# CHAPTER 1

# INTRODUCTION

## 1. Background

Textbooks are inevitably the most perfect guides to a specific subject. A textbook provides instructions or information in any branch of study. However, despite of the abundance of knowledge that can be found within the textbooks, they are not fully utilized by majority of the school students. It is believed that main reason behind this is that textbooks fail to captivate their interest to read. This may be because students who are born in this digital era, often are called Millennials, grew up surrounded by and interacting with technology(McGarvie, 2009). In addition to that, technology has created distractions that keep students away from reading and most significant examples are the emergence of electronic devices such as computers, smartphones and game consoles. Reading has become less attractive for kids in digital age where there are too many distraction and words in the textbook or even storybooks are no longer able to attract their interest. Therefore, in order to attract student to focus on learning using textbooks, technology can be used, adapted and implemented on textbooks.

Augmented reality (AR) is the technology that has the most potential to captivate student's interest in learning. An AR application allow computer-generated objects to appear and coexist in the same space as the real world (Azuma et al., 2001). This characteristic of AR is hypothesized to be able to provide interactive learning experience and captivate student's interest in learning better than dull traditional textbooks. Images created by using AR technology allow students to learn and understand more of a topic in certain field of study because students are able to watch and learn from the images instead of imagining it based on the words in the textbooks.

## 1.1Problem Statement

Nowadays, there are many students who preferred to spend most of their leisure time doing other activities such as sports, playing video games, and even if they spend time on reading, the reading materials are usually unrelated to academic syllabus. Majority of them are struggling to motivate themselves to read because these materials are sometimes too difficult to understand and according to Mariotti (n.d.), most of the time, they do not want to be embarrassed for failing to understand the contents in the textbooks or the task is just not enjoyable. There are also some students who have excellent reading skills but chose not to read because compared to other activities, reading may not provide as much pleasure or fun (Mariotti, n.d.).

Textbooks are inevitably the most perfect guides to any specific subjects. A textbook provides instructions or information in any branch of study. However, it fail to capture the attention of majority of the new generation students. There's a perception among the elder that the Millennials have poor reading culture and dislike reading. However, according to the survey carried out by Pew Research Center, Millennials are actually reading more books than the over-30 crowd. This indicates that the Millennials do practicing good reading habits, but they read differently. They are reading for information, they choose what they want to read, they only read something that can arouse their interest. This is exactly the reason why reading textbooks is unpopular among the Millennials, traditional textbooks hardly able to capture the student's attention and it is consider time consuming as well for the Millennials to sit down and going through a textbook from cover to cover. They can get all the information from the Web faster.

Besides that, there are students who have poor command of languages. It would be difficult for them to understand topics learned as they are not able to get the clear image or picture of the topic that they are learning by just reading the words inside the textbook.

Even though textbooks are too dull to raise student's interest but they will still read it but only for the sake of the examination. In other words, they will only read it just to pass their exam. Students generally only study the topics that will come out in the exam papers and memorize it without understanding the topics. Students are actually forced to read and reading materials are actually drilled into their heads without being literate. As a result, most students would not be able to remember what they have read after the examination because they never really understand the topics that they read in the textbook. In the end, they do not learn the knowledge from the textbook.

## 1.2 Objectives

The main objective of the project is to develop an augmented reality application that will that will provide enjoyable learning experience and create better learning environment which more interactive and interesting for students using textbook.

Another objectives of the project including determine the pattern of textbooks usage among students as well as the usage pattern of smart devices and evaluate the usability aspect of augmented reality and smart devices in education.

## 1.3Scope of Study

The target users of the application are upper secondary schools students. Majority of the students have problems understanding the concept in science subjects and Malaysian student performance in the latest PISA study (PISA 2012) has further proves the point. The Programme for International Student Assessment(PISA) is an international survey that will be held every three years with the aim of evaluate education systems worldwide by testing the knowledge and skills of 15-year-old

students. Malaysia was ranked 52nd out of 65 countries participating in the assessment.

Based on the PISA 2012 report, Malaysia scored only 398 in Reading and 420 in Science and this result was below the global average score of 496 in Reading and 501 in Science. Therefore, this project aims to develop an application to help this group of students to achieve better learning experience and understanding in their science subjects.

# CHAPTER 2

# Literature Review

## 2.1 Textbook

### 2.1.1 History of Textbook

According to the records in history, textbooks have already existed and was presented in many different forms. Some of it are printed on media such as clay tablets, scrolls and papyrus up to bound, mass produced books (Encyclopedia of Education, 2008a). Earliest known textbooks were created in the 16th Century and was written on Latin, the common language of schooling and scholars at the time. Textbooks have being used in ancient Greece, Rome, China, India, Egypt and other early societies based on the records found (Encyclopedia of Education, 2008a).

The revolution for books happened during 15th Century when the printing with changeable type was invented. The new invention paved the way to faster and more efficient book reproduction. During the time of colonization, textbooks were imported from the mother country and taught as facts for the new territory even when the facts are not related to history of the region (Goslin, 2008). When these territories have gained independence and become nations through revolution or their succession from the colonizing country, they changed their textbooks to reflect their new realities (Encyclopedia of Education, 2008a). For example, after Canada achieve independence, textbooks were changed especially the fact that War 1812 was won by Canadians instead of the British or Americans since they had successfully defended the border from invasion from the United States.

There are many standardized textbooks for children was printed as a result of compulsory education and the subsequent growth of schooling in Europe. Textbooks has then become the primary instrument in education.

### 2.1.1 Definition

The definition of textbook is wide and varied. One of the most common definitions is that a textbook is a printed manual of instruction for any branch of study. (Encyclopedia of Education, 2008b). Each textbook contain knowledge and facts about a certain branch of study. Textbooks are most commonly being used in education institutes such as school, college and university as the guideline for the students to learn and acquired the knowledge in the subject they studies. Unlike another books, textbooks are normally assembled more than they are written. Normally, they are made by a corporation to follow a set standard curriculum for education system (Encyclopedia of Education 2008b). While textbooks are still the main teaching resource for majority of the students, different learning materials are being developed to replace the traditional textbooks (Goslin, 2008). Dramatic changes in technology have changed the learning culture in new generation of students, static resource such as textbooks that filled with words no longer able to hold student's attention when there are plenty of other distractions such as social media.

## 2.2 Augmented Reality

### 2.2.1 History

The term "augmented reality" started to become a common term since 1990 but that doesn't mean it was never existed before 1990. Augmented Reality already existed at the moment when gadgets that could supply their users with information after relate it to their environment.

AR remained as much as a toy for the scientist until 1999. Consumer never knew about this field of study due to its expensive, bulky equipment and complicated software. Hirokazu Kato of the Nara Institute of Science and Technology revolutionized augmented reality when he released the ARToolKit to the open source community. For the first time in history, it allowed video capture tracking of the real world to combine with the interaction of virtual objects and provided a 3D graphics that could be overlaid on any OS platform.

The first AR apps come to smartphones on 2008. World can now begin to enjoy the experience somewhere close to what it's supposed to be. Android users are now able to take in the world through their mobile phone cameras and see augmentations on the screen of points of interest by using Wikitude app.

### 2.2.2 Definition

Augmented reality (AR) is the integration of digital information with live video or the user's environment in real time. Basically, AR system generates a composite view for the user that is the combination of the real scene viewed by the user and a virtual scene generated by the computer that augments the scene with additional information. As proposed by Azuma(1997), AR can be defined as a system that fulfill three basic features: a combination of real and virtual worlds, real-time interaction, and accurate 3D registration of virtual and real objects.

### 2.2.3 Concept

Generally, there are two essential components that are important in an augmented reality application. First, the application needs to determine the current state of both physical world and virtual world. Second, the application needs to display the virtual world in registration with the real world in the manner which allows participant to feel the virtual world elements as part of his or her physical world.

Augmented reality systems can be divided into two basic categories which are fixed and mobile. A mobile system is normally using smartphones or tablets as medium and it gives user mobility which allow them to use AR and move around freely in most environments. Fixed systems are exactly opposite to mobile system as it cannot be moved and can only be used wherever they are set up. Nevertheless, both mobile and fixed system should allow user to focus on the AR application rather than the device itself (Kipper & Rampolla, 2012).

Generally, the functions of augmented reality are categorized in two ways which are "the augmented perception of reality" and "the creation of artificial environment". The differences between these types of AR are that each satisfies a different objective. One is practical while another one is imaginary. The first type of AR

shows us reality and enhances what we can see and do while the second type shows what isn't real allowing us to see the imaginary. The type of AR that is involved in augmented reality textbook will be the latter type as it involved the association of the existence between the Real and the Virtual.

### 2.2.4 Hardware and software

There are plenty of essential components for the whole process of AR to work as well as the different types of platforms that can be used for AR. The summary of the core components that normally involved in Augmented Reality application are:

Hardware:

- Computer
- Mobile device
- Monitor or display screen
- Camera
- Tracking and sensing systems
- Marker (the places where digital information is presented in the real world.)

Software:

- An application or program
- Web services
- A content server

### 2.2.5 Hardware components

There are three basic hardware components that is compulsory in all AR applications or systems which are sensors, processors and displays. Each of these three elements can take on many different forms and carries out different roles within different applications. (Kipper & Rampolla, 2012)

Sensors is the information provider of AR application about the real world for a variety of purposes and one of it is to provide information about the location and orientation of the participant to the AR application. This feature allows tracking where the user can determine their location and his or her pose in the real world.

