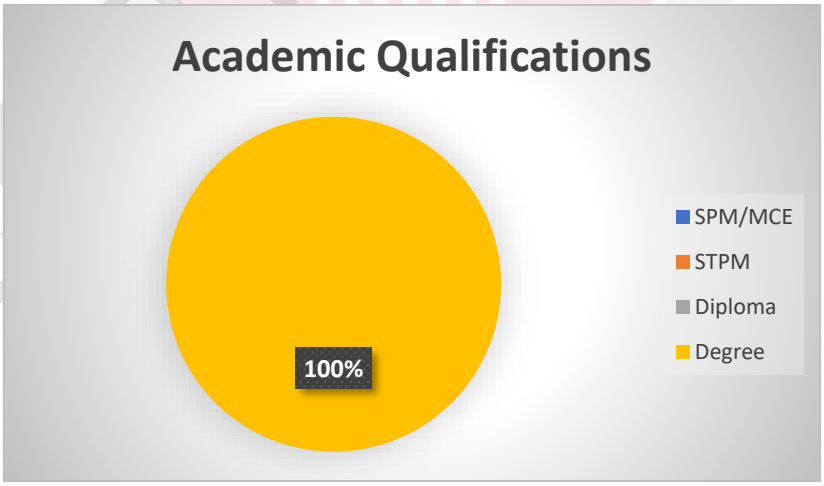


Figure 4.5: Respondent's academic qualification

The figure 4.5 shows all 20 (100.0%) teachers' academic qualification are from Degree level.

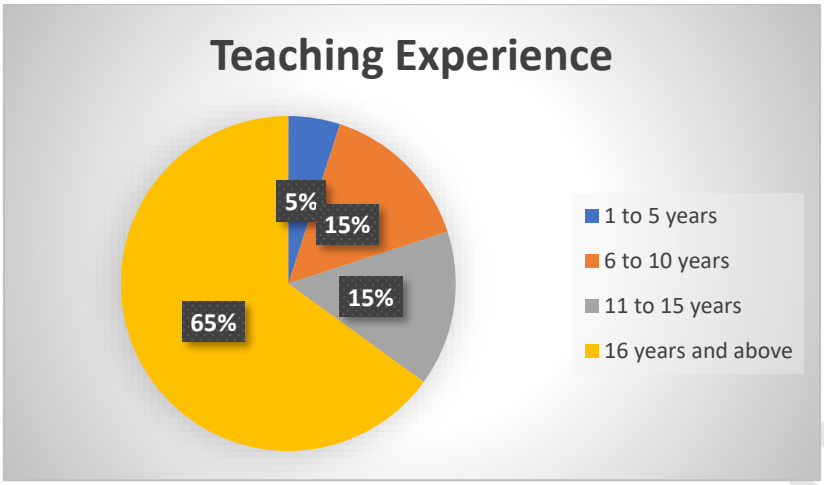


Figure 4.6: Respondent's teaching experience

The majority of teachers involved are experienced teachers as there are 16 (65.0%) teachers who have taught in schools for 16 years and above, 3 (15.0%) teachers for 11 to 15 years, 3 (15.0%) teachers for 6 to 10 years while only 1 (5.0%) teacher teach less than six years.

4.3 Descriptive Statistical Analysis

Descriptive analysis measured through frequency, mean and standard deviation were used to achieve both objectives. Both objectives can be reached from the value of the mean, where its level can be interpreted through Table 4.1;

Mean	Level
1.00 – 1.75	Low
1.76 – 2.50	Moderate
2.51 – 3.25	High
3.26 – 4.00	Very High

Table 4.1: Mean scale interpretation table

4.3.1 The Most Challenging Subtopic in the Topic Gravitation

The descriptive analysis measured through mean and standard deviation was used to explain the study's findings to identify the most challenging subtopic in the topic of Gravitation (Physics KSSM) among 20 Malaysian secondary school teachers. This study was conducted by instructing teachers to answer a questionnaire consisting of four constructs, which is content, teaching aids, activities or exercise and application. The questionnaire is divided into three sections according to the number of subtopics found in the topic of Gravitation. The findings of the study are shown in the table below;

Table 4.2

Descriptive Statistics for Items in the subtopic of Newton's Universal Law of Gravitation

Construct	Items	Item Total	Mean	Std Deviation
Content		5	**2.16**	**.702**
	Insufficient/Incomplete content	1	2.30	.657
	Inaccurate content	1	1.85	.587
	high -level content	1	2.20	.768
	Irregular content	1	1.90	.945
	Too many formulas	1	2.55	.553
Teaching Aids		5	**2.77**	**.755**
	Ineffective teaching aids	1	2.80	.768
	Insufficient teaching aids	1	3.00	.795
	Outdated teaching aids	1	2.65	.671
	Non-standard teaching aids	1	2.35	.813
	Lack of creativity	1	3.05	.759
Activities/Exercise		4	**2.55**	**.789**
	Insufficient exercise/example	1	2.55	.826
	The difficulty of exercise/example	1	2.15	.745
	Insufficient activities/ experiment	1	2.95	.759
	Unenjoyable activities/ experiment	1	2.55	.826
Application		2	**2.50**	**.728**
	Phenomena too complicated	1	2.95	.945
	Irrelevant to the real world	1	2.05	.510
TOTAL		**16**	**2.49**	**.341**

Based on the table 4.2, it was found that the total mean value for the construct of factors to

difficulty in the subtopic of Newton's Universal Law of Gravitation was at a moderate level ($\bar{x}$ = 2.49, SD = .34). However, the mean value for the construct teaching aids ($\bar{x}$ = 2.77, SD = .76) and activities or exercise ($\bar{x}$ = 2.55, SD = .79) was high because it exceeded the overall average value while the application construct ($\bar{x}$ = 2.50, SD = .73) and content ($\bar{x}$ = 2.16, SD = .702) had moderate mean values.

