Android App for Virtual Chemistry

by

Izzati Hanani bt Mohd Marzuki

16246

Dissertation submitted to the
Information and Communication Technology Program
Universiti Teknologi PETRONAS
in partial fulfilment of the requirement for the
BACHELOR (Hons) OF TECHNOLOGY
(BUSINESS INFORMATION SYSTEMS)

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Perak

CERTIFICATION OF APPROVAL

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Approved by,

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(DR LUKMAN A RAHIM)

UNIVERSITI TEKNOLOGI PETRONAS

BANDAR SRI ISKANDAR, PERAK

May 2015

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the reference and acknowledgment, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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IZZATI HANANI BINTI MOHD MARZUKI

ABSTRACT

With the increasing usage of mobile technologies and Internet in this current world, this paper will represents a framework on learning SPM chemistry subject by virtual experiments for secondary upper high school students which age between 16 and 17 years old through mobile application. In Malaysia, mobile learning technology based on education is not yet widely used compared to foreign country such as UK, Japan and China. Other than that, in Malaysia, students are losing their interest in science subjects such as chemistry due to several factors such as difficulty to come up with the right conceptions on the process, failure to analyse pictures and diagrams and problems to construct their own understanding on the subjects. Moreover, mobile applications chemistry available on the market is not suitable to be used as reference because it does not follow the Malaysian syllabus which focuses more on the theories. Hence, the main objective of this project is to develop a mobile application for chemistry subject that acts as an aid and supportive tool for the students in learning chemistry where they can observe the experiment virtually and construct their own understanding based on their observation. This report will focused on the problems and objectives, literature review, research methodology applied which are Rapid Application Development (RAD) model and results and discussion. In data elicitation stage, the authors use both quantitative and qualitative techniques where the author gathers the information through interview and survey to both chemistry teachers and students. Based on the user testing survey conducted to secondary upper high school students, most of the students agreed that this application can help to increase their understanding in chemistry and also applicable to be used in the classroom. Thus, this paper will discuss on how it is achieved.

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I would like to take this chance to thanks all the parties that involve directly or indirectly during my Final Year Project period. Here, I would like to express my gratitude towards the following significant advisors and contributors.

Firstly, I would like to thank Dr Lukman A Rahim for his support and encouragement as my supervisor throughout my final year project period. I would like to thank him for his advices, opinions and encouragement regarding my project in order for me to produce the best project. He also gave me directions on the way to complete the project effectively and efficiently. I sincerely thank him for that.

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I also would like to thank my parents and family for their moral support and encouragement for me to complete this project. The project will not be successful without all of them.

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CHAPTER 1

1. INTRODUCTION

1.1. Background of Study

In Malaysia, science subject is compulsory for the students to learn during their primary and lower secondary school. Meanwhile, chemistry subject is introduced to students during their secondary upper high school. The aim of chemistry subject for high school students is to provide the students with the knowledge and skills in science and technology (Farhana and Zainun, 2013). Chemistry is also vital to create awareness on the need to love and care for the environment and play an active role in its preservation and conservation for future communities (Curriculum Development Centre, 2005).

During secondary upper high school, chemistry is taught for students who enrolled in science stream course. The syllabus is divided into three main sections that are matters, reactions and new products and materials. Under matters section, the topics chemistry covered are on atomic structures, periodic table, chemical bonds, natural polymers and many more. Under reactions section, the topics covered are acid-base, electrochemistry, salts, rates of reactions and oxidation-reduction while under new products and materials, it covers industrial and consumer products and agrochemicals. From the entire syllabus stated, chemistry not only provides the students with chemical background to cope with everyday life, but also give sufficient knowledge for them to further their study in science and technology later.

Other than that, in Malaysia, the education system is targeted based on passing the examinations. The types of assessment to test the understanding of the students are based on homework, tests and examination. If the student does

not perform well during the examinations, they are considered poor in the subject itself. Moreover, the teachers teach in order to make the students understand the theories in the textbook and develop their own understanding based on what they learn. Their primary aim is to help the students passed the examinations.

This research detailed one application that deals with mobile learning that acts an aid for students in chemistry subject. The advancement of smartphone uses have led to the development of mobile devices for learning. It is now possible to deliver course content or studying school subjects across many platforms using the mobile software. This method has gain wider acceptance from user over computer-based eLearning. Mobile learning is the use of handheld computing devices to provide access to learning content and information resources (Jason, 2011).

Since most of the students taking chemistry in Malaysia are showing negative attitude towards learning chemistry subject because of their lack of interest in learning the subject itself, this paper propose a mobile application that act as an aid for chemistry students in learning the chemistry subject.. Hence, this project will provide a virtual chemistry experiments where students can observe the experiments virtually and construct their own understanding by those observation rather than reading a textbook with looking at static images only. It can help the students to analyse the pictures and process and they can use their understanding in doing their assessment such as making lab reports and doing homework.

1.2. Problem statement

In Malaysia, the enrolment of students in sciences compared to art stream at secondary level is less than the expected ratio which is 60:40 percent ratio (EPU,2006). According to some researchers, the factors that influences the lack of interest in science subject such as chemistry is because of problems with translating and 2nalysed2 text, pictures, charts and diagrams as well as failure to come up with the right conceptions of science objects or process (T.

Subahan, 1996; Yee, 1998); inability to apply process skills (Mohammad Najib, 1999; MOE, 1998), and failure to classify, synthesize and evaluate information (MOE, 1994; MOE, 1995; MOE, 1996; MOE, 2001b). This problem have negatively impact the students to lose their interest in studying chemistry subject which they find it difficult to apply on what they are learning. Thus, a study which investigates on how to improve students' learning in chemistry subject is conducted by implementing a mobile application based on secondary level chemistry subject syllabus which could remedy the situation.

1.3. Project Aims and Objectives

The aim of this project is to develop a mobile application for secondary school chemistry subject students which implement interactive laboratories experiments and also chemistry applications according to chemistry syllabus. In order to fulfil the aim of this project, the following objectives will need to be met:

1. To study suitable method of learning and student's motivation towards learning chemistry.
2. To develop a mobile application for learning chemistry.
3. To test the effectiveness of the application in an education environment.

1.4. Project Scope

Project scope is crucial towards the development and the successfulness of a project. Below described the list of detailed scope of the project:

- This application is focused to secondary high school chemistry student with age range between 16 and 17 years old.
- This application is targeted to android-base smartphone user and android based application.
- This application will focus on 'favourite' experiments that are most likely to come out in the SPM examination.

CHAPTER 2

2. LITERATURE REVIEW

Mobile technologies are becoming something that people must have in their life. Mobile by the specific terms means portability which is able to move or be moved freely or easily. People are used to mobile technologies and looking at it as normal that they can use to access and sharing information, taking photograph and communicate with their friends.

The use of mobile technologies in education has growth rapidly nowadays. Mobile phones are the most commonly used for mobile technologies in learning. The challenges of using this mobile technologies in education is that how much sense is that it is useful to be used outside of the school.

2.1. Smartphone as Learning Aid

Smartphone is a gadget that allows user to make phone calls and used other features that is found on personal laptop and not conventionally used in normal phones (eCycleBest, 2014). Nowadays, people are using mobile devices as their platform to learn which is known as mobile learning or also *m*-learning.

The reason smartphones is suitable for learning aid is because of its portability. Smartphones are light and small compared to laptops and computers. This is convenient for the students to learn anytime and anywhere. Along with its portability, smartphones also have internet connectivity where the students can access the internet to have a fast access to information. This is making the smartphones as a supportive tool.

Because of its touch screen features, smartphone is considered delightful by its user. The smartphones are engaging that makes the learning last for a long time. Besides, every student has their own learning styles. Students will be more encouraged to study because of the availability of various educational apps available in the play store.