Basically there are four platforms in which Augmented Reality is used today:

1. Personal Computers (PC) with Webcams
    - Most PC contains some of the needed components for viewing AR which make it an obvious choice as a platform. Normal, a marker will be used and placed within the view of a Webcam and once it identifies the marker, it will create the augmentation on the screen for user's interaction as shown in the figure below.

Figure 1 : Augmentation using a webcam

2. Kiosks, Digital Signage and Window Displays
    - Kiosks are stations where customers can bring items to find out more about them with Augmented Reality information. It is normally used at trade shows and conventions to give attendees a richer experience as shown in figure below.

Figure 2 : Application of AR in car exhibition

3. Smartphones and Tablets
    - This is arguably the most common method to access AR nowadays. Smartphones can identify markers using their cameras and screens as well as augment the locations or points of interest based on relative location by using GPS functions.(Kipper & Rampolla, 2012)

Figure 3 : An Example of Augmented Perception of Reality where Relevant Information is displayed

4. AR Glasses and Head-mounted Displays:

Figure 4: Example of AR glasses and head-mounted Displays

Figure 5: Another Example of AR glasses and head-mounted Displays

## 2.2.6 Software

There are many different kinds of software available to create augmented reality applications such as MixAR and ZooBrust that doesn't require programming knowledge or skill and it is simple to be used. As for serious AR developers, there are also other softwares such that include SDK kits such as ARToolKit and Unifeye Mobile SDK. Compare to softwares like MixAR, these kits are very powerful and allow developers to design various AR applications for variety of devices. In addition to that, these tools require extensive knowledge in computer programming, Java, and 3D virtual reality.

Vuforia is another example of software platform that enable developer to build creative augmented reality applications and give best experiences across the most real world environments. Vuforia platform include the use of computer-vision based image recognition which is superior, stable and technically efficient, and offers wide set of features and capabilities. These characteristic enable developers to have the freedom to extend their visions without technical limitations. Besides that, Vuforia also supported IOS, Android and Unity 3D, which is in other words, it allows develops to build app that can reach to almost everyone across the widest range of smartphones and tablets.

### 2.2.7 The augmented perception of reality

The augmented perception of reality shows the reality and enhance what we can see and do. It is meant to provide useful information that will allow for a better understanding for our surroundings and improve our decisions and actions.(Kipper & Rampolla, 2012)


Figure 6 : Example of AR where relevant information is displayed to aid in decision making

### 2.2.8 The creation of an artificial environment

This is the second category of augmented reality functionality and it show imaginary vision and isn't real. AR is used to move beyond the creation of mental images to a level that allows us to see things that do not exist in the real world.

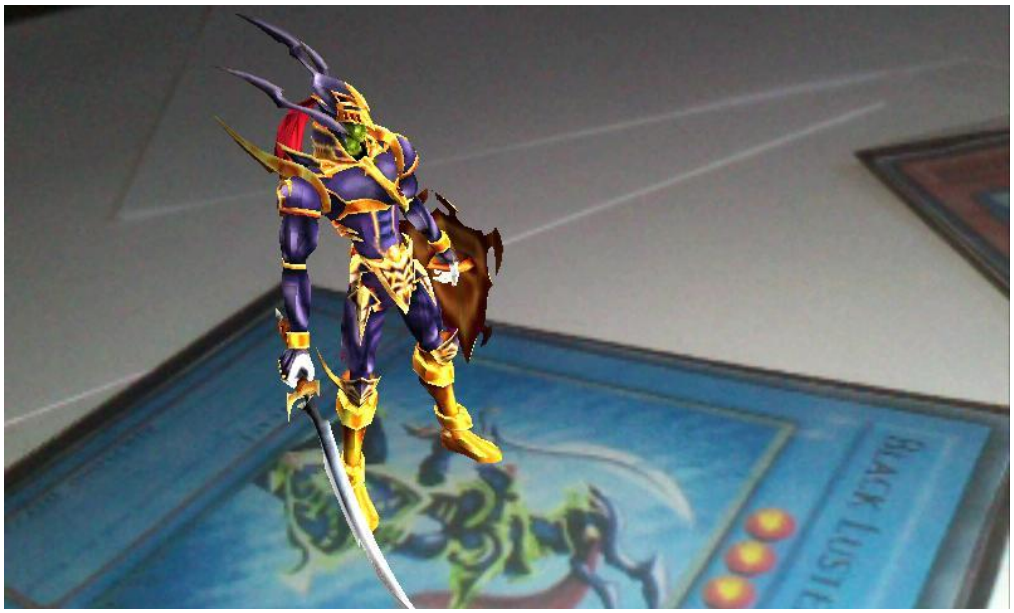


Figure 7: Example of AR in entertainment/games

In short, the first type is practical while the second type is imaginary.

### 2.2.9 Marker-based

Generally, AR systems commonly use AR markers to augment a digital image. Simplest form of marker is a unique pattern that is visible to the AR camera and can be identified in the AR system software (Cawood & Fiala, 2008). The digital image will show up when the camera is pointed to the marker tags. This is called marker based augmented reality.

*A. Microsoft tag*

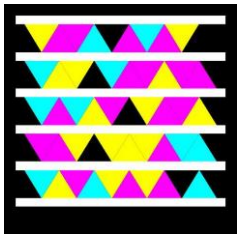


Figure 8 : Microsoft tag

A 2D tag developed by Microsoft that is quite similar but different than QR codes.

*B. Google's Goggles*

It can recognize images scanned by using a smartphone. The application can bring up information about an image or object in absence of being where that object actually resides. For example, user can use Goggles on a picture of the Eifel Tower and find out more information about it without actually being in Paris.

### 2.2.10 Marker-less

There is another method to create an AR effect without using markers which is known as marker-less AR. This method does not require the forethought of adding markers to a scene (Cawood & Fiala, 2008). In other words, a marker-less AR application recognizes images that were not provided to the application beforehand. These application will identify patterns, colors or features that may exist in camera frames based on the recognition algorithm running inside the application.

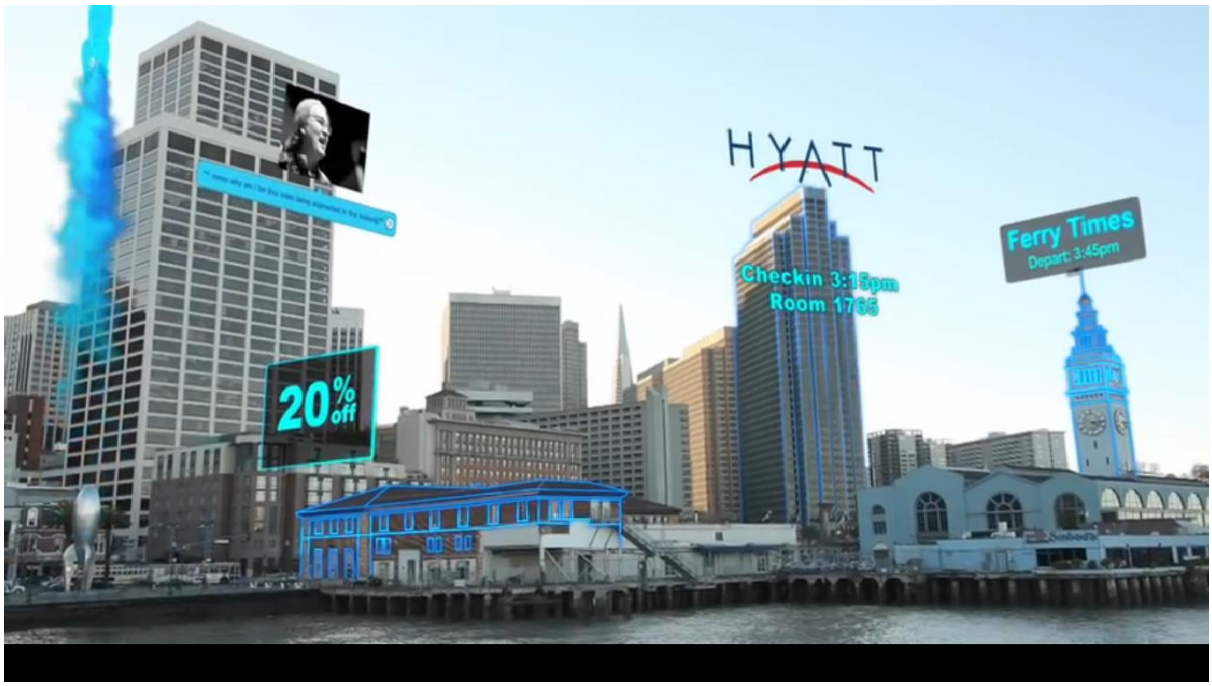



Figure 9 : Example of AR showing relevant information of locations

### 2.2.11 Application of AR

***A. Entertainment***

Augmented reality are actually already implemented in certain areas in the world right now such as gaming. Gamers are able to experience digital gameplay in a real world environment through augmented reality. On 2012, Nintendo, the world largest video game company by revenue create a game called “Pokedex 3D Pro” where the gamers can use Pokemon AR markers to interact with their pokemon in multiple ways. Pokemon is a popular media franchise and its video game is one of the most selling games in the world and widely popular among kids, teenagers and even adults.


Figure 10 : AR technology in Nintendo card games

Besides that, they are also other games that also using augmented reality such as archery games where the player must hit the target that appear on the screen using a reticle to fire arrows.

### *B. Emergency Management*

Besides that, augmented reality systems are also being used in public safety situations. There is a system called "LandForm+" is create for such purpose. Landform includes world map data and is delivered pre-loaded on a ruggedized computer. The compact device will integrates seamlessly with existing hardware. The world map data includes coastlines and national borders, highways, roads and landmarks such as parks and schools. This system improves the situational awareness for the tactical flight officer leading to the transmission of clear and timely intelligence for any mission type including search and rescue as well as disaster relief such as earthquakes or wild land fires.