Table 4.3

Descriptive Statistics for Items in the subtopic of Kepler's Law

Construct	Items	Item Total	Mean	Std Deviation
Content		5	**2.07**	**.702**
	Insufficient/Incomplete content	1	2.00	.562
	Inaccurate content	1	1.90	.641
	high-level content	1	2.30	.801
	Irregular content	1	1.85	.923
	Too many formulas	1	2.30	.587
Teaching Aids		5	**2.42**	**.643**
	Ineffective teaching aids	1	2.50	.607
	Insufficient teaching aids	1	2.60	.681
	Outdated teaching aids	1	2.25	.550
	Non-standard teaching aids	1	1.85	.587
	Lack of creativity	1	2.90	.788
Activities/Exercise		4	**2.31**	**.560**
	Insufficient exercise/example	1	2.35	.813
	The difficulty of exercise/example	1	2.20	.696
	Insufficient activities/ experiment	1	2.35	.671
	Unenjoyable activities/ experiment	1	2.35	.671
Application		2	**2.48**	**.700**
	Phenomena too complicated	1	2.90	.641
	Irrelevant to the real world	1	2.05	.759
TOTAL		16	**2.32**	**.298**

Based on the table 4.3, the researcher found that the total mean value for the construct of factors to difficulty in the subtopic of Kepler's Law was at a moderate level ($\bar{x}$ = 2.32, SD = .30). However, the mean value for all construct, application ($\bar{x}$ = 2.48, SD = .70), teaching aids ($\bar{x}$ = 2.42, SD = .64), activities and exercise ($\bar{x}$ = 2.31, SD = .56) and content ($\bar{x}$ = 2.07, SD = .702) had moderate mean values.

Table 4.4

Descriptive Statistics for Items in the subtopic of Man-made Satellites

Construct	Items	Item Total	Mean	Std Deviation
Content		5	**1.97**	**.664**
	Insufficient/Incomplete content	1	1.85	.671
	Inaccurate content	1	1.80	.410
	high -level content	1	2.10	.718
	Irregular content	1	1.85	.851
	Too many formulas	1	2.25	.671
Teaching Aids		5	**2.25**	**.706**
	Ineffective teaching aids	1	2.15	.587
	Insufficient teaching aids	1	2.20	.768
	Outdated teaching aids	1	2.10	.718
	Non-standard teaching aids	1	2.05	.605
	Lack of creativity	1	2.75	.851
Activities/Exercise		4	**2.04**	**.595**
	Insufficient exercise/example	1	2.35	.813
	The difficulty of exercise/example	1	1.95	.686
	Insufficient activities/ experiment	1	2.45	.759
	Unenjoyable activities/ experiment	1	2.40	.821
Application		2	**2.30**	**.874**
	Phenomena too complicated	1	2.65	.988
	Irrelevant to the real world	1	1.95	.759
TOTAL		16	**2.14**	**.491**

Based on the table 4.4, the researcher found that the total mean value for the construct of factors to difficulty in the subtopic of Man-made satellites was at a moderate level ($\bar{x}$ = 2.14, SD = .49). However, the mean value for all construct application ($\bar{x}$ = 2.30, SD = .87), teaching aids ($\bar{x}$ = 2.55, SD = .71), activities or exercise ($\bar{x}$ = 2.04, SD = .60) and content ($\bar{x}$ = 1.97, SD = .66) had moderate mean values.

Table 4.5

Summary Interpretation of factors to difficulty in all subtopic

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Newton's Universal Law of Gravitation	20	1.81	3.25	49.81	**2.49**	**.34189**
Kepler's Law	20	1.75	2.94	45.81	**2.32**	**.29890**
Man-made Satellites	20	1.00	2.94	43.56	**2.14**	**.49140**
Valid N (listwise)	20					

Based the table 4.5, the researcher found that the mean value for the subtopic of Newton's Universal Law of Gravitation ($\bar{x}$ = 2.49, SD = .34), Kepler's Law ($\bar{x}$ = 2.32, SD = .30) and Man-made satellites ($\bar{x}$ = 2.14, SD = .49) was at a moderate level. However, the mean value for the construct of factors to difficulty in the subtopic of Newton's Universal Law of Gravitation had the highest mean among the others that almost reaches the high-level value.

4.3.2 Efficacy of the Developed Application

The descriptive analysis measured through mean and standard deviation was used to explain the study's findings to assess the user experience and efficacy of the developed simulation among 20 Malaysian secondary school teachers. This study was conducted by instructing teachers to answer a questionnaire consisting of three constructs, which are content, flexibility, and media. The questionnaire is divided into three sections according to the number of subtopics found in the topic of Gravitation. The findings of the study are shown in table 4.6.

Table 4.6

Descriptive Statistics for the efficacy of the developed simulation

Construct	Items	Item Total	Mean	Std Deviation
Content		**6**	**3.40**	**.553**
	Able to give a real-world situation	1	3.45	.510
	Able to improves understanding	1	3.75	.444
	Able to deliver accurate information	1	3.45	.605
	Does not exceed standard KSSM	1	3.50	.513
	Followed content avoid burden on student	1	2.70	.733
	Contain additional information	1	3.50	.513
Media		**5**	**3.59**	**.520**
	Video are relevant to the topic	1	3.50	.607
	The video is full of information	1	3.60	.503
	Video duration is not too long	1	3.65	.489
	UI used is easy to understand	1	3.65	.489
	UI used is interesting	1	3.55	.510
Accessibility		**5**	**3.73**	**.486**
	Free-to-play	1	3.75	.444
	Flexible in access	1	3.70	.571
	Flexible in interaction	1	3.60	.503
	Contain fun-to-play elements	1	3.80	.503
	Suitable for all ages	1	3.80	.410
TOTAL		**16**	**3.57**	**.520**

Based on table 4.6, the mean value for all of them achieves a very high level where it exceeds 3.26 except item for *"Followed content avoid burden on student"* is at a high level ($\bar{x}$ = 2.70, SD = .733). This data informs that teachers believe that notes/information beyond the syllabus does not burden students and even benefits them. In addition, the summary showing the total value for this questionnaire was $\bar{x}$ = 3.57, SD = .52. Based on the mean scale interpretation table, this value is between 3.26 to 4.00 and considered level as very high where it indicates that the level of effectiveness of the use of this simulation is at a high level and further achieves the third objective of the study.

4.4 Developed Simulation

This section will show one of the main objectives for this study which is to develop an interactive simulation-based mobile application that aids the teaching and learning of the previously identified subtopic. This simulation covers the topic of Newton's Universal Law of Gravitation which is the most critical subtopic in topic Gravitation based on earlier analysis data. The flow board for the simulation shows in figure 4.7.

