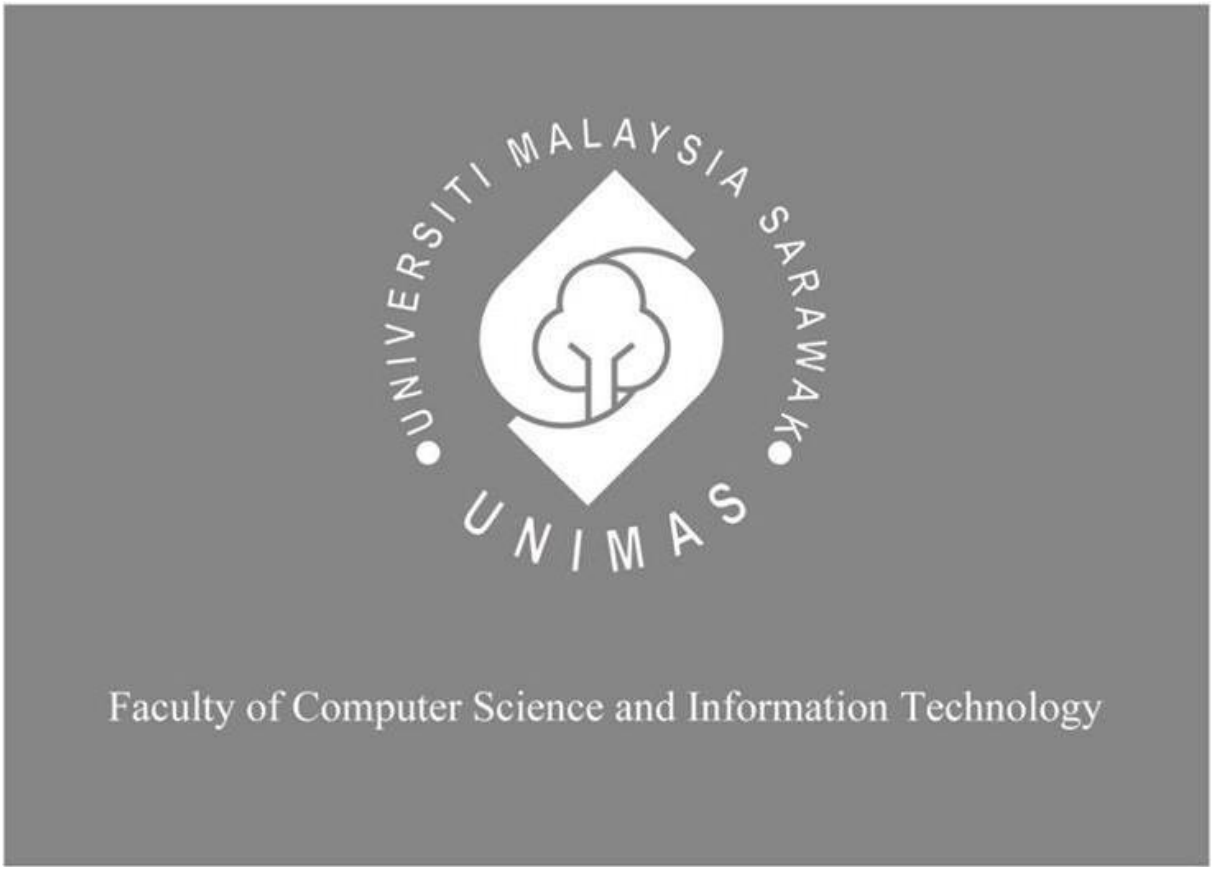

IPERIODIC: INTERACTIVE PERIODIC TABLE USING AUGMENTED REALITY

Syamin Natasya Binti Zainuddin

Bachelor of Computer Science with Honours (Multimedia Computing)

2018

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SYAMIN NATASYA BINTI ZAINUDDIN

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ABSTRACT

This Android mobile application will utilise the Augmented Reality (AR) features and specifically Periodic Table. The situation of the number of science stream students decreased dramatically can be a great deal towards Malaysia in preparing to face the Fourth Industrial Revolution (IR 4.0). The popularity of mobile application and AR is one of the reasons that a mobile application is suitable to be developed and AR is utilised. Since most people are using smartphones, mobile applications can easily be downloaded and always available on the smartphone. In this report, we will be analysing the system used to solve the issues mentioned above. As a result of technological revolution, mobile devices such as smartphones become an excellent choice for the student in order to attract and motivate them to learn about Science subjects especially on Chemistry periodic Table.