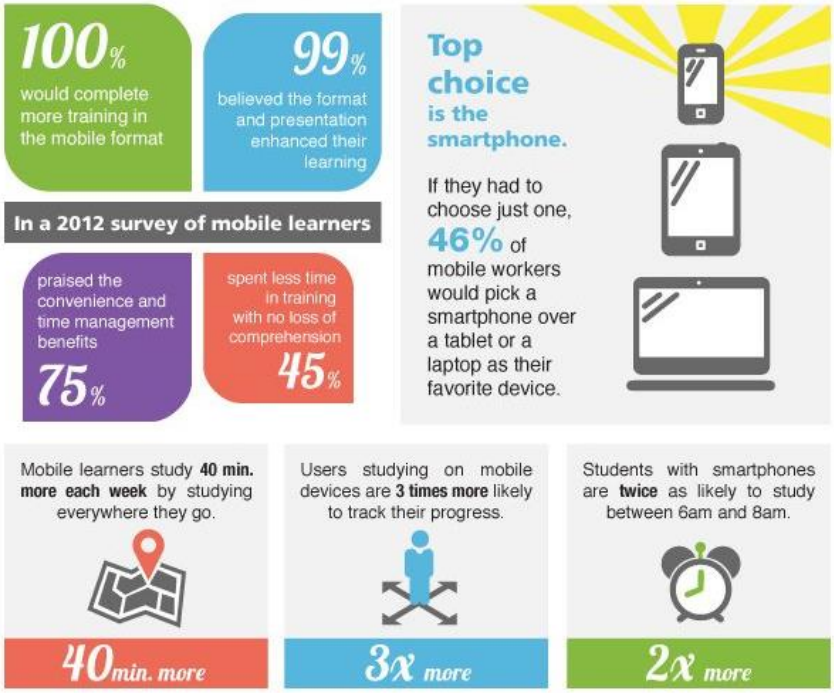

Figure 2.1 Smartphone in Learning

2.2. Android Operating System

Android is an operating system that is developed by Google and also based on Linux kernel. The main difference between Android and Ios is that Android is an open source which means that manufacturers didn't have to pay to Google to use it. This allows the user to modify and customize their apps such as changing the default browser from Google Chrome to Mozilla. This gives a plus point for Android over other operating system.

For the past years, Android has posted some impressive figures that show it has become number one operating system in certain areas. According to the statistic, about 900 million Android devices have been activated as of May 2013. Other than that, Android also owned 52% of US mobile market and

70% globally on July 2012. Although it fluctuates recently, Android has been proven to have dominance in global market for some time.

Figure 2.2 Android Devices

Figure 2.3 Smartphone Purchase Drivers

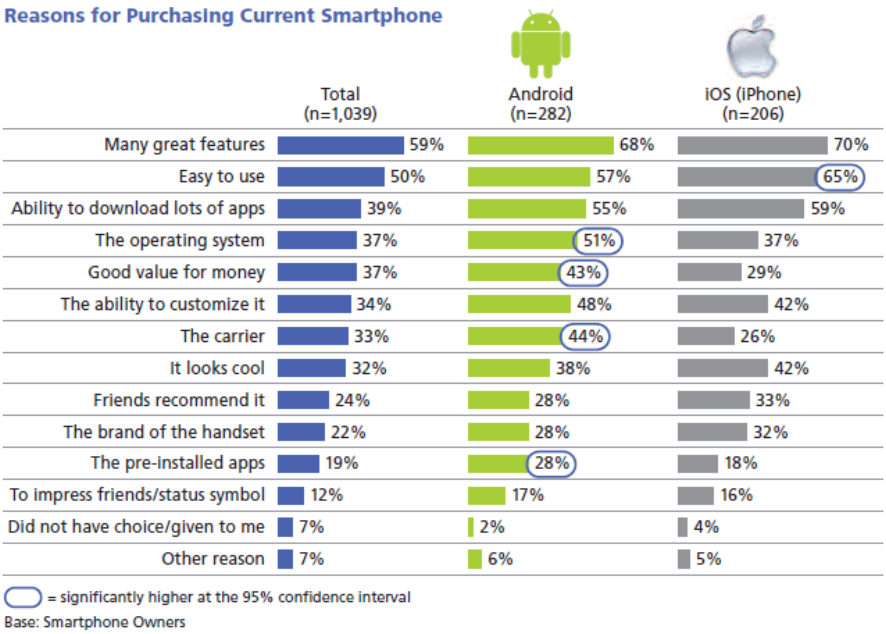

Figure 2.4 Reasons for Purchasing Android vs Ios

Figure 2.3 and Figure 2.4 above shows the comparisons of people's drivers to purchase or choosing an operating system. From both figure, we can conclude that Android is more convenient and attractive in the form of its operating system, the value of money and also the apps in it.

2.3. Learning Theories and Mobile Technologies

By using mobile technologies in education, we can consider some learning theories that can be used in developing the mobile applications. Below is the review of the learning theories with the use of mobile applications in it:

1. Behaviourism

   Behaviourism is a learning that stimulates the changes in learner's observational behaviour ("Learning Theories",n.d.). To apply this by using technology aid, the applications must use the presentation of a problem which acts as the stimulus followed by the learner's response for the solutions. The system will provide reinforcement as the feedback for this action.

2. Constructivism

Constructivism is a learning that imitates the learner's experience and knowledge and constructs their own understanding by using it. ("Learning Theories",n.d.). Instructors or teachers should encourage the students to discover and develop the understanding for themselves. The instructors must provide an appropriate tools and environment for the learners to learn and transform from passive recipients of information to active constructors of knowledge. 'Participatory simulations' is one of the convincing examples in the implementations of constructivist in mobile technologies in learning in which the learners will act out and explore by themselves in order to get their own results.

3. Cognitivism

Cognitivism is learning through the human cognition that enables the learners to form hypothesis and develop intellectuality. This learning is not simply using simulation and reinforcement, but also to involve thinking, (Moore & Fitz, 1993). Cognitivism involves how the learners think and gain knowledge. The example of cognitivism is problem solving and memory. In mobile technologies, a cognitivism theory is adapted by providing the learners the opportunity to make decision on regards to the problems given.

2.4. Motivation Theories

Motivation is a factor that driven the student's performance and the way they learn. Motivation has two types which are intrinsic motivation and extrinsic motivation. Intrinsic motivation is the need to know something, the desire to complete the task and participating in activities and the desire to contribute (Dev, 2007). Some of the examples of intrinsic motivation are mastery goals and the need for achievement. While extrinsic motivation is the things outside that trigger and influence the behaviours that they cause. The examples of extrinsic motivation are authority, peer acceptance, power and fear of failure.

Below is the review of the motivation theory which affects the student's directly or indirectly:

1. Mastery Goals

   A mastery goals or also called as task orientation is defined as the desire to get the understanding of certain topic (Archer, 1994; Miller, Greene, Montalvo, Ravindran, & Nichols, 1996; Garcia & Pintrich, 1996). This theory refers to the students that learn something in order to gain knowledge and skills over the task given. By gaining mastery goals, a student can experience self-improvement which leads to the motivation of them to learn more.

2. Need for achievement

   The need for achievement reflects the student as being independent and self-reliant in things that they do (Shia, 2000). The people who in need for achievement prefer to work that have moderate chance for success and tend to avoid risk. This need is driven by internal drive for action that is called intrinsic motivation and also the pressure exerted by the expectations of others or also called as extrinsic motivation.

3. Authority

   Authority theory of student can be based by the control of parents or lecturer towards the student's achievement (Shia, 2000). Some students learn because their parents told them to do so and their expected them to get good results in examination. This put pressure to the students and leads them to study better. Other authority example is that a student wants to control the classroom in order for them to get recognized if they are performing well in doing specific task.

4. Peer acceptance

   In this theory, a person behaves based on their perceptions of what their peers do and think. Students also are highly motivated by the expectations of their friends and their friend's perception to their friends. Some of the students have a difficulty in suited in community because of their lack of skills or criteria that makes them isolated from their friends. This will

increase their motivation to be successful in order to be accepted in certain group that they desire.