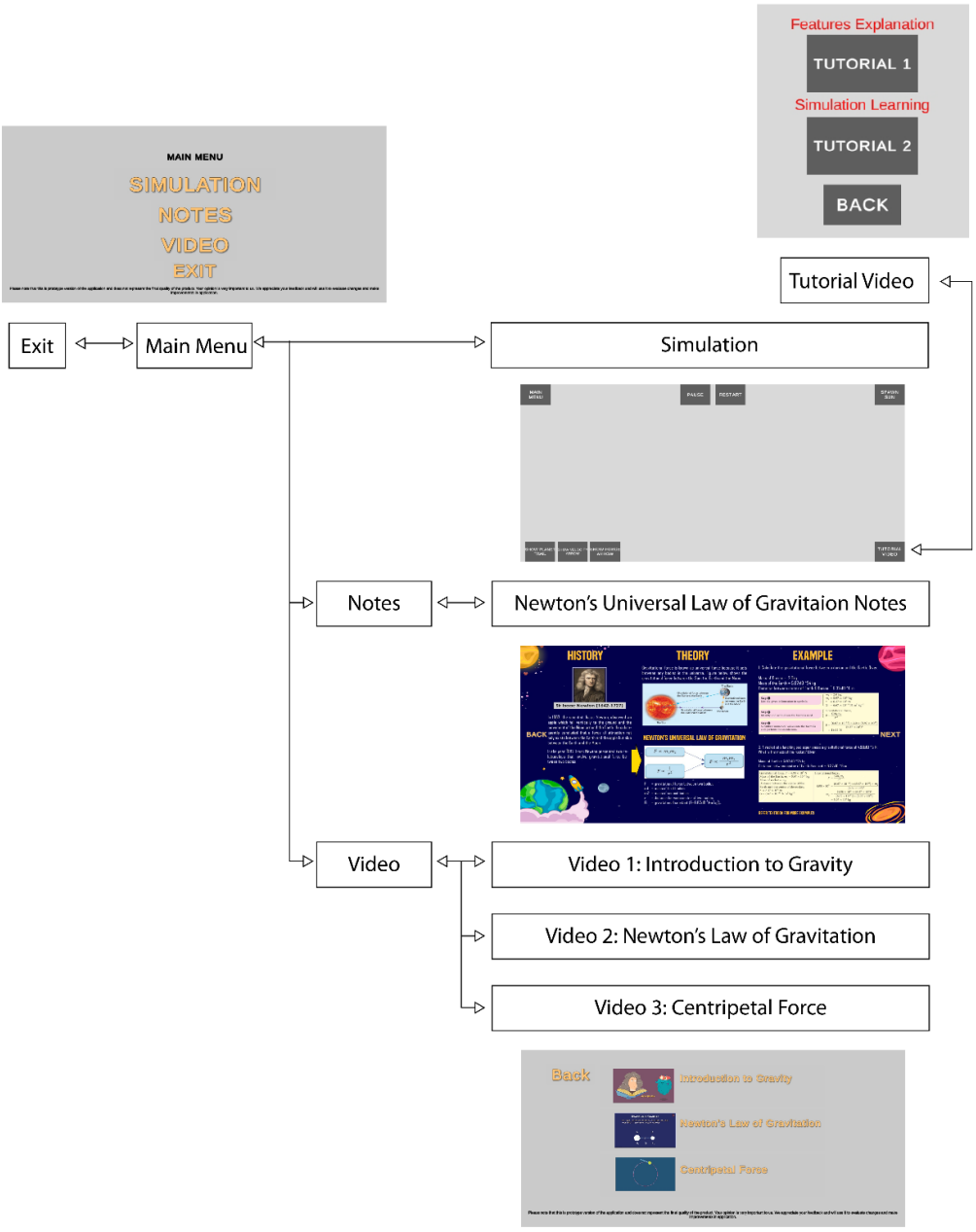


Figure 4.7: Flow board of the application

Flow board is a part of the designing stage to determine the flow of the application. The flow board of the application in this project is shown in Figure 4.7. The application will start with the main menu scene. This main menu scene brings to another three options, which are the simulation, notes and video. Option simulation is the main project for this study where it contains the sub-option where it goes to the tutorial for this simulation. Option notes consist of short notes for subtopic Newton's Universal Law of Gravitation. Lastly, the options video will bring the learning video to the chosen subtopic. Users can either back or forward the scene by clicking on the back arrow or forward arrow button in every scene. To close the application, users can click the exit button on the main menu or click the home button on their smartphones.

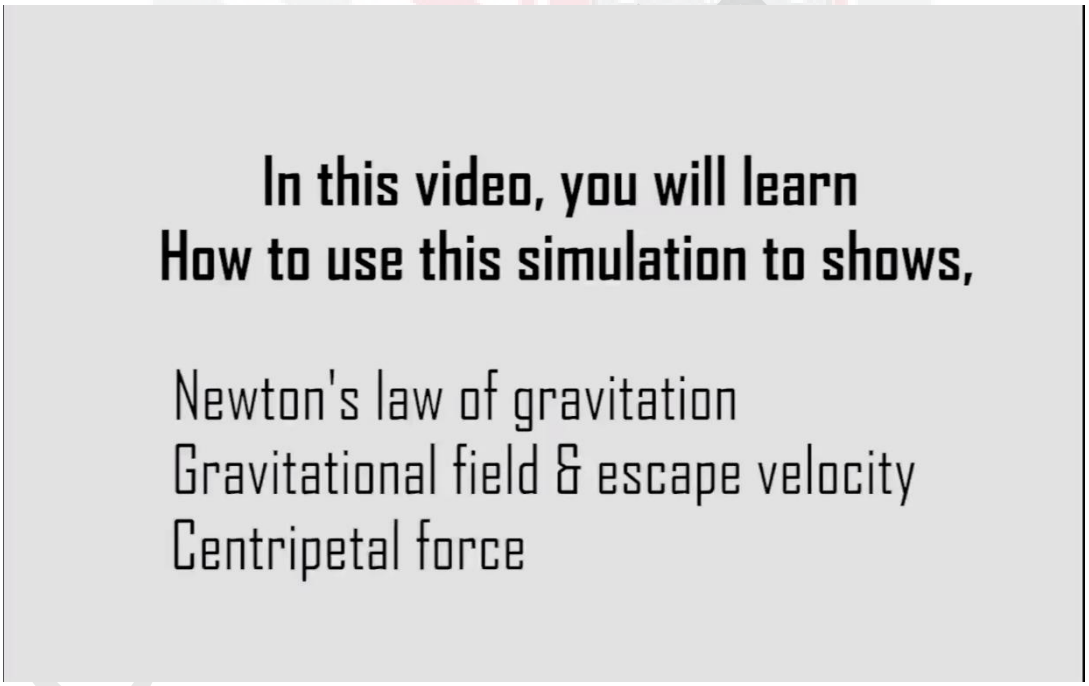


Figure 4.8: One of the tutorial scenes videos

For the Simulation option, users can perform three types of simulation, which is the user can show the planets moving and attracting to each other according to Newton's law of Gravitation. Next, users can show the gravitational field for each planet and their relationship to escape velocity. Lastly, users can show the centripetal force works on the planet or other objects in

space.