ABSTRAK

Aplikasi mudah alih Android ini akan menggunakan ciri-ciri teknologi Augmented Reality (AR) dan khusus untuk Jadual Berkala. Fenomena bilangan pelajar aliran sains yang menurun secara dramatik boleh menjadi penghalang ke arah Malaysia dalam menghadapi Revolusi Perindustrian Keempat (IR 4.0). *Populariti aplikasi mudah alih dan AR adalah salah satu sebab aplikasi mudah alih sesuai untuk dikembangkan dan digunakan. . Oleh kerana kebanyakan orang menggunakan telefon pintar, aplikasi mudah alih boleh dimuat turun dengan mudah dan sentiasa tersedia di telefon pintar. Justeru dalam kajian ini, kami akan menganalisis sistem yang digunakan untuk menyelesaikan isu-isu yang disebutkan di atas. Pada zaman globalisasi ini, penggunaan telefon mudah alih seperti telefon pintar dalam kalangan pelajar semakin meningkat dan merupakan pilihan terbaik untuk menarik dan meningkatkan minat mereka tentang subjek-subjek Sains terytamanya jadual berkala Kimia.*

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CHAPTER 1: INTRODUCTION

1.1 Background

In preparing Malaysia to face the Fourth Industrial Revolution (IR 4.0), the mastery in the field of science, technology, engineering and mathematics (STEM) is crucial (Abas & Kannan, 2017). In order to strengthen STEM education, the challenge lies in getting students to love science and choose science classes. Thus, Science and Mathematics must be made interesting, easy to understand, more hands-on and exploration-based.

Nowadays, Augmented Reality (AR) application has an enormous popularity among us as it can create innovation in the teaching and learning process. AR removes individuals from actual reality by affecting perception and simply evokes the feeling of reality. It also supports enhanced and facilitated plugins to perceive the real world (Taçgın & Arslan, 2017). Research by Serio *et al.* (2013) shows that AR has positive effects on students' motivation. Especially, it offers different degrees of immersion and interaction that might help to engage students in learning activities.

Therefore, *iPeriodic*: Interactive Periodic Table using Augmented Reality can be the answer to this challenge. This Android mobile application will utilise the AR features and 3D electron shell model to attract and motivate secondary students about Science subject through Chemistry periodic Table. The application will be developed using Unity 3D, Vuforia, Android Studio and some designing software such as Adobe Photoshop, Blender and Illustrator. The application will be published in the Google Play store so that all users can download it at any time and from anywhere.

1.2 Problem Statements

Secondary school students especially those from rural areas would feel the cringe of fears in learning science. As a result, the number of science stream students decreased dramatically. According to Edy Hafizan *et.al,* the Malaysia Higher Education Planning Committee instituted the 60:40 Science/Technical: Arts (60:40) Policy in education in 1967 and started implementing it in 1970. However, this policy never been met and currently, only 42% of student in upper secondary level are a STEM stream (MOE, 2016).

The perception of the science stream being tremendously difficult and not appealing to them due to a teaching approach that is theoretical, textbook-based and examination-oriented — especially periodic Table, are some of the reasons why less than a quarter of secondary students in Malaysia opt for the science stream (Rajaendram, 2016). Even though nowadays is the era of technology, students spend most of their time with gadgets rather than books, but there is still a lack of approach to teaching and learning science in mobile applications.

Thus, to overcome this problem, the use of Augmented Reality (AR) technology has been proposed. Since most people are using smartphones, mobile applications can easily be downloaded and always available in the smartphone. In line with this idea, the secondary students will be motivated and interested to further their study in the Science stream.