Figure 11 : View of LandForm+

### C. *Medical and Healthcare*

Implementation of augmented reality has transform medicine and healthcare sectors significantly. AR can help to save lives and in the same time, assist help healthcare organizations to improve the precision and efficiency of the existing processes. Augmented reality also been used by researchers to help doctors conduct surgeries, especially the complicated one, more effectively. EyeDecide is an example of medical application that use AR to helps educate patients in more interactive way. Camera display is used for simulation on the impact of specific conditions on a person's vision. EyeDecide assisted doctors to explain the condition of their patients better through the simulation or demonstration on the impact of conditions such as Cataract.


Figure 12 : Interface of EyeDecide I

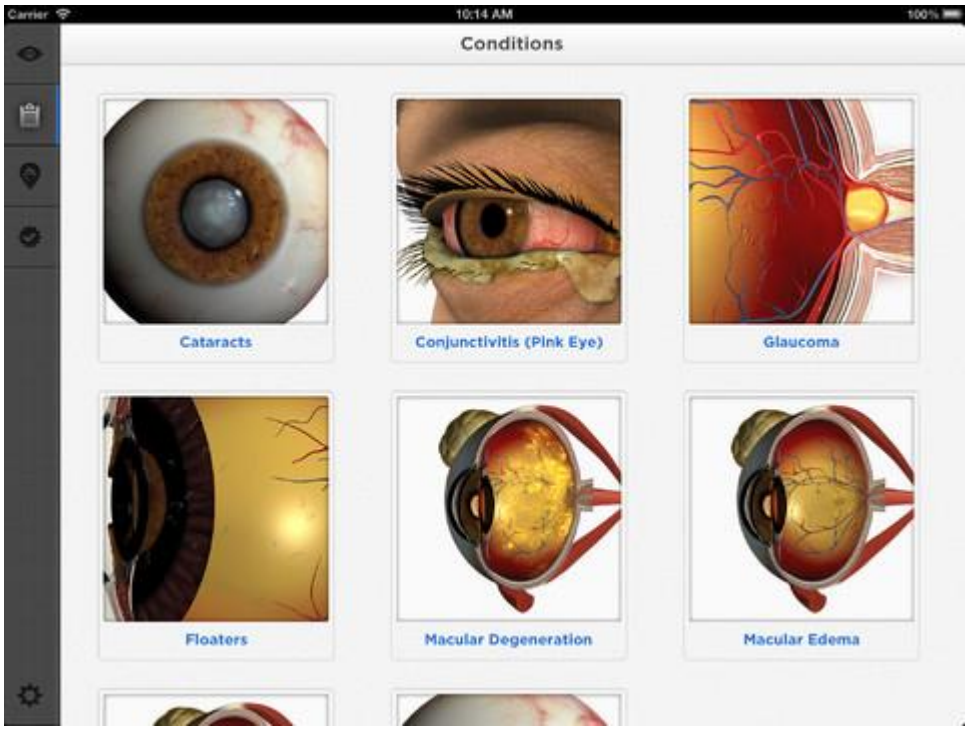



Figure 13: Interface of EyeDecide II

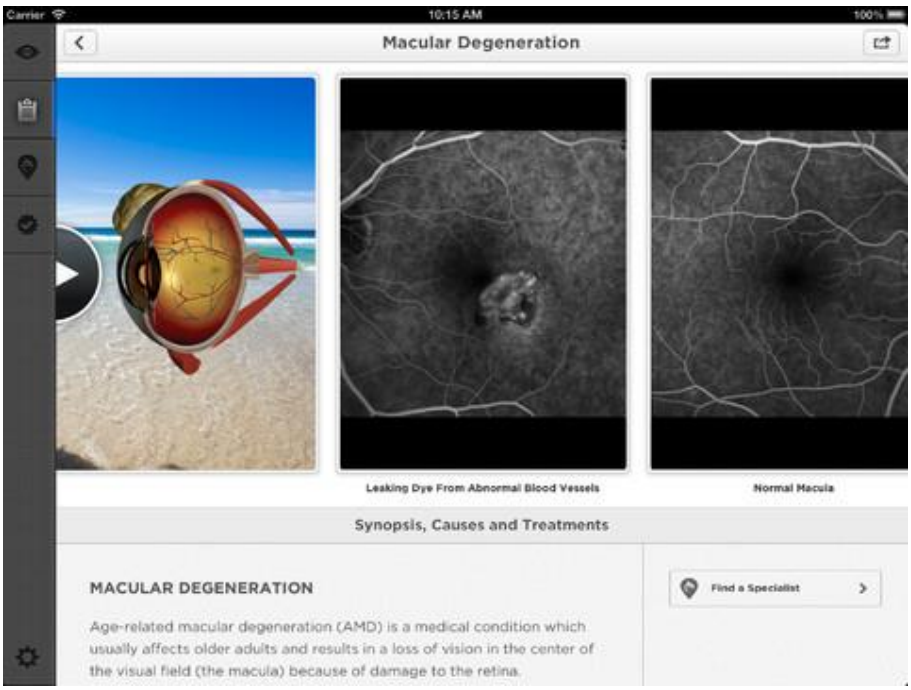



Figure 14: Interface of EyeDecide III


Figure 15: Interface of EyeDecide IV

### D. *Industrial Design*

Augmented reality also can help industrial designers to test their products before completion. For example, AR is used to for the crash tests through the evaluation of computer-generated simulations with physically crashed cars. Crash tests are mandatory for each car model, however, it would be costly due to the increasing variety of car models (Noelle, 2002). Therefore, AR offers a new way of evaluating simulation that can reduce the cost and in the same time, retain the characteristics of traditional car test which are realistic and comparable. In addition to that, AR also can visualize the body structure and engine layout of the car which paved the way for the engineers to modify it. Volkswagen, a German automobile manufacturer already apply the augmented reality in their vehicle development.

Figure 16: Simulation using AR technology

Figure 17: Simulation of car engine

### 2.2.12 Application of AR on reading materials

**A. Storybook**

Besides that, In November 2012, "Wonderbook™: Book of Spells" have been released for PlayStation 3. It is an Augmented Reality book experience that works with the PlayStation Move Motion Controller and the PlayStation Eye Camera. The book-slash-game transforms readers into students of Harry Potter's Hogwars. Readers can cast spells as they read through pages by using the motion sensitive controller as a magic wand.

**Figure 18:** Wonderbook™: Book of Spells

## B. Newspapers/ Magazines

On 27 May 2012, Australians revolutionize their newspapers. By using a specialized app for Iphone and Ipad, the readers are connected to their news in a whole new way. News Australia Sales, the integrated sales division of New Limited have collaborated with Commonwealth Bank to launch the new revolutionary augmented reality advertising concept, News Alive. Australians that opened their Sunday papers over breakfast will be able to download the apps and use it to view the new launch commercial simply by holding their devices over the Commonwealth Bank's logo appearing in the newspapers pages. News Alive delivered a richer and deeper

experience for reader with the addition of sound and full animated 3D motion to the printed product.

Figure 19: AR commercial

## C. Textbooks

A Japanese publishing company Tokyo Shoseki had been producing textbooks that support AR apps on smartphones and brought characters to life for students to listen to. The textbooks are part of an English course called New Horizon which are intended for adults looking to study English at a high school level. Users have to download the apps and once the app is downloaded, all they have to do is to hover the camera over the correct section of the page to launch scenarios where the characters are having conversation in English.

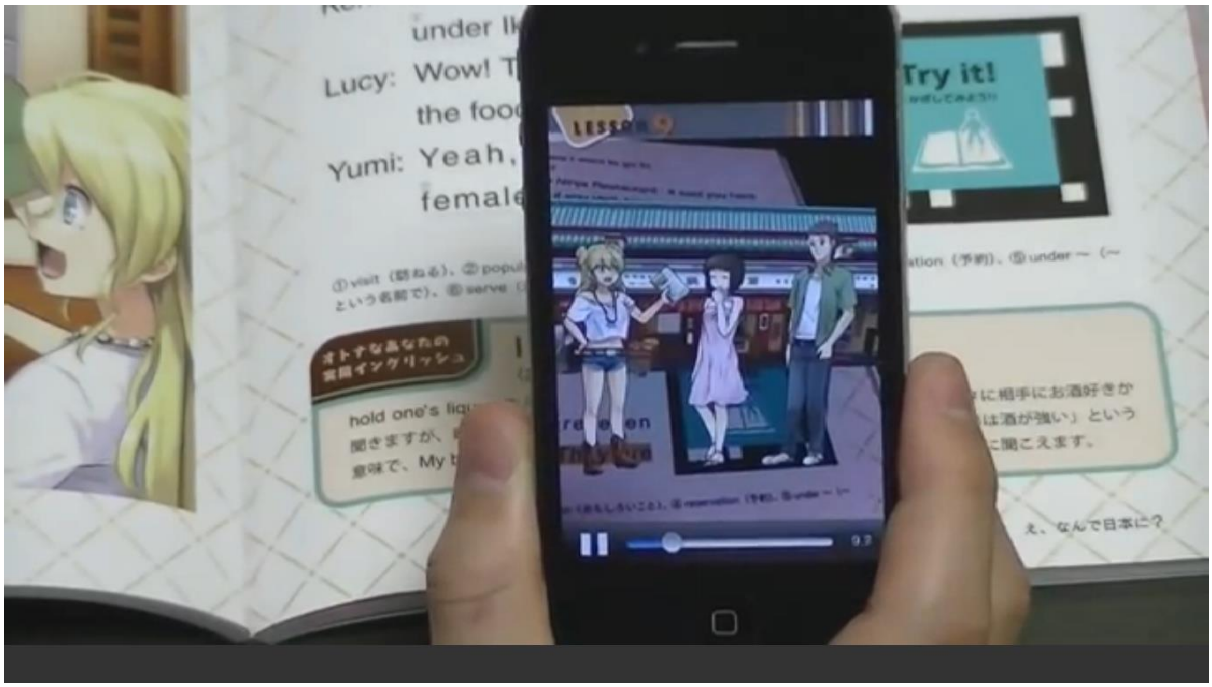



Figure 20: Conversation scene using AR

Besides that, Institute for the Promotion of Teaching Science and Technology in Thailand has developed a 3D augmented reality textbook about geology. This textbook use augmented reality to teach students geology including discovery of the different layers of the earth, their relationships and functions, as well as seismic waves and more.