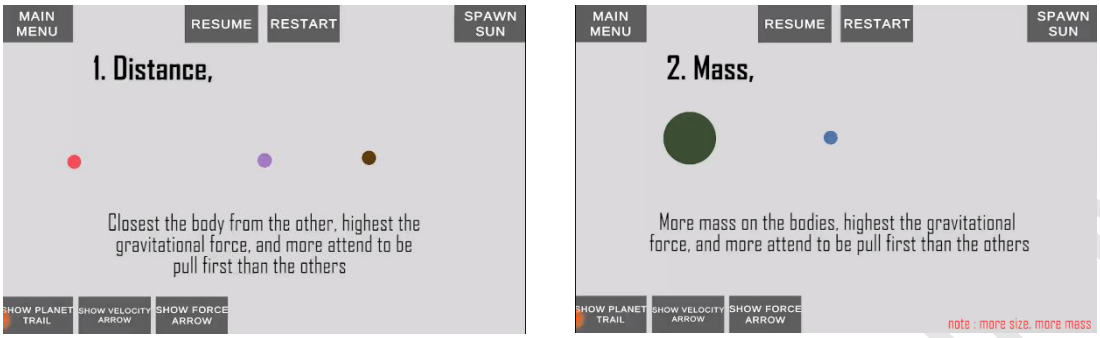


Figure 4.9: Tutorial on Newton's Law of Gravitation

In this simulation, users can create a planet by tapping on the screen. In addition, users can tap and hold the planet to increase the size of the planet where the size of the planet is directly proportional to the mass of the planet. Users can perform the simulation on Newton's Law of Gravitation in 2 different ways based othe n distance between planets or mass differences. According to Newton's Law of Gravitation, the force acts between the planets high directly proportional to the planet's mass and inversely proportional to the distance between the planets. The researcher implements an algorithm that is almost the same as the actual situation where if three or more planets was created, they would pull each other, and the planets with a higher amount of force will be attracted first than others. The amount of force depends on the size of the planet created and the distance between them.

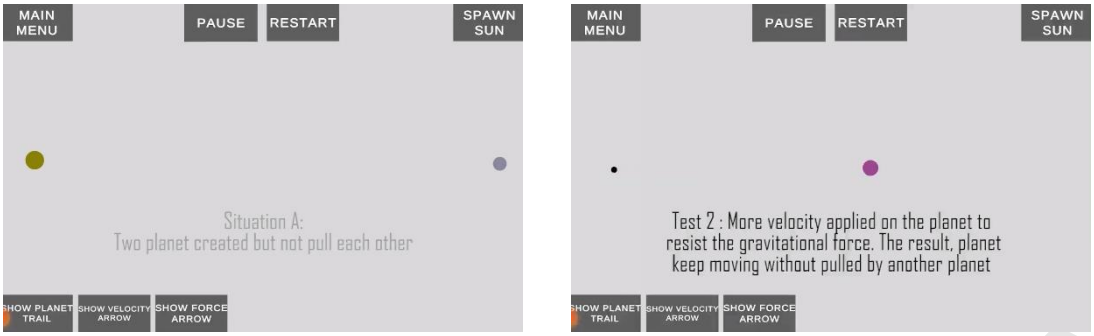


Figure 4.10: Tutorial on the gravitational field and escape velocity

Secondly, users can perform the simulation to show the gravitational field and escape velocity. Every planet created has its field, and the other planet or object inside the range of field will cause the attraction between them, and there is no attraction if they are out of range. Users can also perform the planet's escape velocity by holding and dragging the planet to produce velocity. The dragging distance determines the value of the resulting velocity. By this, users can try and escape the planet attraction by directing the planets in the opposite direction with a certain velocity.

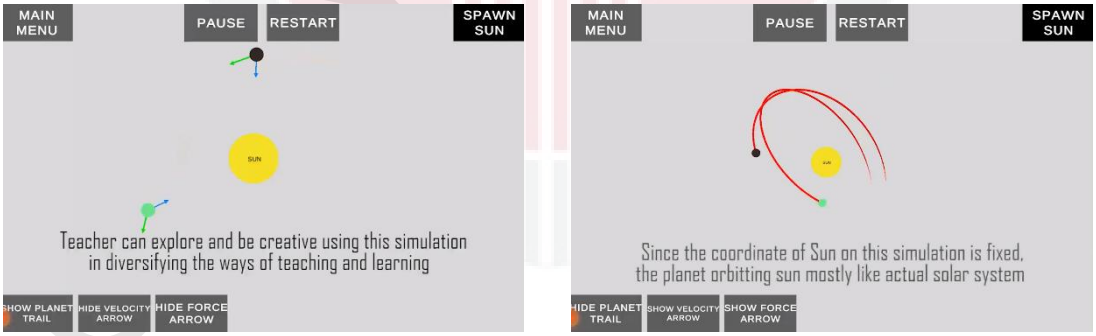


Figure 4.11: Tutorial on centripetal force

Lastly, the user can perform the simulation to show the centripetal force between the planet or sun. Centripetal force in this situation is equal to gravitational force, but the planet will move in a circular state instead of being attracted directly towards the planet. It is because the

planet is moving at a constant speed with a direction perpendicular to gravitational force.