1.3 Aim and Objectives

This project aims to develop an interactive periodic Table using AR to support and enhance learning process as well as to attract students to further their study in the Science stream. Based on the problem statements and the project's aim, the objectives of this project are as follows:

- To design an interesting application to attract student to further their study in the Science stream specifically Chemistry subject.

- To develop an interactive application that enhances student's learning experiences for learning chemical elements in the periodic Table.
- To evaluate the usability of the mobile application among students.

1.4 Methodology

The methodology used for this project is Multimedia Development Life Cycle (MDLC). Figure 1.1 shows the phase involved in MDLC methodology.

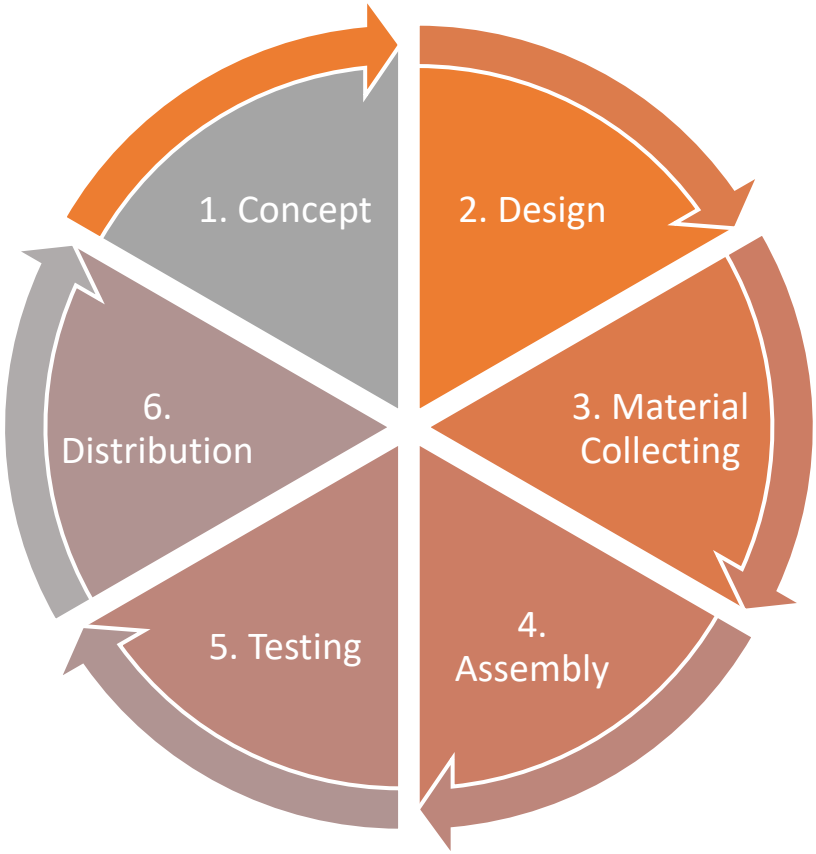

Figure 1.1 Multimedia Development Life Cycle stages (Luther-Sutopo, 2003)

All phases involved in developing this project are similar to the method proposed by Luther-Sutopo which are: -

- Concept

  In this phase, the scope of the project is to identify and analyse.

- Design

  There were two (2) activities involved in this phase. The activities are database design (including a 3D model for the AR) and user interface design.

- Material Collecting

  In this phase, there will be collecting all the material needed for this project.

- Assembly

  In this phase, all the design interfaces are translated into programming code. This is also the first step in the prototype cycle.

- Testing

  In this phase, there will be two (2) types of testing which are

  - Alpha testing – to be tested by the developer and then proceed
  - Beta testing – to demonstrate the system to the users to get feedback.

  The system prototype then will be amended upon users request and should be friendly to the user.

- Distribution

  After the testing phase complete, the application will be published in the Google Play store. Troubleshoot and maintenance will also be involved in this phase.