Figure 21: AR EARTH model

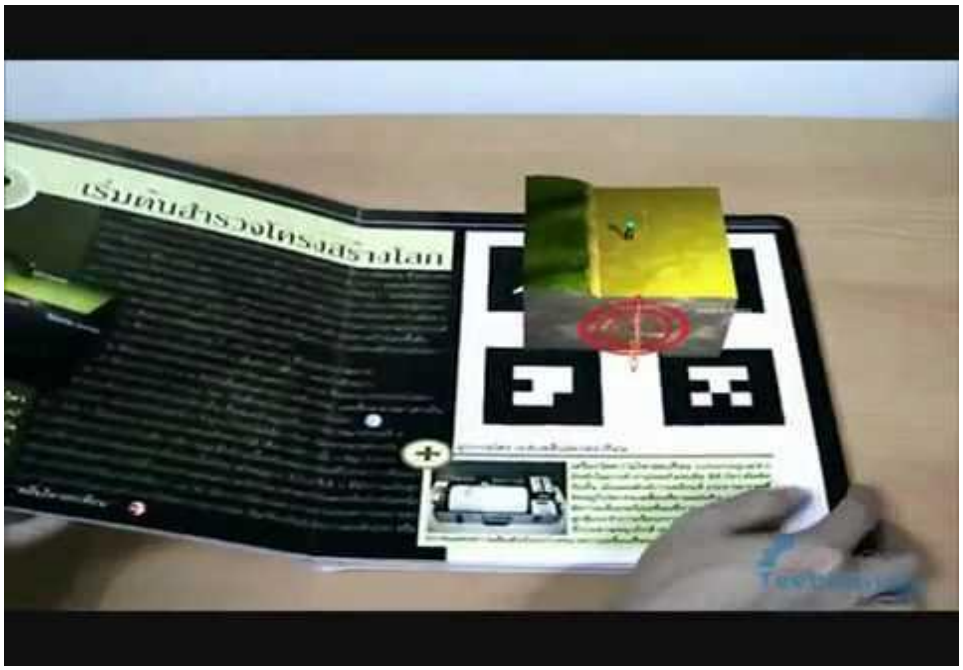
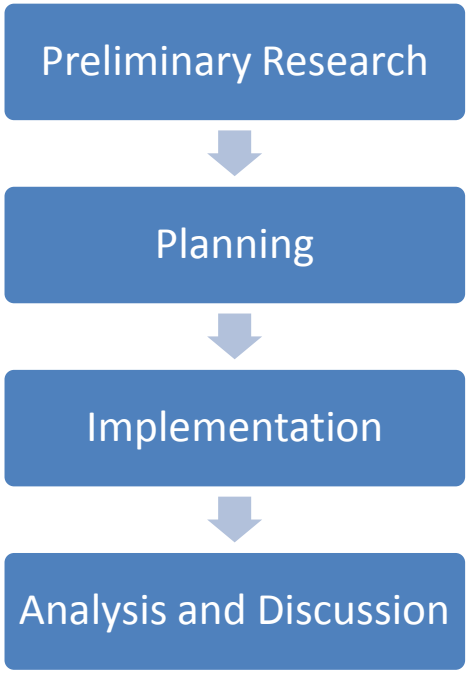


Figure 22: AR model of landscape

# CHAPTER 3

# Methodology

## 3.1 Research Methodology




### 3.1.1 Preliminary Research

Before deciding and start planning for the project, research is done to determine the problem statement and the purpose of the project. Besides that, another objective of the research is to understand fundamental theories and concepts on augmented reality, application of augmented reality in different industry and examples of existing augmented reality textbooks which will be used as part of the literature review of the project.

### 3.1.2 Planning

This stage determines the plan to develop the application for the project including the type of software to be used to develop the application and the scope of the application. Initial design of the application and storyboard is created during the planning stage to serve as the guideline or blueprint throughout the whole development process.

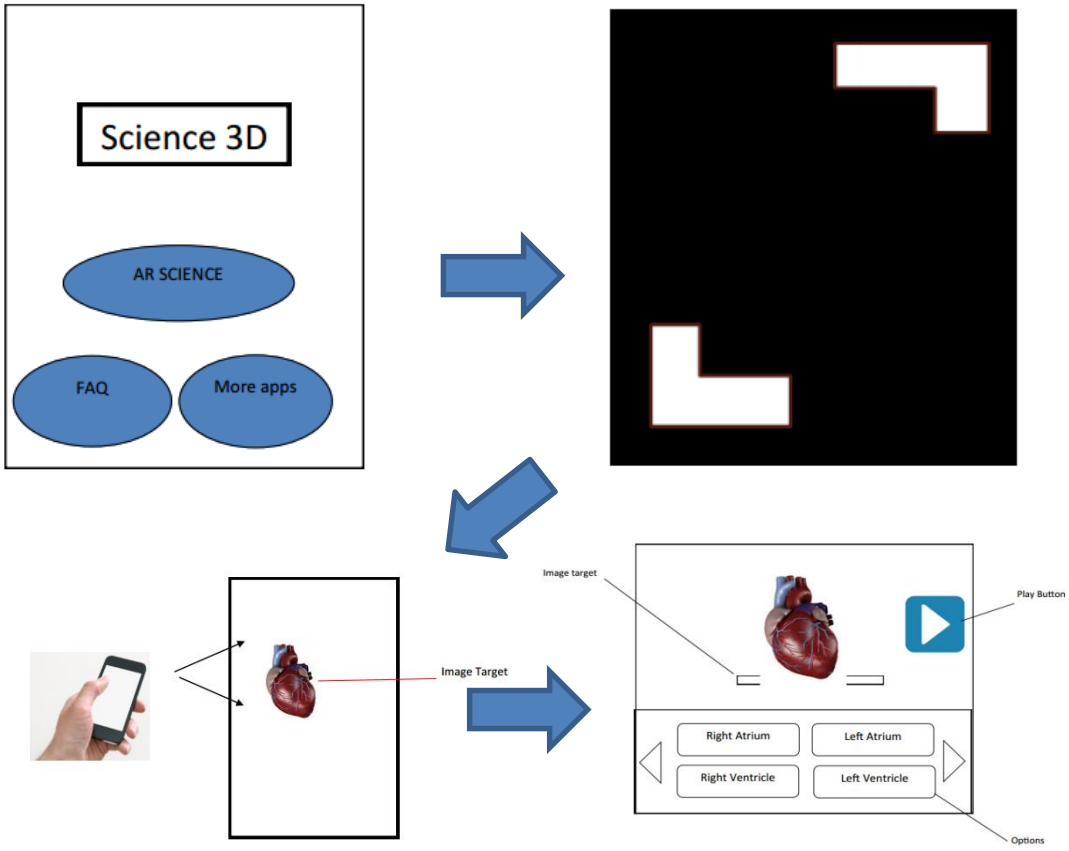



Figure 23: Storyboard

### 3.1.3 Implementation

This is the where the development of the application took place according to the plan made during the planning stage. The prototype will be developed using the software as planned and also at this stage, the prototype will be tested after being developed.