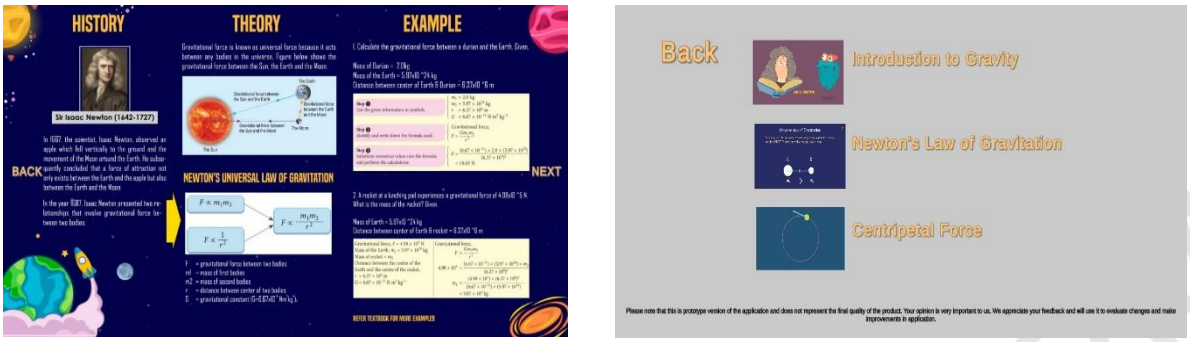


Figure 4.12: Notes and Video option

This application has sub-options placed by the researcher to make this application more enjoyable, which are the Notes and Video options. This note is a summary made by the researcher based on the textbook and only focuses on the subtopic of Newton's Universal Law of Gravitation. The video featured is a learning video from the Youtube website and only has content involved in the subtopic Newton's Universal Law of Gravitation.

4.5 User's Feedback and Experiences

This section presents and qualitatively discusses the user's experience from their feedback provided through a questionnaire form. This feedback was optional, and only seven respondents were willing to give their opinions. Their feedback is included in appendices.

Based on the given feedback, a few points are to be highlighted for future improvement, and it's more focused on the media aspect. Firstly, users suggested adding background music to the scene. This simulation lacks background music because this application is still in the prototype phase, where researchers are testing more in terms of algorithms and simulation physics. In addition, researchers are less skilled in producing their music and avoid using background music from the internet as copyright issues will cause it.

Secondly, users suggested changing the background colour from grey to another colour similar

to actual space, precisely any dark colour or dark blue. This suggestion aligns with the researcher's wishes at the beginning of the simulation development. But due to programming algorithms not being able to read specific colour codes, created planets often use dark colours and this cause the planets to be invisible on dark background colours. However, researchers are in the process of creating an algorithm that can read only bright colour codes, and these features will be implemented in future updates.

Next, users have identified information errors in the video tutorial, but unfortunately, users did not specify which part of the video had errors. However, the researcher will review all the videos and identify the mistakes. Users are also advised to add voice-over when explaining. The information session in the video needs to be extended so that users can understand the procedure more clearly. Lastly, users think there is a need for an explanation in Malay because some schools or students use Malay in P&P.

However, a few respondents have given a rough idea. They believe that this simulation provides various benefits and is suitable for use in P&P, such as this simulation full of information, simulation can represent real-life situations, easy-to-use and simulation running smoothly. Each feedback is very important to the researcher for future improvement.

4.6 Summary

This chapter summarises the data collection and data analysis for objectives 1 and 3. The analysis involved includes descriptive analysis using SPSS. Before conducting descriptive analysis, the researcher first started the data analysis by identifying the response rate, data scanning and initial analysis. From the analysis conducted by researchers, the data shows that the most critical subtopic in topic Gravitation was Newton's Universal Law of Gravitation. This data was used in the developed simulation for its content. The developed simulation covered gravitation force, gravitational field, escape velocity and centripetal force. Teachers tested the developed simulation, and the data given shows that the effectiveness of the developed simulation used in P&P was at a very high level.

CHAPTER 5

CONCLUSION AND SUGGESTION

5.1 Introduction

In this chapter, the researcher discusses the findings of the study that have been obtained in chapter 4. In addition, the researcher also discusses the contribution of the study, the limitations of the study and research recommendations in the future. Finally, the researcher summarized the study that had been done thoroughly.

5.2 Conclusion of Study

This study was conducted to examine the most critical subtopics in the topic of Gravitation. The subtopics that have been identified will be the basis in the development of digital simulations based on smartphones of which it is the second objective. The developed simulations will be given to teachers to be tested in their teaching and learning (*Pengajaran & Pembelajaran*, P&P) as teaching aids. This leads to the last objective for which the researcher wants to see the level of effectiveness of the simulation and see the feedback from teachers about the developed simulation.

The study design used was a cross-sectional survey design. A total of 20 secondary school Physics subject teachers in Malaysia selected by systematic random sampling were involved in this study.

Descriptive statistics which are mean and standard deviation were used to determine the most critical subtopics in the topic of Gravitation and the level of effectiveness of the simulations developed. This study found that the criticality of all three subtopics in the topic of Gravitation, Newton's Universal Law of Gravitation, Kepler's Law and Man-made Satellites are at moderate levels. Since the researcher needs only one subtopic, the researcher has taken the subtopic of Newton's Universal Law of Gravitation as the most critical topic because it has the highest mean value compared to the others and its value is close to the high levels. The study also found that the level of effectiveness of the simulations developed was at a very high level.

5.3 Study Contribution

This topic will discuss the contributions found in this study. Among the contributions obtained is that this study can help teachers in the production of teaching aids (*Bahan Bantu Mengajar*, BBM) for the new topic of physics, which is Gravitation. Due to the changes in the Malaysian education system that are still new, there is a lack of BBM for new topics and researchers have taken action to help create a BBM to be used in P&P for those topics. The approach used by the researcher is the creation of technology-based BBM and thus, this digital simulation has been produced.

In addition, this study has also identified the most critical subtopics in the topic of Gravitation. The critical meaning in this context is that the issues contained in the subtopic complicate the P&P process. From the findings of the study, BBM is the most critical issue because it has shown the highest mean value. The issues that arose include the combination of inadequate, ineffective, outdated, non-standard teaching aids and lack of creativity in BBM and the most affected topic was the topic of Newton's Law of Gravitation. Therefore, from the findings of this study, teachers can focus more to produce more BBM, especially for this topic.

5.4 Suggestion for Future Study

This study was conducted using qualitative methods only for a sample of teachers. Researchers suggest that further studies use a combination of quantitative and qualitative methods in collecting data and obtaining information. By using quantitative methods, researchers are able to obtain more information and data directly and improve the quality of the study findings.

In addition, this study is a cross-sectional study that involves the collection of data over a period of two months. Thus, in order to obtain that finding comprehensive and accurate, future studies can be conducted on a research basis longitudinal

In terms of analysis, making a study involving the relationship between ordinal such as gender, academic level and teaching experience with the objectives of the study by using one-sample T-test analysis, paired-samples T-test and one-way ANOVA to obtain the results of the analysis more in-depth and the findings of the study is more comprehensive in all aspects.