5. Power

   A student who is motivated by power has the feel to control his/her environment. They will try to prove their competence to others and trying to show their achievement to others. This motivation can be seen as individual need of a person to be competent as a student. This motivation are also difficult to spot in students because they increase the achievement measures (Hoyenga & Hoyenga, 1984).

6. Fear

   Fear is an avoidant approaches in order to avoid such fear. The common things that student fear the most is failure. The purpose to avoid fear of failure is that to avoid embarrassment and shame when the outcome of the task is failure. Research shows that the fear of failure is shown when the students are given a difficult task to be completed (Hoyenga & Hoyenga, 1984).

2.5. Android App for Virtual Chemistry

Chemistry subject is introduced to Malaysian students during their study in secondary upper high school. One of the aims of chemistry subject is to provide the students with the knowledge of science and technology. Chemistry is also vital to create awareness on the need to love and care for the environment and play an active role in its preservation and conservation for future communities (Curriculum Development Centre, 2005).

Students are losing their interest in learning chemistry subject as they find it difficult to understand and how to apply on what they are learning to their real life. Other than that, another factor that contribute to the lack of interest in learning chemistry is that the environment and the way they were teach make them hard to understand the syllabus. For example, students may not have the chance to do all the laboratories experiments as shown on the syllabus and this limits their imagination and application of the experiments

only in the classroom. Sometimes, they are eager to know the results of the experiments that may not be shown by the teacher but they didn't get the opportunity to do it.

Therefore, this research believes that helping chemistry students to explore and understand more about chemistry is crucial. With that, the method proposed to accomplish this objective is by developing a mobile application on chemistry subject for secondary school.

Laboratories applications are important in chemistry education. Due to limited time or insufficient instruments in the laboratories at schools, hands on experiments are rarely performed by the chemistry students. With that, Android App for Virtual Chemistry is proposed to act as an aid that enable chemistry students to observe the experiments conducted virtually and get explanations for each of the experiments conducted. This will help the students to construct their own understanding by observing the experiments.

Chemistry is frequently perceived as the most difficult subject because of the difficulty in illustrating the abstract concepts to the hands on applications. According to some research, students are having difficulties in constructing chemical changes in their mind as the teachers do not support the construction process effectively. (Palmer & Treagust, 1996; Ayas & Demirbas, 1997; Ayas, Karamustafaoglu, Sevim & Karamustafaoglu, 2002; Kabapinar & Adik, 2005; Ozmen, 2005; Atasoy, Genc, Kadayifci, & Akkus, 2007) Lack of laboratory practice also leads to this problem. (Yang & Heh, 2007) However, it is not possible to overcome this situation by using technology-based teaching to the students.

The experiments in Android App for Virtual Chemistry are a virtual chemistry with animations where students convert their theoretical knowledge learnt through textbook into practical knowledge by observing the experiments. This virtual experiment will present the students with an attractive way in applying important concepts, principles and processes learnt in chemistry.

Virtual experiments are suitable to be used by constructivist student where they learn by observing, understand and construct their own learning. Android App for Virtual Chemistry provides an interactive interface using

animations and simulation of experiments in the syllabus for the students to construct and understand difficult topics easily. Simulations provided in this application provide the students to express their cognitive styles by developing their own hypothesis and develop their problem solving method about the topic that they choose. Complex information that is given to the students is simplified by technology and this provides them the opportunity to learn it by themselves. (Isman et Al, 2002)

2.6. Existing Mobile Apps for Chemistry

1. Virtual Chem Lab

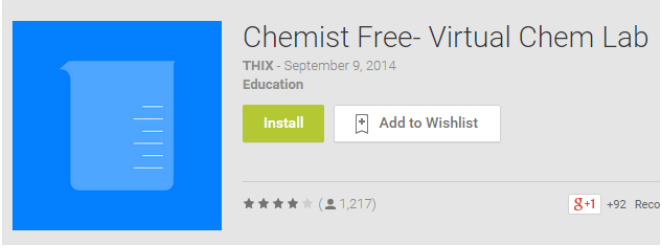

Figure 2.5 Chemist Free-Virtual Chem Lab

Virtual Chem Lab is an application that represents a virtual laboratory which has built-in database with more than 200 chemical reagents in it. Virtual Chem Lab allows the students to conduct chemistry experiments virtually, explore the reactions with different tools with their own understanding. This application offers 3D stages that enable the student to do experiments like they are doing it in the real laboratory.

Figure 2.6 Virtual Chem Lab Features

2. Virtual Laboratory

Figure 2.7 Virtual Laboratory

Virtual laboratory is also a mobile app that consists of virtual laboratory which consists of three experiments that are concentration, built an atom and molarity. The feature of this app is that the student will execute the experiments and the result of the experiment will be stored in the local storage. From this, students can retrieve back the experiment and result if they want to view it later.

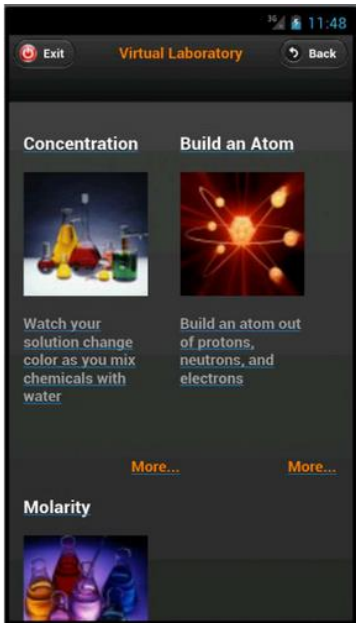

Figure 2.8 Virtual Laboratory Features

2.7. Technology Comparative Study

TABLE 1. Comparisons between Android App for Virtual Chemistry and existing apps

Mobile Apps Features	**Virtual Chem Lab**	**Virtual Laboratory**	**Android App for Virtual Chemistry**
Experiments animations	Yes	Yes	Yes
Free download	The user will have to pay to download premium feature	Free download to the users	Free download to the users
Complete notes and explanation for each experiments	The app allows the users to try and error conducting the experiment freely without any instruction and explanation given.	The app allows the users to try and error conducting experiment with little instructions provided.	The app allows the user to observe the experiments animation and provided notes and explanation for better understanding
Applicable to use in Malaysia education syllabus	Not applicable because the contents are not related to the Malaysia chemistry syllabus.	Not applicable because the contents are not related to the Malaysia chemistry syllabus.	The contents in the applications follows Malaysia chemistry syllabus and applicable to be used in the classroom.

Topic selection	The app does not provide topic selection for the user to choose the experiment they want to conduct	The app focuses on three topics that are concentration, build an atom and molarity	The app focuses on chemistry SPM topics that are electrochemistry and salt
Android Platform	Yes	Yes	Yes

CHAPTER 3

3. RESEARCH METHODOLOGY

The methodology being used is discussed further in this chapter. Both quantitative and qualitative approach has been taken which is relevant and helpful in assessing the response of chemistry teachers and students based on their opinion and behaviours. Survey questions have been distributed to the students and interview had also been conducted to the chemistry teacher. The system methodology used to develop this project is taken from System Development Life Cycle (SDLC) methodology. This system methodology will be discussed further in the next section.

3.1. System Development Life Cycle (SDLC) Methodology

The methodology that is applied to this project is Rapid Application Development (RAD) model. RAD is a type of incremental model. RAD model is a software development model in which it uses minimal planning in favour of rapid prototyping. Since our time allocation for final year project is short, this model is suitable to be implemented as the project is developed in parallel with the prototype and to make the product delivery faster. This can give the end user a quick glance on what they need to see and give feedback regarding the delivery and the system's requirements.