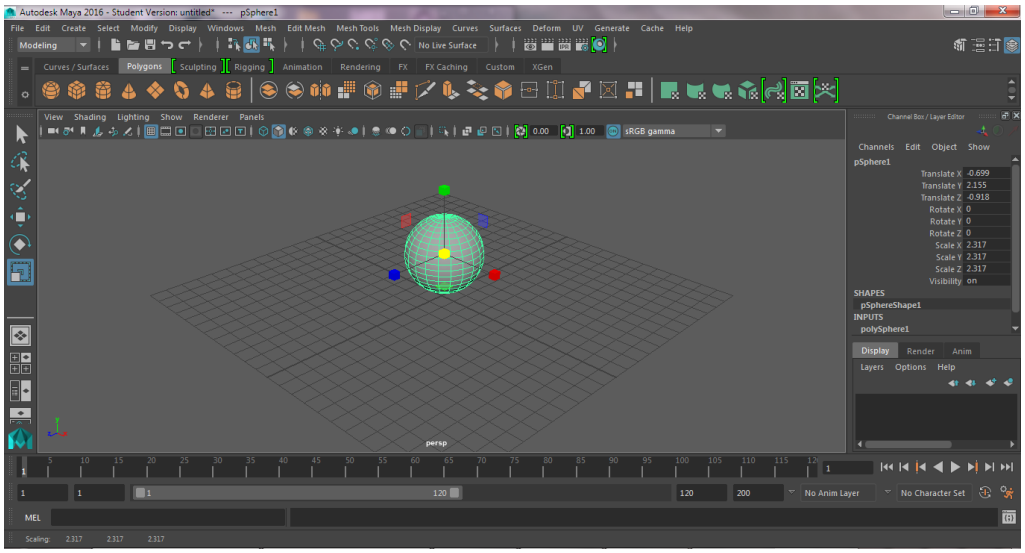


Figure 24: 3D modelling using Maya

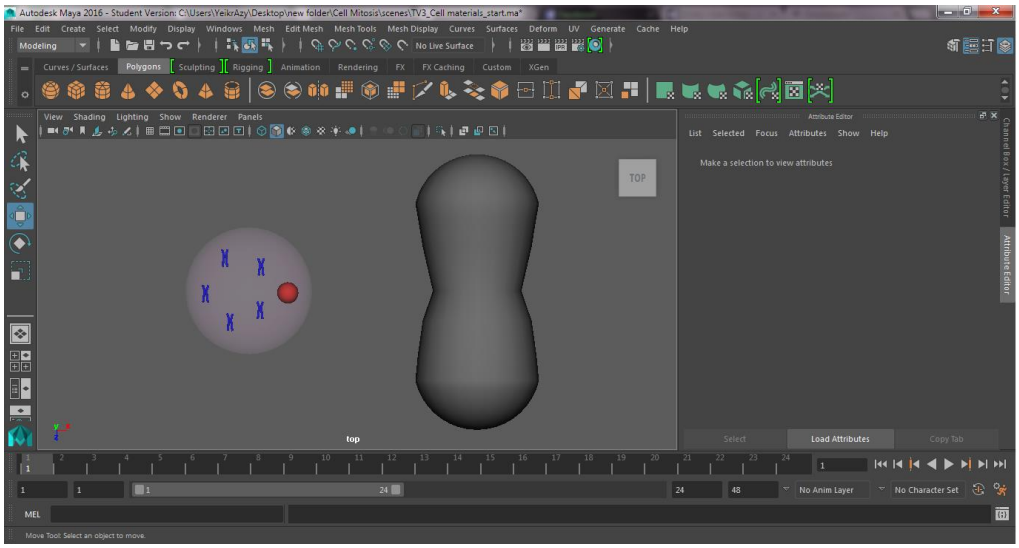



Figure 25: Animation using Maya

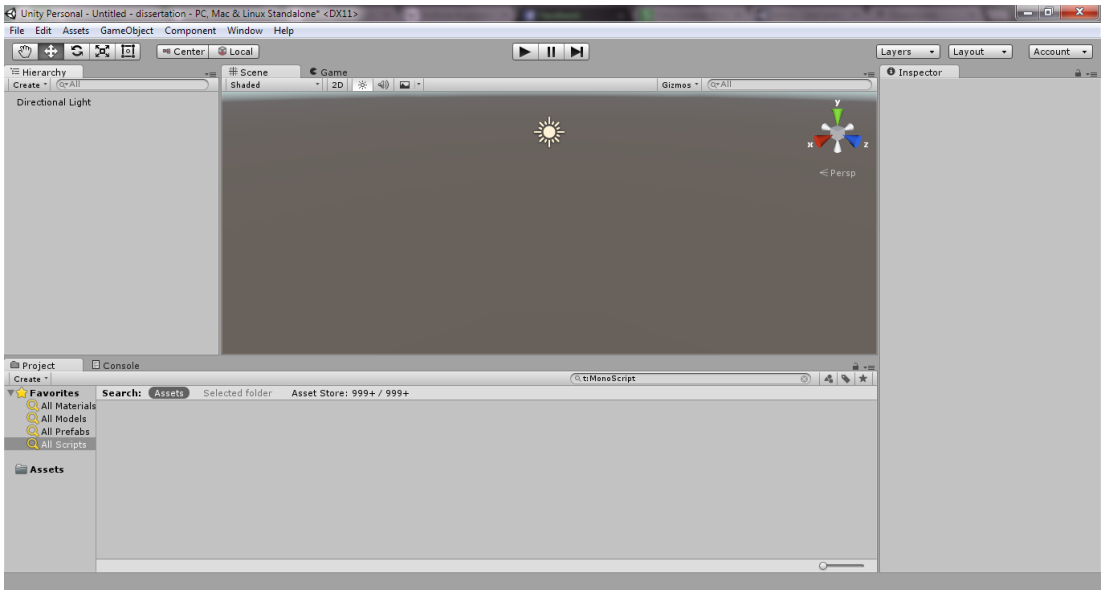



Figure 26: Application development using Unity

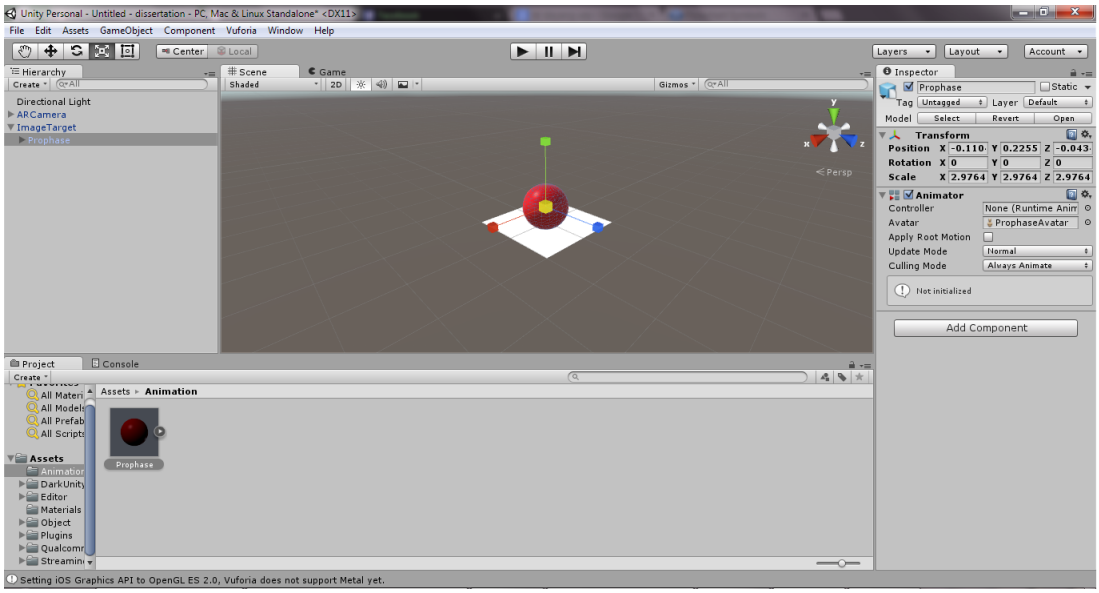



Figure 27: Imported model and animation from Maya

### 3.1.4 Analysis and Discussion

In this stage, data collected from the survey form will be analyzed and presented in table and charts. Patterns or trends of targeted user's behavior can be determined.

## 3.2 Development Model Framework

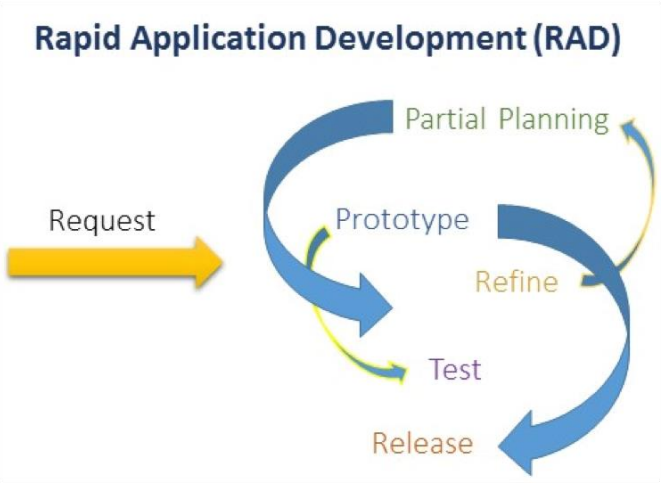



Figure 28: Rapid Application Development

The development model framework that has being adapted to develop this project is Rapid Application Development (RAD). RAD is an alternative to the conventional waterfall model. In general, RAD is a model based on the concept that products can be developed faster through more expedient processes, such as early prototyping, reusing software components and less formality in team communications. RAD approaches to software development does not require as much emphasis on task planning compare to other development model. It emphasize the necessity of adjusting requirements in reaction to knowledge gained as the project progresses. Flexible process that can adapt to any changes during the development is also emphasized in RAD approaches rather than focusing on defining specifications and planning at the start of the project.

## 3.3 Software and Hardware

| **Software** | **Hardware** |
|---|---|
| Unity 5 | Computer |
| Vuforia | Smartphone |
| Autodesk Maya 2016 | |

Table 1: List of software and hardware

### 3.3.1 Unity


Figure 29: Unity Logo

Unity is a cross-platform game engine developed by Unity Technologies and can be used to develop video games for PC, consoles, mobile devices and websites. There are two different type of Unity: Unity Pro that only available for a fee while Unity Personal is free to download for personal use. Five versions of Unity have been released up to date. Unity 5 is the latest version of Unity that was released on March 3, 2015 and is also the version that is being used to compile and build the application in this project.

### 3.3.2 Autodesk Maya 2016


Figure 30: Maya logo

Autodesk Maya is a 3D computer graphics software that can run on several different platform including Windows, OS X and Linux. It is originally developed by Alias

Systems Corporation which is formerly known as Alias|Wavefront and currently owned by Autodesk, Inc. Autodesk Maya can be used to create interactive 3D models for video games, animated film or TV series. Autodesk Maya 2016 is used in this project to develop the 3D model of the cell and animation of the cell division process.