For the development of the simulation, this study be done by more than one researcher. In the development of a simulation, several groups need to be created such as groups to focus on systems, graphics and analysis. Then, the development of simulations that focus on one researcher only makes the process difficult because the researcher needs to be proficient in all things. With more researchers in this study, will make the simulations developed faster, more sophisticated and more modern in terms of User Interface (UI).

Finally, the study in the future can be done with the involvement of more respondents. In this study, the researcher had difficulty in getting many respondents due to Movement Control Order (MCO) by the Malaysian government. Therefore, the researcher hopes that this study can be conducted at a time and current conditions that are stable and free from epidemics so that the findings of the study are more accurate and diverse.

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ATTACHMENT A

BORANG SOAL SELIDIK
KAJIAN STRATEGI & PUNCA KESUKARAN DALAM AKTIVITI PENGAJARAN & PEMBELAJARAN (P&P) BAGI TOPIK KEGRAVITIAN

Borang soal selidik ini digunakan untuk mengkaji strategi dan punca kesukaran dalam aktiviti pengajaran dan pembelajaran (P&P) bagi topik Kegravitian tingkatan 4 KSSM. Segala maklumat yang diberikan dalam soal selidik ini adalah SULIT dan hanya digunakan untuk tinjauan kajian semata-mata.

Terdapat tiga (3) bahagian dalam soal selidik ini:

BAHAGIAN A	Latar Belakang Responden
BAHAGIAN B	Strategi Pengajaran & Pembelajaran Yang Diguna Pakai
BAHAGIAN C	Punca Kesukaran Dalam Aktiviti Pengajaran Dan Pembelajaran Bagi Topik Kegravitian

Kerjasama tuan-tuan dan puan-puan untuk menjawab soal selidik ini dengan ikhlas dan telus amat dihargai. Sekian, terima kasih.

BAHAGIAN A

LATAR BELAKANG RESPONDEN

1. JANTINA

Lelaki ☐

Perempuan ☐

2. UMUR

20 hingga 30 tahun ☐ 41 hingga 50 tahun ☐

31 hingga 40 tahun ☐ 51 tahun dan ke atas ☐

3. BANGSA

Melayu ☐ India ☐

Cina ☐ Lain-lain ☐

4. KELULUSAN AKADEMIK

SPM/MCE ☐ Diploma ☐

STPM ☐ Ijazah ☐

5. KELULUSAN IKHTISAS

Sijil Perguruan ☐ KDPM ☐

KPLI ☐ Ijazah Sarjana Muda Pendidikan ☐

6. PENGALAMAN MENGAJAR

1 hingga 5 tahun ☐ 11 hingga 15 tahun ☐

6 hingga 10 tahun ☐ 16 tahun dan keatas ☐

BAHAGIAN B

STRATEGI PENGAJARAN & PEMBELAJARAN YANG DIGUNA PAKAI

a) Sila baca dengan teliti setiap penyataan di bawah.
b) Pada setiap penyataan, tindakan (/) pada ruang yang sesuai dengan diri anda mengikut skala berikut:

1 = Tidak Pernah Digunapakai
2 = Kurang Digunapakai
3 = Kerap Digunapakai
4 = Sentiasa Digunapakai

No. Item	Item	1	2	3	4
1	Saya menggunakan buku teks/buku nota.				
2	Saya menggunakan buku latihan.				
3	Saya menggunakan slaid pembentangan.				
4	Saya menggunakan bahan kitar semula sebagai bahan bantu mengajar.				
5	Saya menggunakan radas makmal sebagai bahan bantu mengajar.				
6	Saya menggunakan video berkonsepkan pendidikan.				
7	Saya menggunakan laman sesawang pendidikan berkonsepkan quiz seperti Kahoot & Quizizz.				
8	Saya menggunakan laman sesawang pendidikan berkonsepkan simulasi seperti PhET Interactive Simulation.				
9	Saya menggunakan laman sesawang pendidikan berkonsepkan permainan video seperti Common Sense Education.				
10	Saya tidak menggunakan sebarang bahan ketika mengajar (selain penyampaian lisan).				
11	Saya hanya mengarahkan murid untuk membayangkan kejadian-kejadian alam yang dipelajari				
12	Saya menggunakan aplikasi telefon pintar berorientasikan pendidikan.				
13	Saya menggunakan bahan bantu mengajar yang berlainan daripada yang disenaraikan di atas.				

BAHAGIAN C1

PUNCA KESUKARAN DALAM AKTIVITI PENGAJARAN & PEMBELAJARAN (P&P) BAGI SUBTOPIK HUKUM KEGRAVITIAN SEMESTA NEWTON

a) Sila baca dengan teliti setiap penyataan di bawah.
b) Pada setiap penyataan, tandakan (/) pada ruang yang sesuai dengan diri anda mengikut skala di bawah ini:

1 = Sangat Tidak Setuju, 2 = Tidak Setuju, 3 = Setuju, 4 = Sangat Setuju

No. Item	Item	1	2	3	4
1	Saya mendapati subtopik ini mempunyai kandungan yang tidak mencukupi.				
2	Saya mendapati subtopik ini mempunyai kandungan yang salah.				
3	Saya mendapati kandungan dalam subtopik ini terlalu mendalam untuk murid tingkatan 4.				
4	Saya mendapati bahan bantu mengajar sedia ada mengenai subtopik ini tidak berkesan/tidak sesuai.				
5	Saya mendapati bahan bantu mengajar sedia ada mengenai subtopik ini tidak mencukupi				
6	Saya mendapati bahan bantu mengajar sedia ada mengenai subtopik ini tidak dikemaskini.				
7	Saya mendapati bahan bantu mengajar sedia ada mengenai subtopik ini tidak mengikut piawai KSSM.				
8	Saya mendapati fenomena dalam subtopik ini sukar digambarkan oleh murid.				
9	Saya mendapati subtopik ini tidak relevan dengan aplikasi kehidupan seharian.				
10	Saya mendapati subtopik ini terlalu banyak rumus yang perlu dihafal dan diterbitkan.				
11	Saya mendapati kandungan dalam subtopik ini tidak disusun dengan baik di dalam buku teks.				
12	Saya mendapati soalan-soalan penyelesaian masalah sedia ada tidak mencukupi untuk murid membuat latihan.				
13	Saya mendapati soalan-soalan penyelesaian masalah sedia ada dalam subtopik ini terlalu sukar untuk murid.				
14	Saya kekurangan idea kreatif untuk menyampaikan kandungan mengenai subtopik ini.				
15	Saya mendapati aktiviti-aktiviti/eksperimen sedia ada (didalam buku teks) untuk subtopik ini tidak mencukupi.				
16	Saya mendapati aktiviti-aktiviti/eksperimen sedia ada tidak menyeronokkan bagi murid.				