The advantages of using this RAD model are that the changing requirements of the product by the user can be accommodated. Other than that, RAD model also reduce the overall development time due to the parallel development. The RAD methodology is illustrated in Figure 3.1 below.

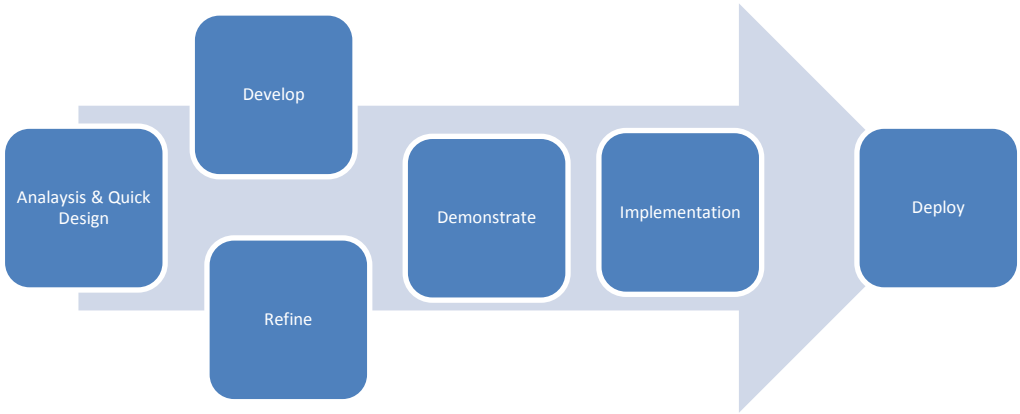

Figure 3.1 RAD Methodology Cycle

3.1.1. Analysis and Quick Design

In this analysis phase, the problems and goals of the project are identified. A preliminary investigation has been done in order to gather the information on learning method that is being implemented by the school teachers and also the motivation theory that driven the students to study. Other than that, the preliminary research also aiming to know the student's acceptance of chemistry and their need in mobile application for chemistry subject. The method been used to conduct all this is by distributing surveys and questionnaire.

The data that the author got from conducting the survey and interview will be analysed. A few actions are taken in this project are listed below:

a) Study and research on what topics in SPM chemistry syllabus that is suitable to be included in the mobile applications.
b) Doing a research and making comparisons with the existing and similar chemistry applications concept in the market.
c) Analysing on the student's motivation theory in learning and also teacher's learning style adoption.

In this project, the target user will be secondary high school chemistry students which aged between 16 and 17 and also use Android based operating system in their mobile devices. The reason for this is because majority of the user among this age group has their own mobile devices according to some research.

The author conducted a survey which involved 30 secondary high school chemistry students and also interview to teachers from Sekolah Menengah Teknik Alor Star, Kedah to get some useful information to be used and implement in the applications. From the survey, the author has concluded some functionality that will be included in the application. Amongst the functionality are:

a) The application should be able to provide explanation on every experiment that students choose to learn from.
b) The application should show the result of experiments that has been conducted.
c) The application should include quiz feature to test their understanding in the topic and also to match with their study motivation theory.

In analysis part, the identification of tools used in the project is also required. The tools that will be used will be divided into two types that are hardware and software.

1. Hardware
    - Computer
    - Mobile Phones
2. Software
    - MIT App Inventor

        App Inventor is an open source web application originally owned by Google, and currently maintained by Massachusetts Institute of Technology (MIT). App Inventor is one of the best platforms for new developers to create an application for Android operating system. It uses graphical interface where the developers can drag and drop the visual objects to create an application that can run on Android devices. App Inventor uses programming control blocks that looks like programming textual language. App Inventor is suitable to be used because it is easy to learn and developers can develop their applications in short time.

- Android Application Package (apk)

  Android application package is a file format used for installing the software on Android operating system. Softwares that are usually use .apk file are games or apps. To make an apk file, the program will be compiled first and then all of its parts are packaged into one file. The apk file will contains the program's code, resources, assets and many more.

3.1.2. Prototyping

This phase will be the longest stage as it includes developing, demonstrating and refining the project using a prototype. A prototype simulates a few aspects of the final projects. Prototyping is useful for the designer to get a feedback from the user early in the project development. The developer will design and develop a prototype that follows the user requirements stated in the analysis phase earlier. The user and developer will be engaged throughout the prototype cycle and the user will give continuous feedbacks until they are satisfied. This feedback will be used to do the refinement to the project until it meets the expectation. The final prototype will be used as the final application later.

3.1.3. Implementation

At this stage, the system is completed tested based on its interfaces and also functionality. This phase involve all the coding part in order to make the system function correctly. All of the functionality must be running and working successfully according to the plan.

3.1.4. Deployment

This phase involve on the data conversion, testing and user training. The system testing was done to two categories of users which are both chemistry students and teachers from Sekolah Menengah Teknik Alor Star, Kedah. Three teachers will be tested first in order to confirm whether the contents within the application are following the SPM syllabus and similar to their learning theory which is constructivism theory. The system is also tested to the main user of this application that is chemistry students. The students were given the Android phone and tablet to test the application. After that, a qualitative approach has been done by doing an interview with the students to get feedbacks on the effectiveness of the application. Some of the questions are:

a. What do you think about this application?
b. Does this application help you to understand chemistry?
c. Does this application can help you to do the school assessment such as doing reports and homework?
d. Is this application applicable to be used in the classroom?
e. What suggestion that you want to give to improve this application?

3.2. Gantt Chart

No	Details	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Selection of Project Title																								
2	Identification of problems																								
3	Study on project background																								
4	Defining the objectives of the project																								
5	Defining scope and limitation																								
6	Preliminary Research																								
7	Literature Review																								
8	Extended Proposal Submission																								
9	Define research methodology																								
10	Data requirements gathering																								

11	Analyzing of data gathering																							
12	Construct Use Case Diagram and Activity Diagram																							
13	Submission of Interim Report																							
14	Proposal Defence																							
15	Project Design																							
16	Developing the application																							
17	Application Pre-Testing																							
18	Pre-Sedex																							
19	User Acceptance Testing																							
20	Submission of Technical Report																							
21	Submission of soft-bound dissertation																							
22	Submission of hard-bound dissertation																							

CHAPTER 4
4. RESULT AND DISCUSSION

In this chapter, the information gathered from the surveys are being analysed and further discussed. Findings from conducted survey confirmed of the initial hypothesis of current problem. Respondents answer the survey based on their preferences and knowledge and this response give the author a clearer view about the teacher's learning style, student's motivation theory and also the need of them having the mobile chemistry application. Each question emphasize on the situations and problems that the respondent is facing. The following sections show the finding of the survey after doing analysis on it.

4.1. Results from Teacher's Interview

From the interview that is conducted with three secondary high school teachers from Sekolah Menengah Teknik Alor Star, Kedah, it shows that the teachers are using constructivism approach where the students are teaches based on their knowledge and experiences. The teachers also encourage the students to construct and develop their own understanding based on what they learnt. We will discuss more about constructivism theory and how they are applied to chemistry mobile application.

In constructivism, teachers will be focusing on making connections between facts and fostering new understanding to the students. The teacher will use the techniques to trigger the students to analyse, interpret and predict the information.

In order for the teacher to teach well, they must understand the way student receive and process the information and making assumptions to support those information. The purpose of this is to make the students

construct his or her own understanding and not just memorising the right answer.

This approach is relevant in teaching the chemistry as the students will need to observe and interpret what they learnt through their own understanding. Hence, this is applicable in mobile application for chemistry as this application will encourage the students to do virtual experiments where the students can observe, understand and construct their own understanding on the chosen experiments.