1.5 Scope

The scopes of this project including:

- The mobile application is supported on any Android platforms.
- The users for this application are secondary school students (lower level and upper level) and secondary school teachers.
- The content is based on chemistry subject and specifically on chemical elements in the periodic Table.

1.6 Significance of Project

This project will contribute to the benefit of society considering that Science stream plays an important role in today's science and technologies fields. Science is valued from the application of scientific knowledge helps to satisfy many basic human needs and improve living standard. Hence, the immersive and interactive capabilities of AR help to foster student's motivation and engagement in learning Science subjects. With advancement in teaching and learning process, it also helps introduced to motivate students towards science learning.

1.7 Project Schedule

Final Year Project takes about 8 months for the development in overall. It started from 12th September 2018 until 10th May 2019 and divided into two parts which are Final Year Project 1 and Final Year Project 2. The project schedule is shown in the Gantt chart (refer to Appendix A).

1.8 Expected Outcomes

At the end of this project, an *iPeriodic*: Interactive Periodic Table using Augmented Reality will be successfully developed and ready to be tested and used. Upon completion of this project, it will

- Increase student knowledge about some of the chemical elements in the periodic Table.
- Offer an interactive Periodic Table using Augmented Reality that allows the user to experience interesting facts about chemical elements in a fun way.
- Improve student motivation and interest towards Science stream as well as to strengthen the STEM education.

1.9 Project Outline

This project is divided into five chapters which include introduction, literature review, requirement analysis and design, implementation and testing and conclusion and future work.

Chapter 1: Introduction

This chapter contains a brief overview of the proposed project. The topic covers include an introduction, problem statements, aim and objectives, methodology, scopes, the significance of project, project schedule, and expected outcomes.

Chapter 2: Literature Review

This chapter discusses the reason for choosing the proposed technology in developing the project and reviews on the current development tools. Reviews on several existing mobile application about periodic Table for the purpose of the analysis is done to compare and filter their strengths and weaknesses. Based on the data analysed, the strength will be adopted, and a few improvements are taken to omit of the proposed application.

Chapter 3: Requirement Analysis and Design

This chapter focused more on identifying requirements and designing the proposed system based on the analysed data in the previous chapter. The choice of software and hardware are also discussed in this chapter.

Chapter 4: Implementation

This chapter discuss the development of the proposed project. Discuss thoroughly the steps on how to implement the proposed project which is from the configuration in tools to design user interface until the programming used.

Chapter 5: Testing

This chapter will conduct testing on each of the functionalities and the non-functionalities. In this project there will be two (2) types of testing which are alpha and beta testing.

Chapter 6: Conclusion and Future Work

This chapter discuss the achievement of the objectives for the proposed project. The limitations that encountered during the development stage, suggestion and future works of this project will be discussed in this chapter.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

To properly develop a good AR application, several investigations and researches are being done – review of several existing AR software and review of existing applications available on the market. The strength and weakness of the comparison will be discussed in this chapter to adopt their good features and a few improvements are taken to omit of the proposed application.

2.2 Reasons for choosing Augmented Reality technology

In recent years, Augmented Reality (AR) has become a vital technology for the mobile application industry due to the advances in the capabilities on processing and displaying computer generated 2D and 3D graphics on top of captured image (Boletsis & McCallum, 2013). Hence, *iPeriodic* adopts this technique to create an interactive periodic Table that allows the user to experience interesting facts about chemical elements in a fun way with this project.

The rise of Augmented Reality has consolidated both the elements from physical and virtual environment concurrently. Due to the hype of Pokémon Go, a mobile application that using the Augmented Reality technology, the approach in developing an application using Augmented Reality has become a hot subject (Rauschnabel, Rossmann, & Tom Dieck, 2017). Besides, the use of technology in education enables the learning process to be more active, attractive, motivating, simulating, and meaningful to the student (Nischelwitzer et. al., 2007).