BAHAGIAN C2

PUNCA KESUKARAN DALAM AKTIVITI PENGAJARAN & PEMBELAJARAN (P&P) BAGI SUBTOPIK HUKUM KEPLER.

a) Sila baca dengan teliti setiap penyataan di bawah.
b) Pada setiap penyataan, tandakan (/) pada ruang yang sesuai dengan diri anda mengikut skala di bawah ini:

1 = Sangat Tidak Setuju, 2 = Tidak Setuju, 3 = Setuju, 4 = Sangat Setuju

No. Item	Item	1	2	3	4
1	Saya mendapati subtopik ini mempunyai kandungan yang tidak mencukupi.				
2	Saya mendapati subtopik ini mempunyai kandungan yang salah.				
3	Saya mendapati kandungan dalam subtopik ini terlalu mendalam untuk murid tingkatan 4.				
4	Saya mendapati bahan bantu mengajar sedia ada mengenai subtopik ini tidak berkesan/tidak sesuai.				
5	Saya mendapati bahan bantu mengajar sedia ada mengenai subtopik ini tidak mencukupi				
6	Saya mendapati bahan bantu mengajar sedia ada mengenai subtopik ini tidak dikemaskini.				
7	Saya mendapati bahan bantu mengajar sedia ada mengenai subtopik ini tidak mengikut piawai KSSM.				
8	Saya mendapati fenomena dalam subtopik ini sukar digambarkan oleh murid.				
9	Saya mendapati subtopik ini tidak relevan dengan aplikasi kehidupan seharian.				
10	Saya mendapati subtopik ini terlalu banyak rumus yang perlu dihafal dan diterbitkan.				
11	Saya mendapati kandungan dalam subtopik ini tidak disusun dengan baik di dalam buku teks.				
12	Saya mendapati soalan-soalan penyelesaian masalah sedia ada tidak mencukupi untuk murid membuat latihan.				
13	Saya mendapati soalan-soalan penyelesaian masalah sedia ada dalam subtopik ini terlalu sukar untuk murid.				
14	Saya kekurangan idea kreatif untuk menyampaikan kandungan mengenai subtopik ini.				
15	Saya mendapati aktiviti-aktiviti/eksperimen sedia ada (didalam buku teks) untuk subtopik ini tidak mencukupi.				
16	Saya mendapati aktiviti-aktiviti/eksperimen sedia ada tidak menyeronokkan bagi murid.				

Bahagian C3

Punca Kesukaran Dalam Aktiviti Pengajaran & Pembelajaran (P&P) Bagi Subtopik Satelit Buatan Manusia.

a) Sila baca dengan teliti setiap penyataan di bawah.
b) Pada setiap penyataan, tandakan (/) pada ruang yang sesuai dengan diri anda mengikut skala di bawah ini:

1 = Sangat Tidak Setuju, 2 = Tidak Setuju, 3 = Setuju, 4 = Sangat Setuju

No. Item	Item	1	2	3	4
1	Saya mendapati subtopik ini mempunyai kandungan yang tidak mencukupi.				
2	Saya mendapati subtopik ini mempunyai kandungan yang salah.				
3	Saya mendapati kandungan dalam subtopik ini terlalu mendalam untuk murid tingkatan 4.				
4	Saya mendapati bahan bantu mengajar sedia ada mengenai subtopik ini tidak berkesan/tidak sesuai.				
5	Saya mendapati bahan bantu mengajar sedia ada mengenai subtopik ini tidak mencukupi				
6	Saya mendapati bahan bantu mengajar sedia ada mengenai subtopik ini tidak dikemaskini.				
7	Saya mendapati bahan bantu mengajar sedia ada mengenai subtopik ini tidak mengikut piawai KSSM.				
8	Saya mendapati fenomena dalam subtopik ini sukar digambarkan oleh murid.				
9	Saya mendapati subtopik ini tidak relevan dengan aplikasi kehidupan seharian.				
10	Saya mendapati subtopik ini terlalu banyak rumus yang perlu dihafal dan diterbitkan.				
11	Saya mendapati kandungan dalam subtopik ini tidak disusun dengan baik di dalam buku teks.				
12	Saya mendapati soalan-soalan penyelesaian masalah sedia ada tidak mencukupi untuk murid membuat latihan.				
13	Saya mendapati soalan-soalan penyelesaian masalah sedia ada dalam subtopik ini terlalu sukar untuk murid.				
14	Saya kekurangan idea kreatif untuk menyampaikan kandungan mengenai subtopik ini.				
15	Saya mendapati aktiviti-aktiviti/eksperimen sedia ada (didalam buku teks) untuk subtopik ini tidak mencukupi.				
16	Saya mendapati aktiviti-aktiviti/eksperimen sedia ada tidak menyeronokkan bagi murid.				

BORANG SOAL SELIDIK

KEBERKESANAN PENGGUNAAN SIMULASI E-GRAVITI DALAM

ATTACHMENT B

PENGAJARAN DAN PEMBELAJARAN (P&P) UNTUK SUBTOPIK HUKUM KEGRAVITIAN SEMESTA NEWTON

Borang soal selidik ini digunakan untuk mengkaji Keberkesanan Penggunaan Simulasi E-Graviti Dalam Pengajaran & Pembelajaran (P&P) untuk subtopik Hukum Kegravitian Semesta Newton. Segala maklumat yang diberikan dalam soal selidik ini adalah SULIT dan hanya digunakan untuk tinjauan kajian semata-mata. Terdapat tiga (3) bahagian dalam soal selidik ini:

BAHAGIAN A	Latar Belakang Responden
BAHAGIAN B	Keberkesanan Simulasi dalam Pengajaran & Pengajaran
BAHAGIAN C	Maklum Balas dan Penambahbaikan Simulasi

Kerjasama tuan-tuan dan puan-puan untuk menjawab soal selidik ini dengan ikhlas dan telus amat dihargai. Sekian, terima kasih.