4.2. Student's Result on Motivation Theory

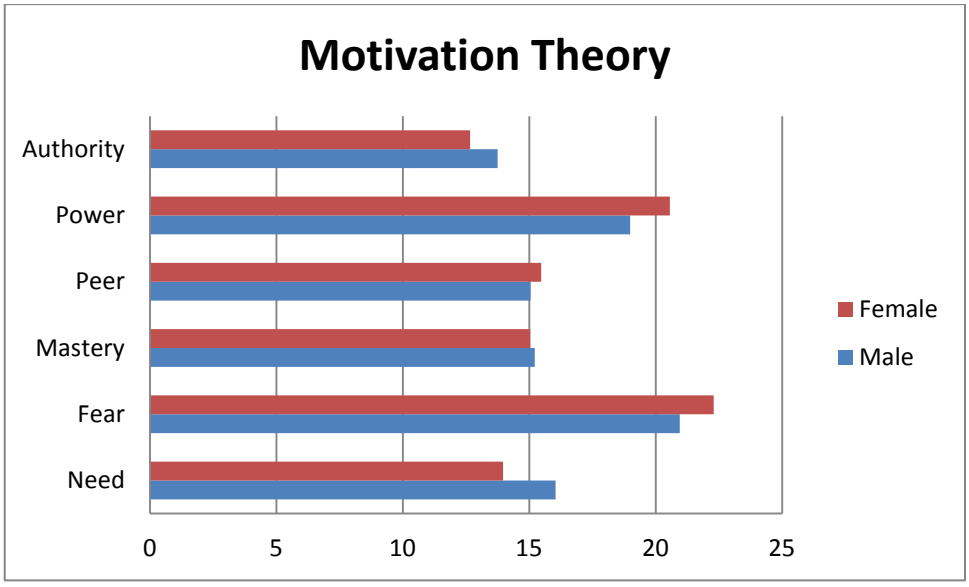

Figure 4.1 Chemistry Student's Motivation Theory

Figure above shows the result of survey based on motivation theory. This survey was conducted involving 30 respondents from Sekolah Menengah Teknik Alor Star which consists of 12 male students and 18 female students. From the chart, we can see that fear has the highest percentage from both male and female students. "Fear" in this research indicates the fear of failure that exist in themselves.

In average, students are driven by their fear of failure in studying and examination. Fear of failure can be comprises into 2 factors that are negative

expectations in which the individual worry about possible failure and reflexivity in which the person put an effort to avoid any possible failure.

This fear of failure in student's perspective can be in term of expectation of failure before doing any task, feeling ashamed or embarrassed when they received low grade and also challenging task that may lead them to failure or success.

4.3. Student's Survey on Mobile Applications

Question 1: Did you have a hard time to understand the experiments in chemistry subject?

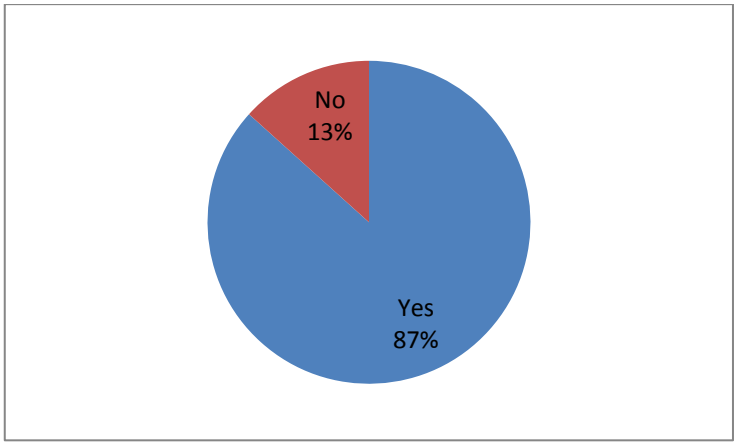

Figure 4.2 Understandability of chemistry to students

Based on the figure above, it is shown that 87% of the students agree that they are having a hard time to understand the experiments in chemistry subject while the rest find it easy. This situation might be caused by the difficulties in understanding the purpose of the experiments and they don't understand the chemical reaction provided with the chemical formula in each experiments. This is important in determining on how to make the learning easier to understand and applied.

Question 2: Did you enjoy conducting experiments in laboratories?

Every respondent agree that they enjoy conducting experiments in laboratories. This is because they can observe the real applications of chemistry experiments and see what the outcome for each experiment is. Furthermore, by doing experiment, they can interact more with the teacher while asking questions and gain lots of knowledge about the subjects.

Question 3: Do you think that it is necessary to conduct all the experiments mention in the syllabus?

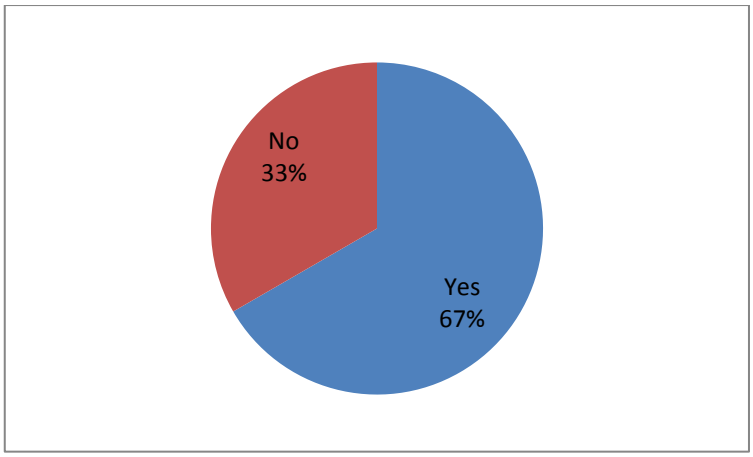

Figure 4.3 Necessaries to conduct all experiments in syllabus

Figure 4.3 above shows that 67% of the respondent said that it is necessary to conduct all the experiments in the syllabus. This is because they want to know and to experience by themselves on conducting the experiment and see the real results for each of it. The rest of the respondents do not think it is necessary because the experiments in the syllabus are too many and the time allocated in laboratories is limited. Besides, they think that simple experiments can be read and understand through the book and only do big experiments in the laboratory.

Question 4: Are you having a situation where you are unable to explore and understand more about chemistry experiments in the laboratories?

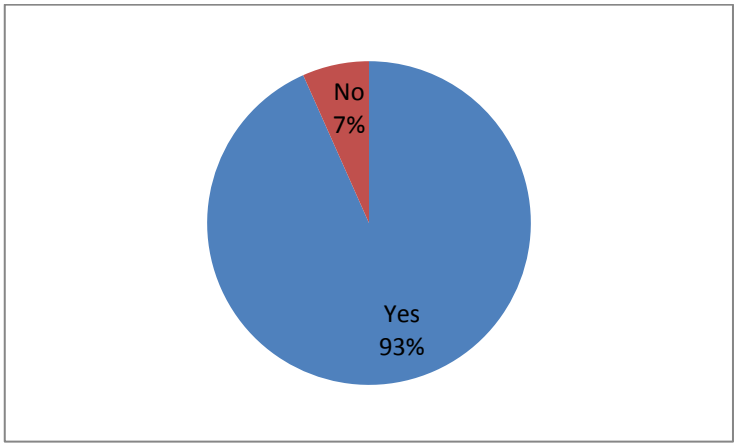

Figure 4.4 Unable to explore about chemistry due to several reasons

93% of the respondent said that they didn't have the chance to explore more in each experiment due to the limited time that is provided by the teachers to them. Another reason is caused by the insufficient equipments caused by broken during conducting the experiment or lost. Another factor is regarding safety concerns where some of the experiment may involve risk due to release of poisonous gas in the laboratories that can give harm to the students.

Question 5: Have you ever use any mobile apps on chemistry subject before?