From this point of view, Augmented Reality is used to enhance learning and the capability of Augmented Reality has to be determined to reach at a suitable instructional design. Furthermore, Sarracino (2014) explains that Augmented Reality can provide an intensive and motivated concentration of cognitive activity by merging both “play” and “interactivity”. Thus, interactivity is the crucial criteria and it acts as the medium to connect the learning process

with mobile application and the intrinsic characteristic of Virtual World such as immersion, presence, and illusion (Slater, 2018). Therefore, the proposed interactive periodic Table that leverages Augmented Reality technology is capable of enhancing and engaging students in learning experiences with entertainment for students.

2.3 Reasons for Choosing Mobile Platform

The implementation of Augmented Reality into mobile application is not a new thing. In the past years, most Augmented Reality mobile application required expensive yet bulky and cumbersome equipment. As the technology advances, a regular smartphone has an inbuilt accelerometer, detect the orientation of the phone, and gyroscope which adds an additional dimension to the information supplied by the accelerometer by tracking rotation or twist (Karaman, Erisik, Incel, & Alptekin, 2016). Both of this increase the pervasiveness of handheld devices in adopting Augmented Reality within this ubiquitous device (Grubert, Langlotz, Zollmann, & Regenbrecht, 2017). In addition, handheld devices are affordable and porTable to carry anywhere and anytime. Thus, the use of mobile platform makes the user free from the bulky equipment issues.

2.4 Review for Augmented Reality Software Development Kit (SDK)

As the Augmented Reality technology currently a popular trend, there are tons of Augmented Reality SDKs available in the market to choose. In this project, three commonly Augmented Reality SDKs – *ARMedia*, *ARToolkit*, and *Vuforia* have been selected to compare their type of license, supported platforms, and plugin compatibility. These are all the basic features and requirements needed to develop the interactive Periodic Table, *iPeriodic*. The comparison of the Augmented Reality SDKs is shown in Table 2.1.

Table 2.1 Comparison of Augmented Reality SDKs

SDK		*ARMedia*	*ARToolkit*	*Vuforia*
Types of License		Free/Commercial	Open Source	Free/Commercial
Platform	Android	✓	✓	✓
	iOS	✓	✓	✓
	Web	✓		
Tracking Approach	Marker-based	✓	✓	✓
	2D Marker	✓	✓	✓
	Image Marker			✓
Plugin Compatibility	Unity (3D)	✓	✓	✓
Others	Cloud Support	✓		✓
	Virtual Button Support			✓

By referring to Table 2.1, *Vuforia* also known as Qualcomm *Vuforia* Augmented Reality, will be adopted as the development kit for this project. Besides form being the lead of Augmented Reality platforms, which specially designed to be implemented on handheld devices, now it is also supported by different platforms which are Android, iOS as well as Microsoft *HoloLens.* Plus, it supports Unity (3D) Plugin which is the most attractive features that user would enjoy while using applications with Augmented Reality. *Vuforia* also supports marker-based tracking which can be used to detect images. This is important features in order to overlay the 3D information on the real-world scenery.

2.5 Review of Existing Application

There are thousands of applications that are using Augmented Reality technology in Education available in the Google Play Store for Android-based handheld devices, but there is less variety of application when it comes to Chemistry or Science genre or more specific - Periodic Table application. Therefore, four out of hundreds of applications been selected based on the application's genre (Periodic Table), and the interestingness to showcase the variation of Augmented Reality application characteristics that could be adopted for this project. The selected application is: -

i. *Periodic Table 2018. Chemistry in your pocket*
ii. *Periodic Table* (Royal Society of Chemistry)
iii. *Periodic Table ARVR*
iv. *Periodic Table* (Tokyo Electron)

2.5.1 Periodic Table 2018. Chemistry in your pocket

Periodic Table 2018. Chemistry in your pocket is an application that give information about chemical elements in the periodic Table developed by JQ Soft for Android players. According to JQ Soft (2018), this application has accumulated of more than 1,000,000 downloads and has 4.5/5.0 rating from the 72,059 reviewers. This application has both a free version and PRO version. The free version contains random advertisement while the PRO version removes the advertisement and add some additional features, such as isotope, image for each element, solubility chart, and molar mass calculator, for RM 7.99 on Google Play Store.