BAHAGIAN A

LATAR BELAKANG RESPONDEN

1. JANTINA

Lelaki ☐

Perempuan ☐

2. UMUR

20 hingga 30 tahun ☐ 41 hingga 50 tahun ☐

31 hingga 40 tahun ☐ 51 tahun dan ke atas ☐

3. BANGSA

Melayu ☐ India ☐

Cina ☐ Lain-lain ☐

4. KELULUSAN AKADEMIK

SPM/MCE ☐ Diploma ☐

STPM ☐ Ijazah ☐

5. KELULUSAN IKHTISAS

Sijil Perguruan ☐ KDPM ☐

KPLI ☐ Ijazah Sarjana Muda Pendidikan ☐

6. PENGALAMAN MENGAJAR

1 hingga 5 tahun ☐ 11 hingga 15 tahun ☐

6 hingga 10 tahun ☐ 16 tahun dan keatas ☐

BAHAGIAN B

KEBERKESANAN SIMULASI E-GRAVITI DALAM PENGAJARAN & PEMBELAJARAN (P&P)

a) Sila baca dengan teliti setiap penyataan di bawah.
b) Pada setiap penyataan, tandakan pada ruang yang sesuai dengan diri anda mengikut skala di bawah ini:

1 = Sangat Tidak Setuju, 2 = Tidak Setuju, 3 = Setuju, 4 = Sangat Setuju

No. Item	Item	1	2	3	4
1	Aplikasi pendidikan percuma seperti ini membantu murid mendapatkan medium pembelajaran yang pelbagai dan berkesan.				
2	Aplikasi pendidikan yang mampu diakses melalui telefon pintar membantu murid mengekses maklumat dimana sahaja.				
3	Simulasi yang terdapat di dalam aplikasi ini mampu menggambarkan situasi sebenar				
4	Simulasi yang terdapat dalam aplikasi ini membantu murid memahami hukum/teori dengan lebih mudah.				
5	Hukum/teori sebenar yang diaplikasikan dalam simulasi membantu memberi maklumat yang tepat kepada murid.				
6	Simulasi yang terdapat di dalam aplikasi ini bersifatkan fleksibel/bebas berinteraksi				
7	Simulasi yang fleksibel/bebas berinteraksi memberi keseronokkan dalam pembelajaran murid				
8	Nota/maklumat yang terdapat di dalam aplikasi ini tidak melebihi silibus kurikulum yang ditetapkan				
9	Nota/maklumat yang melebihi silibus akan membeban murid.				
10	Nota/maklumat yang terdapat di dalam aplikasi ini mempunyai maklumat tambahan yang mampu menambah ilmu pengetahuan kepada murid.				
11	Video yang terdapat di dalam aplikasi ini sesuai dengan topik yang sedang dipelajari.				
12	Video yang terdapat di dalam aplikasi ini penuh dengan maklumat.				
13	Video yang terdapat di dalam aplikasi ini tidak terlalu panjang yang boleh membosankan murid.				
14	Antaramuka Pengguna (UI) yang digunakan mudah difahami oleh semua golongan seterusnya memberi keselesaan kepada pengguna.				
15	Rupa bentuk grafik yang digunakan mampu menarik murid untuk terus menggunakan aplikasi ini.				
16	Isi kandungan keseluruhan aplikasi ini mengikut Dokumen Standard Kurikulum dan Pentaksiran (DSKP) yang mengikut kurikulum Malaysia.				

17	Aplikasi ini sesuai untuk digunakan oleh semua golongan terutamanya murid dan guru dalam proses pengajaran dan pembelajaran (P&P)				

BAHAGIAN C

MAKLUM BALAS & PENAMBAHBAIKAN APLIKASI

Jika anda mempunyai idea dan pendapat mengenai aplikasi ini, sila sertakan dibawah. Maklum balas anda amat dihargai bagi memperbaiki mutu aplikasi ini untuk kegunaan pada masa akan datang.

_____
_____
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Terima Kasih

APPENDICES

USER'S FEEDBACK ON THE SIMULATION

Sebuah aplikasi yang menarik dan cukup lengkap untuk digunakan pada waktu pdp. Jika untuk tambahan, mungkin boleh ditambah suara ketika penjelasan tentang teori dalam aplikasi tersebut. Selain itu, mungkin boleh diperbaiki lagi design untuk latar belakang dan pilihan warna yg menampakkan seperti di alam cakerawala (gelap, biru gelap) supaya tampak lebih menarik.

1. Video versi English sahaja. Tak semua pelajar belajar dalam English.

Aplikasi yang menarik dan berguna. Simulasi menunjukkan keadaan sebenarnya berlaku apabila planet-planet dipengaruhi oleh daya graviti masing-masing. Simulasi menunjukkan situasi sebenar di mana orbit berbentuk elliptikal dan situasi apabila planet berlanggar. Lebih mudah untuk pelajar memahami konsep dan teori. Video amat menarik dan cukup singkat untuk pemahaman pelajar. Video tutorial amat mudah untuk difahami namum mungkin sedikit penambahbaikan yang boleh dilakukan ialah meletakkan tutorial penggunaan ketika kali pertama pengguna membuat aplikasi.

Masa utk penerangan perlu lebih masa sikit sebab agak cepat utk murid yg baru hendak belajar n tahap murid yg berbeza di sekolah.

Aplikasi yang sangat sangat bagus dan mampu membantu pelajar memahami topik tersebut. Simulasi yg digunakan sangat simple dan aplikasi pun mudah nak install dalam phone. Cuma ada sedikit ralat dalam video tutorial simulasi. Video tersebut ada lag sikit2 tapi video tersebut sangat mudah untuk difahami. Nota yg diberikan juga padat dengan info. Yang lain sangat okay dan menarik. Tahniah zul!!

Verry goood. Saya percaya yang aplikasi seperti ini pasti akan memberi banyak kebaikan kepada para guru dan pelajar dalam memahami tajuk tajuk seperti ini. Kalau dahulu, cara tradisional sering digunakan tapi mengikut peredaran semasa, memang aplikasi seperti ini yang patut diketengahkan.

Aplikasi ini sangat interaktif dan berinformasi di mana pelajar boleh memahami konsep graviti dengan lebih mendalam melalui simulasi secara langsung dan nota/video yang disediakan. Aplikasi ini bagus dari segi kelancaran penggunaannya (tidak lag). Saya mencadangkan supaya meletakkan sound background dalam bahagian simulation supaya pengguna tidak bosan ketika bermain dengan aplikasi ini.