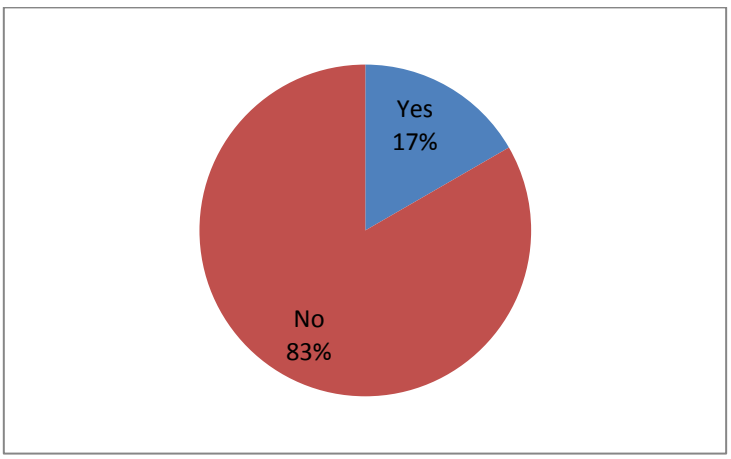

Figure 4.5 Experience in using mobile apps on chemistry

Based on Figure 4.5, 83% responded that they never use any mobile apps on chemistry subject. Some of them don't even know that there are mobile apps on chemistry available in the market. 17% of the respondent said that they used apps on chemistry before but the apps did not help them that much. This is because the apps do not provide specific description on what they are going to learn in it and it does not help them in increasing their level of understanding in chemistry.

Question 6: Do you think that it is proper to have a mobile application on chemistry that will help you to understand more about chemistry?

All of the respondents are strongly agree to have a proper mobile application on chemistry that will help them to understand more about chemistry. This mobile application will be considered as an aid for them to explore and learnt more about chemical reaction by doing the virtual experiments. This application can be convenient to them as they can access it anywhere by using mobile devices.

4.4. Use Case Diagram

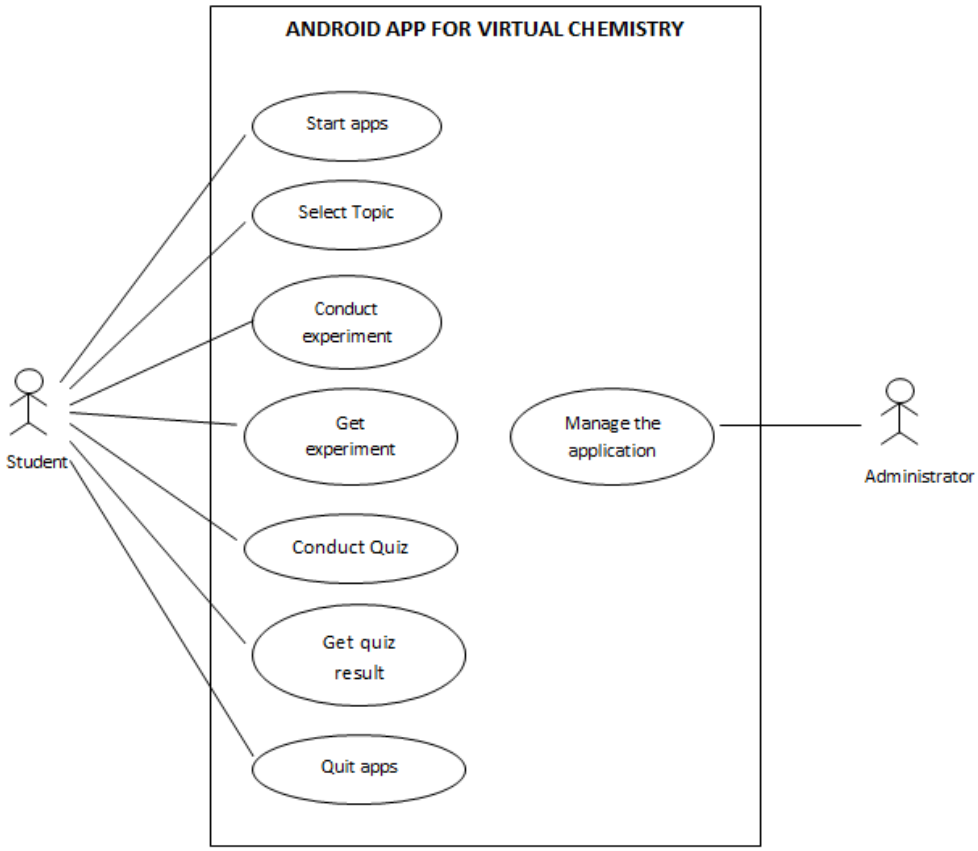

Figure 4.6 Android App for Virtual Chemistry Use Case Diagram

Figure 4.6 shows the use case diagram for Android App for Virtual Chemistry. Two actors are engaged in this system are students and administrator. It illustrates two main functions in this application that are run experiments and conduct quiz. The administrator will manage the application in term of improving the performance of the application.

4.5. Activity Diagram

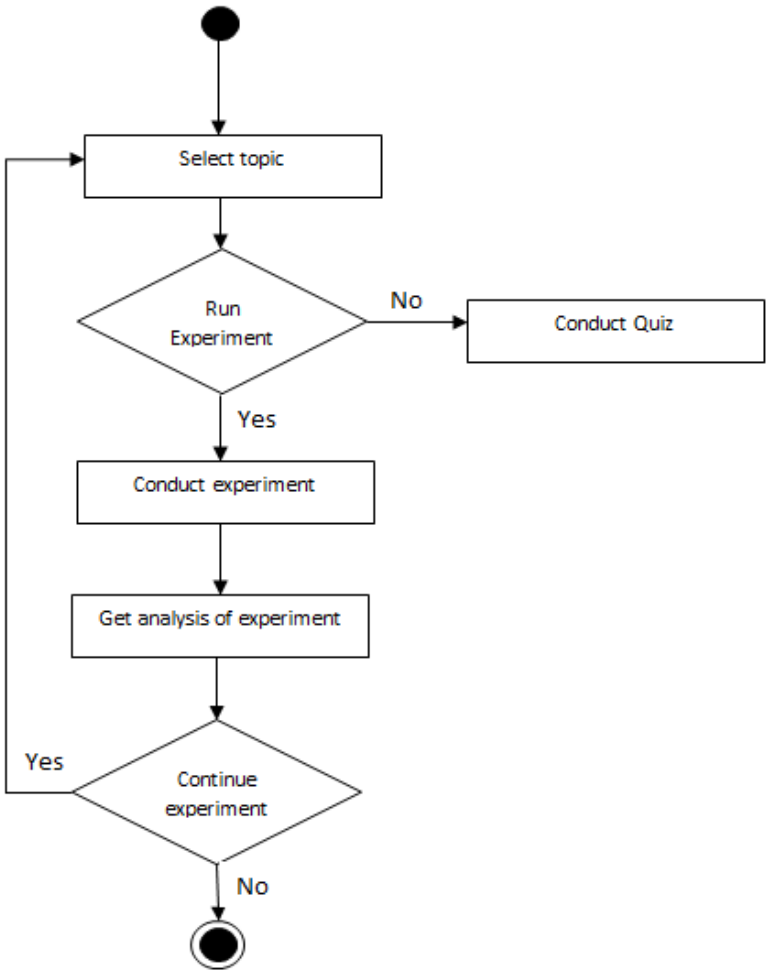

Figure 4.7 Android App for Virtual Chemistry Activity Diagram

Figure 4.7 above shows the activity diagram for Android App for Virtual Chemistry. Firstly, the user will need to select a topic that they wish to explore about. The user are given the choice whether to choose run experiment or conduct quiz. If the user selects to run experiment, then the application will redirect to conduct experiment. After completing conducting experiment, the user will get the analysis of the experiment. After that, if the user wishes to continue another experiment, then he will need to select the topic back. If he does not want to continue, he can quit the apps.