### 3.3.3 Vuforia


Figure 31: Vuforia logo

Vuforia is the software platform that enables the creation of augmented reality application. It can recognize and track image targets and simples 3D objects in real-time by using Computer Vision technology. This allow developers to position virtual objects such as 3D models and other media, in relation to real world images when viewed through the camera of a mobile device. The Vuforia SDK supports a variety of 2D and 3D target types including markerless Image Targets. Besides that, it also supports both native development for iOS and Android while enabling the AR applications development in Unity as Vuforia provides Application Programming Interfaces in several programming languages including C++ and Java.

## 3.4 Gantt Chart

### 3.4.1 FYP I

| Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Project Topic Selection/ Proposal | | | | | | | | | | | | | | |
| Supervisor Introduction | | | | | | | | | | | | | | |
| Proposal Submission | | | | | | | | | | | | | | |
| Preliminary Research Work | | | | | | | | | | | | | | |
| Logbook Submission | | | | | | | | | | | | | | |
| Software Tutorial | | | | | | | | | | | | | | |
| Application Development | | | | | | | | | | | | | | |
| Interim Report Submission | | | | | | | | | | | | | | |
| Proposal Defense | | | | | | | | | | | | | | |

Table 2: Gantt Chart for FYP I

### 3.4.2 FYP II

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Development of the application(continue) | | | | | | | | | | | | | | |
| Logbook Submission | | | | | | | | | | | | | | |
| Poster Design for Pre-Sedex | | | | | | | | | | | | | | |
| Pre- Sedex | | | | | | | | | | | | | | |
| Submission of Technical Paper | | | | | | | | | | | | | | |
| Submission of Dissertation(Softbound) | | | | | | | | | | | | | | |
| Viva Presentation | | | | | | | | | | | | | | |
| Submission of Dissertation(Hardbound) | | | | | | | | | | | | | | |

Table 3: Gantt Chart for FYP II

## 3.5 Key Milestones

### 3.5.1 FYP I

| Week | Activity |
|---|---|
| 4, 6, 8, 10, 12 | Logbook submission |
| 12 | Interim Report Submission |
| 13,14 | Proposal Defense |

Table 4: Milestones for FYP I

### 3.5.2 FYP II

| Week | Activity |
|---|---|
| Every week | Logbook submission |
| 9 | Pre-Sedex |
| 10 | Technical paper submision |
| 11 | Dissertation submission(softbound) |
| 13 | Viva presentation |
| 14 | Dissertation submission(hardbound) |

Table 5: Milestone for FYP II

# Chapter 4

# RESULT AND DISCUSSION

## 4.1 Survey

An online survey form was created to gather information and students opinions on their opinion on traditional textbooks. The targeted participant's age range is between 15 to 24 years old since the target users for augmented reality textbook in this project are upper secondary schools students.

### 4.1.1 Student's device ownership and usage pattern

Among the 33 respondents participated for the survey, only 1 of them doesn't have a smartphones or tablets. This proves that majority of the students nowadays owned at least a smart device that could provide easy access to the application that going to be developed in this project. In addition to that, from the data collected, approximately 55% of the respondents spent a huge amount of time on their smartphones or tablets which indicates that majority of the students are highly dependent on their smart devices.

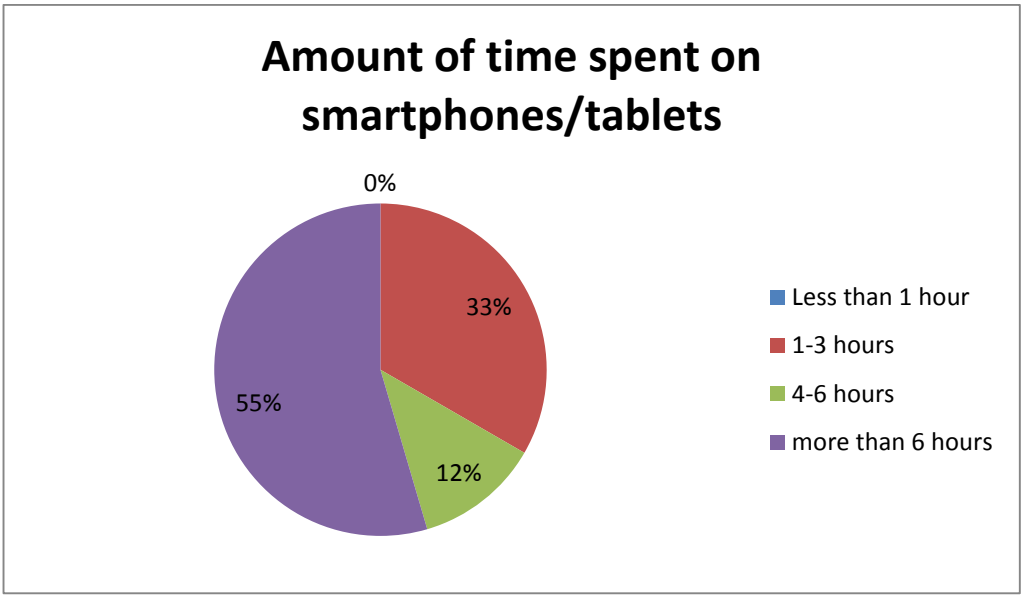



Figure 32: Amount of time spent on smartphones/ tablets

### 4.1.2 Student's Reading Culture

Only 3 out of 33 respondents that willing to spend more than 4 days in a week on doing revision using their textbooks. In addition to that, majority of the students didn't spend too much of their time on reading textbooks. Based on the data collected, the longest period of time that student would spend to read textbooks are one to 2 hours. Approximately 45% of the respondents spend 1 to 2 hours to read textbooks while there are 16 out of 33 respondents only spend less than 30 minutes everytime they read textbooks.

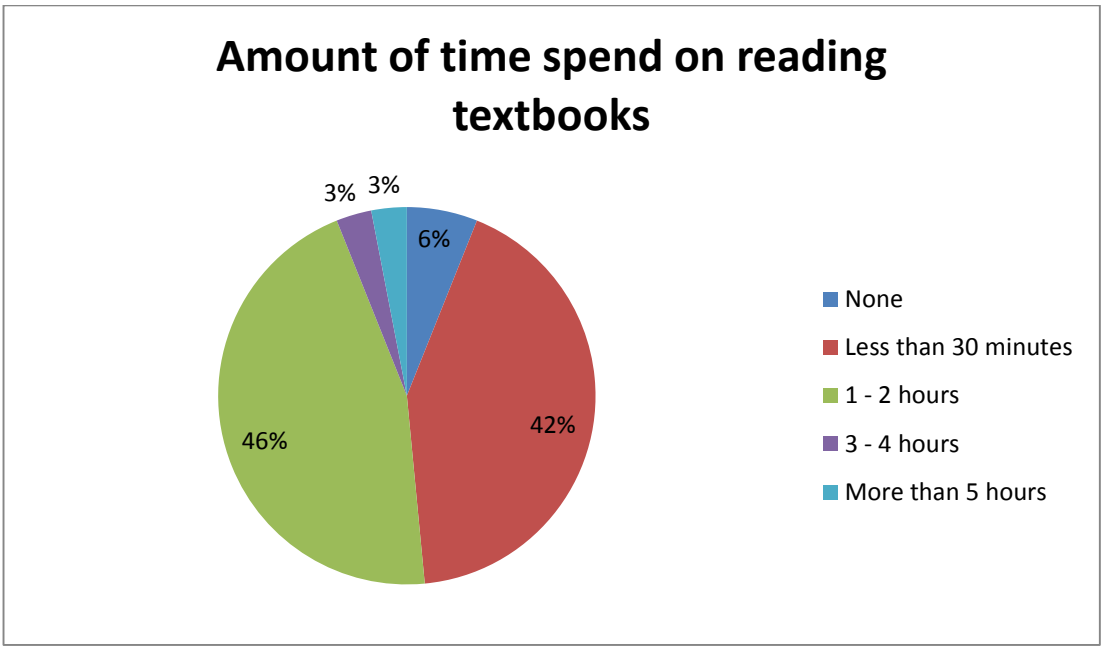



Figure 33: Amount of time spent on reading textbooks

The result shows that the not many of them would actually spend their time to read textbooks during their leisure time.

### 4.1.3 Students preferable study medium

Based on the data collected, majority of the students prefer pictures and videos as the medium of learning. About 49% and 36% of respondents chose pictures and videos as their preferable learning medium respectively. This indicates that most students would be more likely to accept the concept of augmented reality textbook as AR will involves extensive use of images and motions.