This application is in education genre. The user had to choose which chemical elements they wish to gain information based on the periodic Table menu as shown in Figure 2.1. For

each chemical element, *Periodic Table 2018. Chemistry in your pocket* provides the user with some information as shown in Figure 2.2. The information are:

- Basic Information (Name, Atomic Number, Group, Period, Block, CAS Number, Number Electrons, Protons, And Neutrons)
- Electron Shell Diagram, Overview (Latin Name and Discovery Year)
- Atomic Properties (Atomic Mass, Oxidations States, Ionic Charge, Electron Per Shell, Electron Configuration, Gas Atomic Multiplicities, Atomic Radius, Covalent Radius and Van Der Waals Radius)
- Material Properties (Colour, Density, Molar Volume, Refractive Index, Sound Speed, And Thermal Conductivity)
- Electromagnetic Properties (Magnetic Type, Volume Magnetic Susceptibility, Mass Susceptibility, And Molar Magnetic)
- Reactivity (Electronegativity, Valence, And Electron Affinity)
- Nuclear Properties (Radioactive, Half-Life, Lifetime, And Neutron Cross Section)

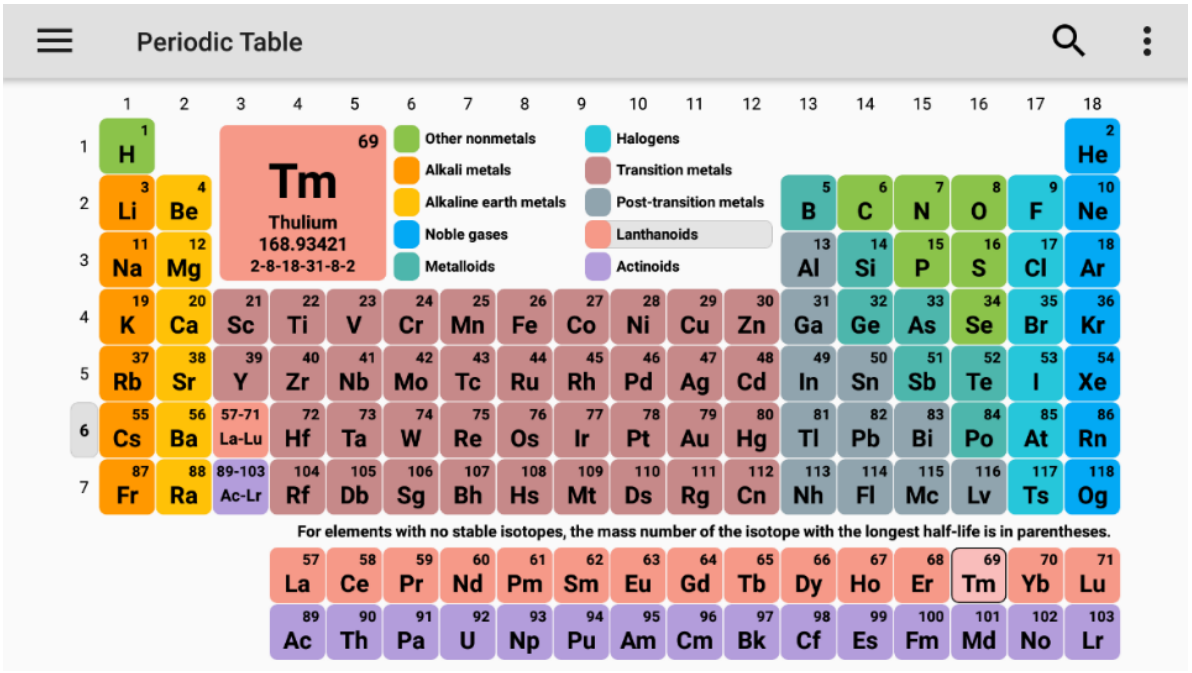

Figure 2.1 Periodic Table menu which contains chemical elements to choose for (JQ Soft, 2018).