4.6. Logo

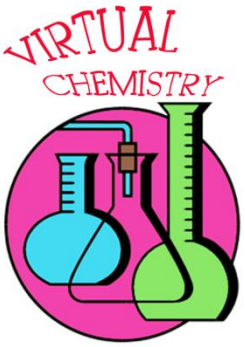

Figure 4.8 Android App for Virtual Chemistry Logo

The logo of the application is created using Adobe Photoshop. The logo was designed to be simple and understandable. The logo has a picture on beaker, conical flask that represents the equipment used in chemistry subject.

4.7. User Interface

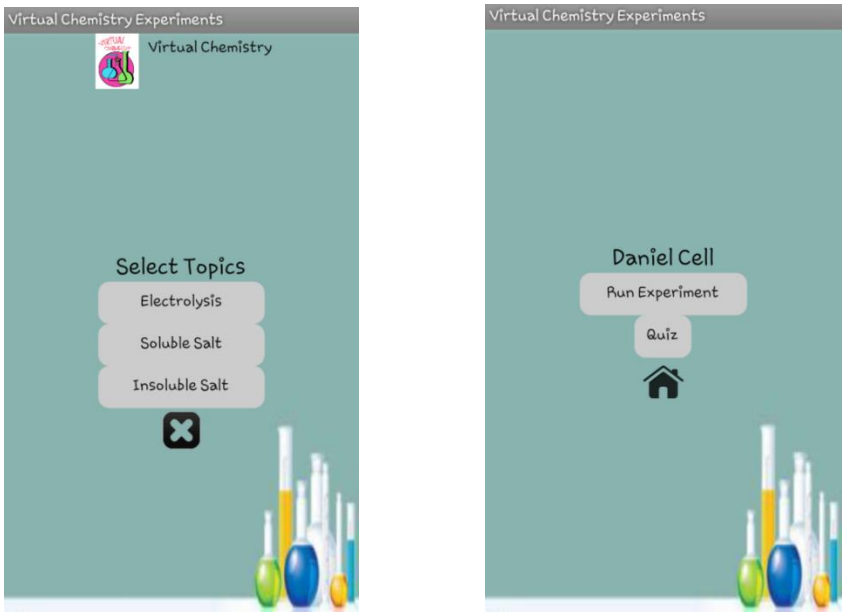

Figure 4.9 Front page and menu selection in Android App for Virtual Chemistry

Figure above shows the front interface of Android App for Virtual Chemistry where the user will need to choose a topic that they want to explore about. After the user click on the topic that they prefer, the user will once again

need to choose whether to proceed to “Run Experiment” or conduct quiz on the chosen topic.

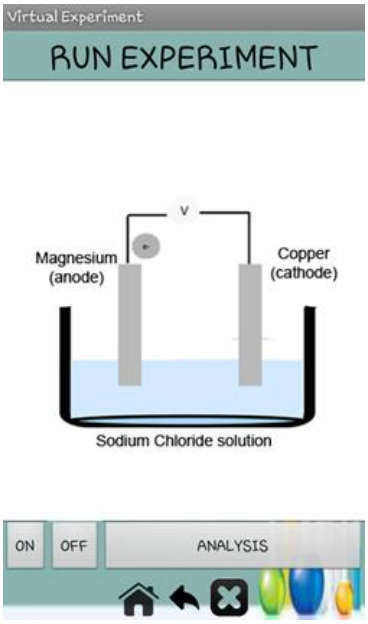

Figure 4.10 Run Experiment Interface

Figure above shows the interface for “Run Experiment” feature. This feature will shows the virtual experiment with image animations. Users are able to observe the solutions, methods, apparatus and equipments used and results in conducting the experiments. The On and Off button are for the users to pause the experiment or resume back the experiments. The users are encouraged to observe the experiments until they understand about the process.

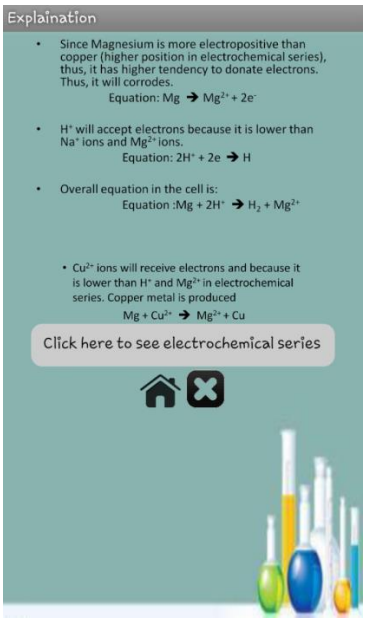

Figure 4.11 Experiment explanation interface

The explanation feature is where the user are given the analysis of the experiment conducted earlier. This feature will explain on how the reactions happen in the experiment and chemical equation are also provided to show the user the reaction take place throughout the process.

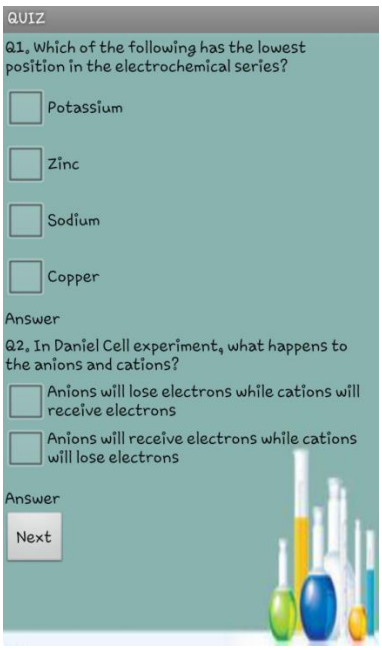

Figure 4.12 Quiz Interface

Figure above shows the "Quiz" feature in the application. The user will be tested their understanding on the topics by answering four questions.

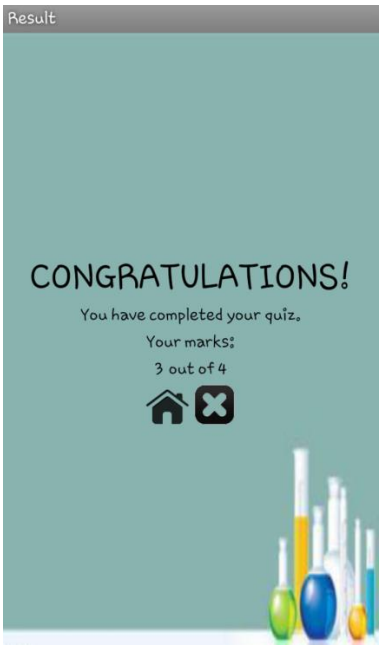

Figure 4.13 Quiz Result Interface

At the end of the quiz, the quiz marks will be shown on the screen. Mark with 1 and less is considered fail in the topic. Basically, the quiz feature is related to the motivation theory identified earlier in order to decrease the student's fear of failure in the subject. The students will try to study and understand more about the topic before they answer the quiz in order to avoid getting low marks that also indicates failure to them.

4.8. System Testing

Basically, the author has conducted two categories of testing that are application pre-testing to the chemistry teachers and user acceptance testing to chemistry students.

4.8.1. Teacher's Testing

The testing was done to chemistry teachers at Sekolah Menengah Teknik Alor Star, Kedah. The purpose of this testing is to give the overview of the application before it is tested to the students. The teacher is needed to check whether the contents of the applications are suitable to be used and follows SPM chemistry syllabus. From the testing, the teachers agreed that this application is suitable to be used in classroom and education environment if it were given the chance. Besides, the teachers also agreed that this application follows the constructivism approach where the user of Android App for Virtual

Chemistry will need to observe the virtual experiments and construct their own understanding based on their observation. Several improvements such as changes on some of the contents and process have been suggested for the refinement of the application before the final application is tested to the students.