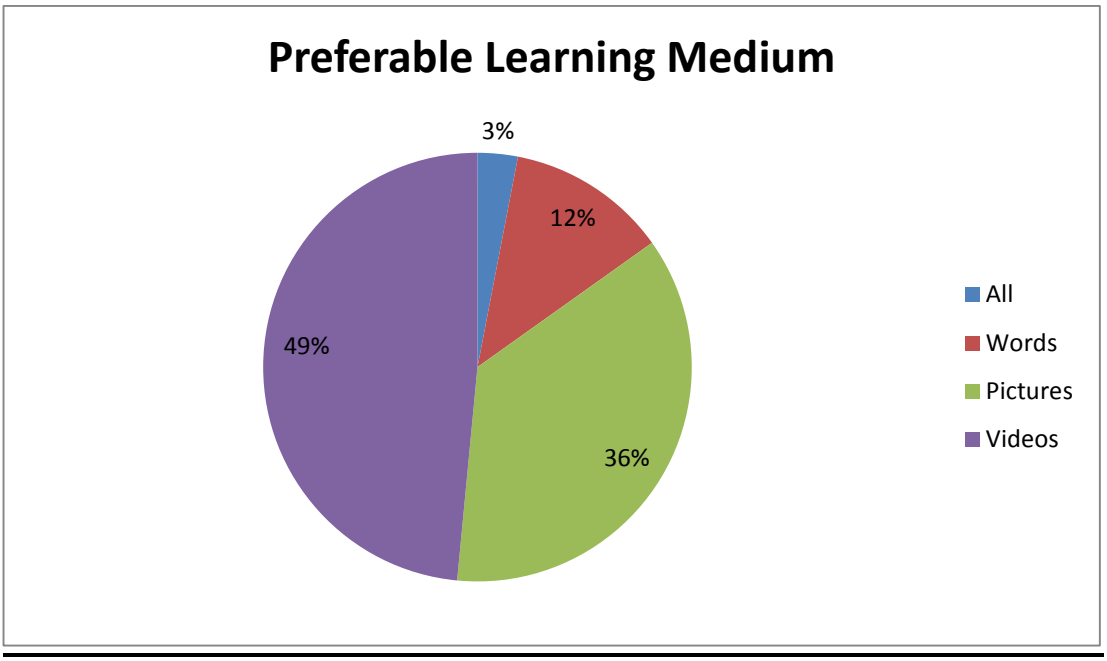



Figure 34: Preferable learning medium

## 4.2 Preliminary Interview

While it is important to study student's reading culture and their opinions on the traditional as well as the usage pattern of their smart devices, teacher's opinions and feedbacks is just as important as well. Interview sessions had been done with teachers that teaches different subject and with different period of teaching experiences. The interview was conducted through several methods including emails, facebook chat and online questionnaires. There are 5 teachers in total that accept interview and provide their valuable opinions and feedbacks.

There are few major questions asked in the interview session:

**A. What do you think about the idea of implementing augmented reality on textbooks?**

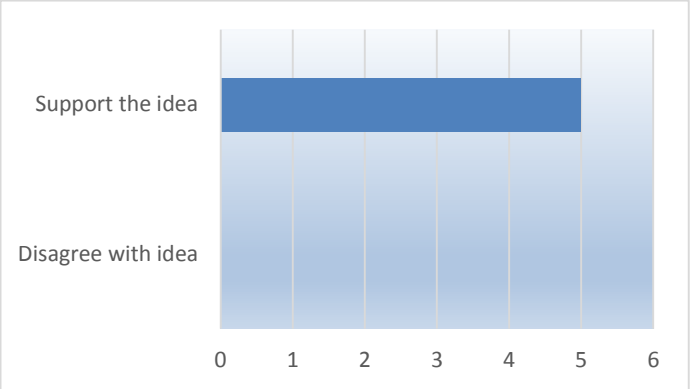



Figure 35: GRAPH I

All 5 teachers agree that the nature of the augmented reality will be able to captivate the interest of student better and provide the effective learning process for the students. However, one of the teacher added that although she is supporting idea, she suggests that augmented reality should be added as references instead of replacing words inside the textbook.

**B. In your opinion, do you think augmented reality textbook can replace traditional textbooks?**

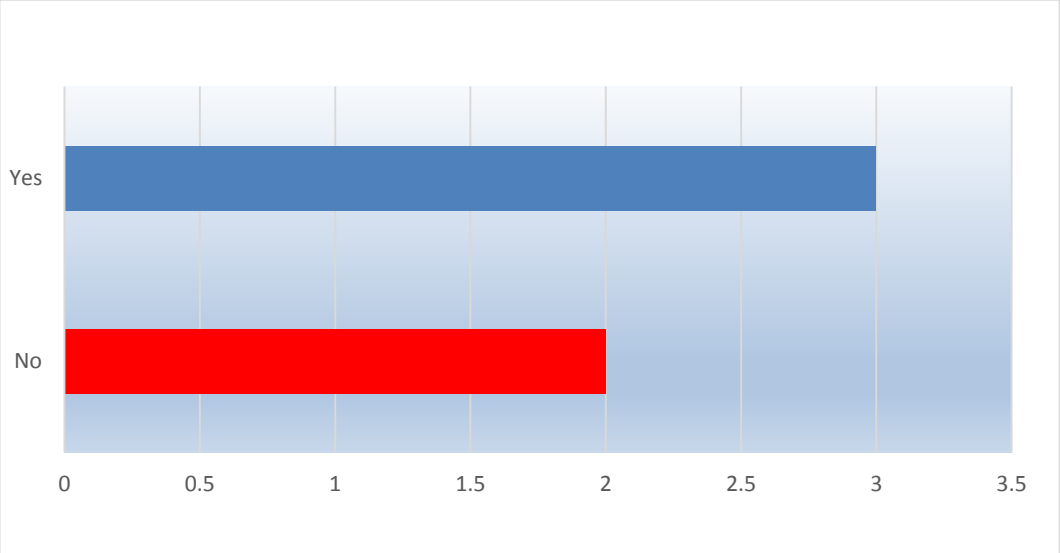



Figure 36: GRAPH II

Three of the teachers agrees that augmented reality textbook should replace the traditional textbooks while there are two of them disagree with the idea. There are several factors to be considered such as the facilities, facilitator, cost and most importantly, it wouldn't be affordable for students in rural area.

## 4.3 The Prototype

### 4.3.1 The System Architecture

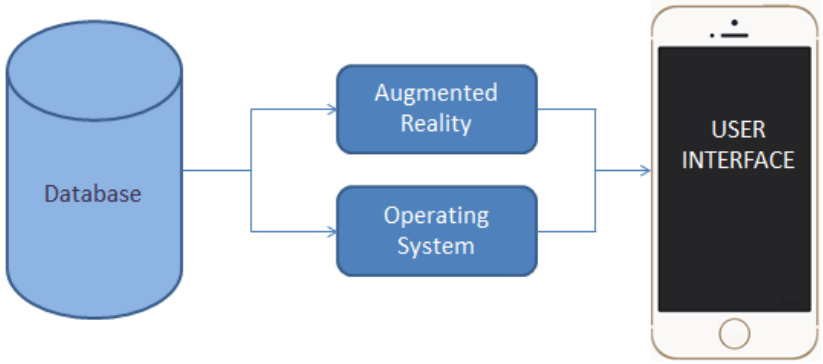



Figure 37: System Architecture

Figure above illustrates the system architecture of the system. Database that includes image and animation will be created during the development of the application. The database along with augmented reality and operating system will produce the end product which allows the users to interact with the application through the user interface.

### 4.3.2 The Flowchart of the System Application.

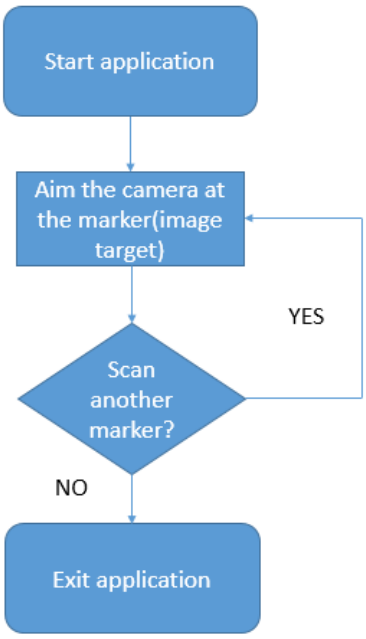



Figure 38: Flowchart

Figure above shows the flowchart of the system. After user open the application, he/she have to aim the camera at the selected marker in order to see the augmented reality image of the image target. When the AR image popped out, an user interface will appear along with the image. After finish viewing the selected marker, user can aim the camera to another marker if they want to check the information of another topic or tap " Exit" button to close the application.