4.8.2. Student's Acceptance Testing

The aim of conducting user acceptance testing is to test the interfaces and functionality of Android App for Virtual Chemistry to the students. Another purpose is to evaluate the effectiveness of this application to them. The user acceptance testing was done to 6 secondary upper high school students which range from excellent, medium and poor students in chemistry at Sekolah Menengah Teknik Alor Star. Firstly, the students were tested on the virtual experiments which show the image animations on how the experiments should be conducted and its reactions. After the students were able to understand the process of the experiment, they will read the explanation part for further explanation on reactions that happens during the experiment.

The user's evaluation also includes on the motivation theory identified earlier during application's requirement elicitation that results on fear of failure. The student's fear was tested by the quiz feature in this application. Each topic has its own quiz. At the end of the quiz, the marks will be shown. After the testing completed, the author have interviewed each students on their thoughts of using the applications and their suggestion for the improvement. Among the advantages highlighted by the students were this application is good and can help them to understand better about chemistry experiments. This application can be a supportive tool for them to better understand about SPM chemistry subject. Other than that, all of the students agreed that this application is applicable to be used in classroom if it were to be implemented by the teacher. Among the recommendations that students mention for the application in the interview are having an audio features to explain about the experiment process to make it more attractive and also to make a bilingual features that can help students that have poor English to understand more about the contents.

Figure 4.14 Testing Android App for Virtual Chemistry with chemistry teacher

Figure 4.15 Introduction of Android App for Virtual Chemistry to the students

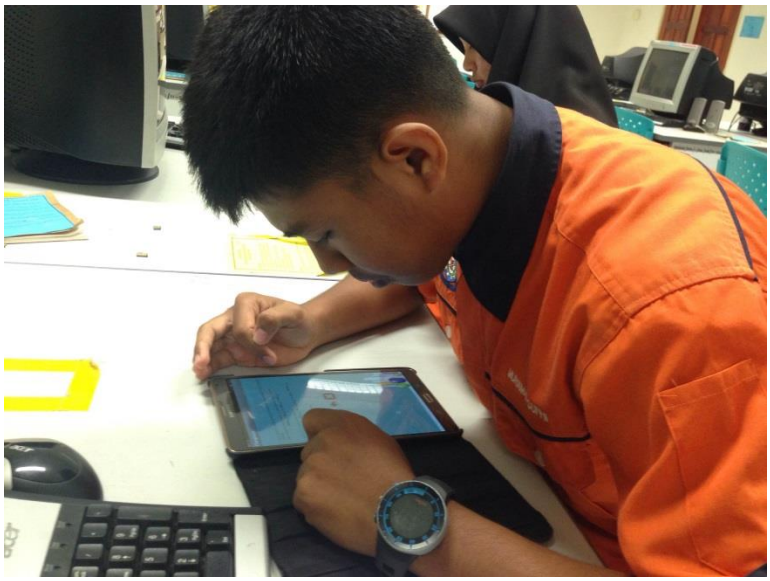

Figure 4.16 Student's acceptance testing

CHAPTER 5

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

This chapter will summarize the project study and results. As stated earlier in introduction part, the author has identified several objectives that need to be achieved in this project.

The first objective will be to analyse the learning styles of secondary high school chemistry students. This objective has been achieved by the author through survey session with high school chemistry students at Sekolah Menengah Teknik Alor Star, Kedah. This session involved 30 students which consist of 12 male students and 18 female students. Other than that, the author also conducted interview with three chemistry teachers on their teaching approach to the students. From both survey and interviews, it can be concluded that this application is suitable to be implemented as the main purpose of this application is to encourage chemistry students to observe and conduct virtual experiments and constructs their own understanding just like the way the teacher's approach in the classroom.

Android App for Virtual Chemistry will have features where students can choose which topic they want to conduct and they will observe the experiments based on the graphic animations. Each experiment will be given adequate explanation and also chemical formula at the end of the experiments. Learning through animations is said to be effective in increasing the understanding as people most likely to be attracted to learn in an attractive way.

This project hopefully will give benefits to the community especially chemistry students in increasing their understanding to chemistry by conducting these virtual experiments.

5.2. Recommendation

In this project, the current target for the applications is to provide virtual chemistry for certain topics. Due to limited time available to develop this project, it is suggested that this apps can be improvise to provide more topics and experiments for the students to explore it. An audio explaining each experiment are also recommended to make the apps attractive and easy to learn to the students. Other than that, it is also important to maintain the user interactivity and ease of use in order to make this app successful and better than the existing apps in the market.

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APPENDICES

Comparisons between Behaviourism, Cognitvism, Constructivism

	Behaviourism	**Cognitivism**	**Constructivism**
Description	• Learning produces by stimulation and reinforcement • Operates on principle of "stimulus-response"	• Learning not to be simply stimulation and reinforcement, but to involve thinking (Moore & Fitz 1993) • The mind is essentially a 'black box' that should be opened and understood	• Learning to be active, constructive process • Actively construct or create their own subjective representation of objective reality
Assumptions	1. Learning is manifest by change in behaviour 2. Environment shapes the behaviour 3. Contiguity and reinforcement to explain learning process (Grippin & Peters 1983; Shlechter 1991;Watson 1997)	1. Memory system is active, organized processor of information (Merriam & Caffarella, 1999) 2. Prior knowledge plays important role in learning (Merriam & Caffarella, 1999)	1. All knowledge is constructed and all learning is a process of that construction.

Principles	1. Direct instruction (Engelmann, Z., 1964) 2. Programmed instruction (Skinner, 1954) 3. Social learning theory (Bandura, 1965)	1. Attribution theory 2. Elaboration theory 3. Stage theory of cognitive development 4. Theory of conditional learning	1. Social development theory 2. Problem based learning 3. Cognitive apprenticeship 4. Discovery learning 5. Case-based learning 6. Situated learning theory 7. Activity theory

Chemistry Student Survey
Final Year Project I
Universiti Teknologi PETRONAS

This survey is used for Mobile Applications for Chemistry in which the students will be able to conduct, explore and apply the chemistry concept and knowledge through virtual experiments that they are not able to conduct in real laboratories.

Gender: Male / Female **Age: _____**

Section 1

Read each question and choose the number that best describes you. There are no wrong or right answers.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	I work best in a group environment such as group discussion (N)	1	2	3	4	5
2.	I wait to the last minute to complete my homework/assignment (N)	1	2	3	4	5
3.	When I faced a difficult test, I expect to fail before I expect to do well (F)	1	2	3	4	5
4.	I feel ashamed when I received a low grade (F)	1	2	3	4	5
5.	I enjoy challenging tasks (F)	1	2	3	4	5
6.	Sometimes I do more revision and reference to help me understand the subject better (Mas)	1	2	3	4	5
7.	I tried to do my best in every task (Mas)	1	2	3	4	5
8.	I feel ashamed when I received low mark from my friends (Peer)	1	2	3	4	5
9.	I like to be one of the most recognized students in my class (Peer)	1	2	3	4	5
10.	I am satisfied with my grades, as long as I learn from my mistakes (Pow)	1	2	3	4	5
11.	I find my ability is higher than most of my friends (Pow)	1	2	3	4	5
12.	It does not bother me when my friends perform better than me (Pow)	1	2	3	4	5

13.	I have no problem telling my parents when I receive bad grades on exam (Auth)	1	2	3	4	5
14.	I feel that I should be recognized when I demonstrate my abilities in the classroom (Auth)	1	2	3	4	5

Section 2

Read the entire question and tick (✓) whether you agree or not.

	Yes	**No**
Did you have a hard time to understand the experiments in chemistry subject?	☐	☐
Did you enjoy conducting experiments in laboratories?	☐	☐
Do you think that it is necessary to conduct all the experiments mention in the syllabus?	☐	☐
Due to specific reasons, you are not able to explore more about chemical reactions and you didn't get the chance to repeat any incorrect experiments.	☐	☐
Do you ever use any mobile apps on chemistry subject before?	☐	☐
Do you think it is proper to have a mobile application on chemistry that will help you to understand more about chemistry by conducting virtual experiments that you are not able to do in laboratories?	☐	☐