### 4.3.3 Initial Interface

### A. AR textbook

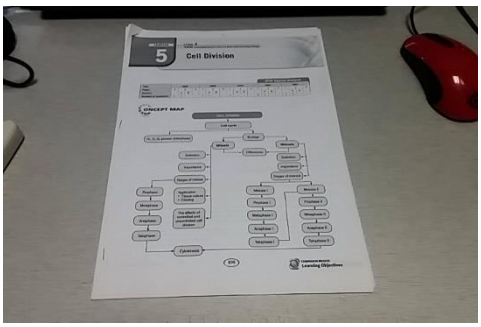



Figure 39: TEXTBOOK USED AS IMAGE TARGET

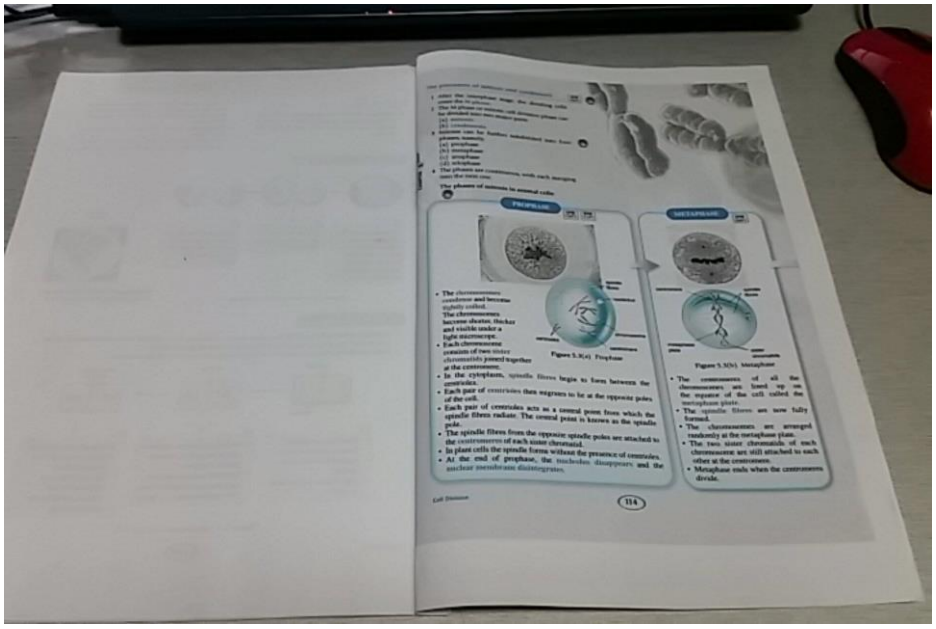


Figure 40: OTHER VIEW OF TEXTBOOK

## B. AR application

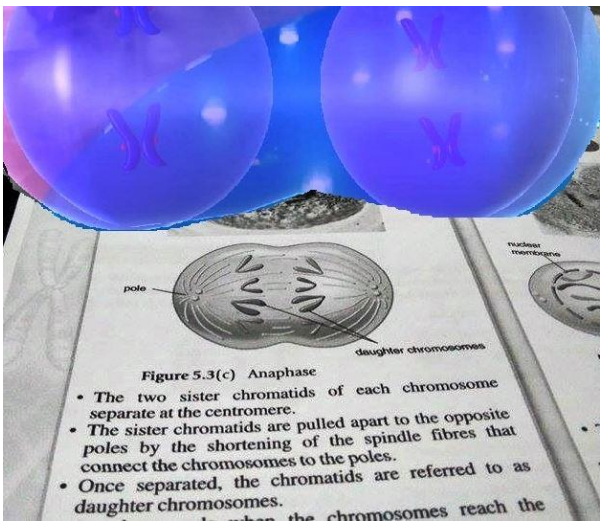



Figure 41: SCREENSHOT OF AUGMENTED MODEL I

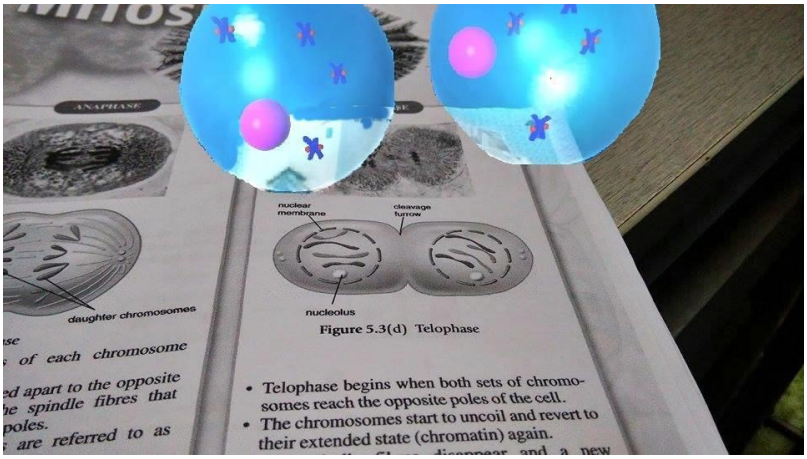



Figure 42: SCREENSHOT OF AUGMENTED MODEL II

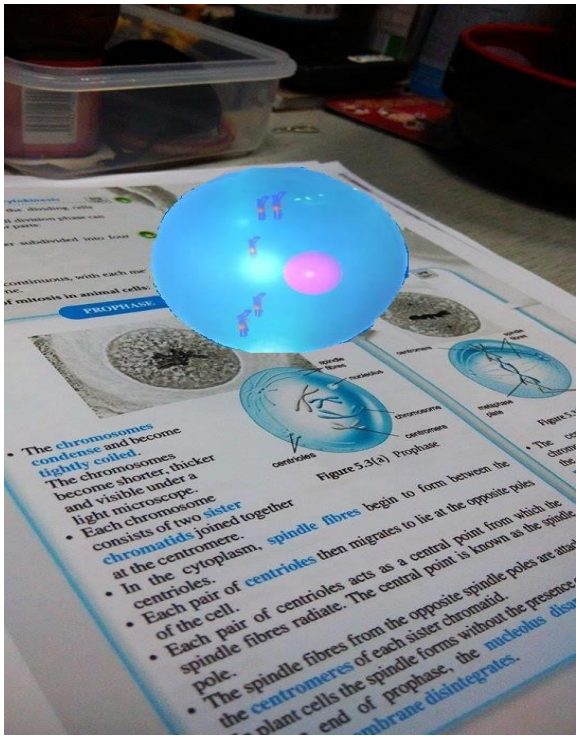



Figure 43: SCREENSHOT OF AUGMENTED MODEL III

# CHAPTER 5

## Conclusion and recommendation

In conclusion, this research is focusing on exploring the potential of augmented reality in education with the aim of improving the learning processes in current education system. The idea of implementing augmented reality into textbooks definitely receive responses from the students and teachers as compared to traditional textbooks, augmented reality able to provide a more interactive learning environments and 3D images and motion are able to attract student's interest better than words in the traditional textbook.

Various recommendations can be put forward for future research and development of augmented reality textbooks. First of all, instead of limiting the implementation of augmented reality on science subjects, augmented reality textbooks should also cover other subjects as well such as Mathematics, History, English and etc. Secondly, instead of using smart devices as platforms, it can also be developed and used in other platforms such as computers and laptops.

In overall, augmented reality textbooks definitely has potential to grow and replace the traditional which could prove to be key component in the future education.

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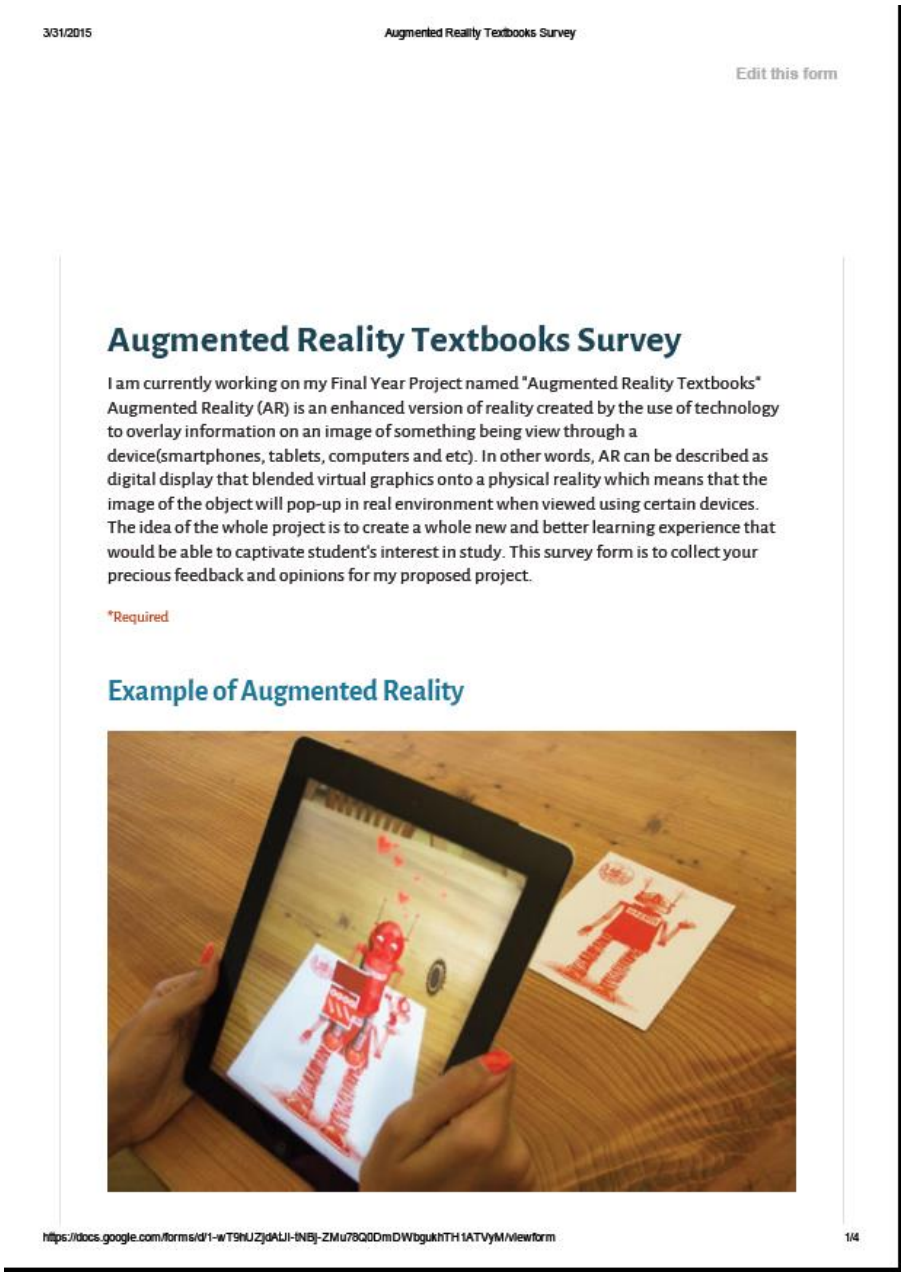
[8] Yuen, S. ; Yaotuneyong, G.; & Johnson, E. (2011). Augmented reality: An overview and five directions for AR in education. Journal of Educational Technology Development and Exchange, 4(1), 119-140

# Appendices



3/31/2015 Augmented Reality Textbooks Survey

Edit this form

## Augmented Reality Textbooks Survey

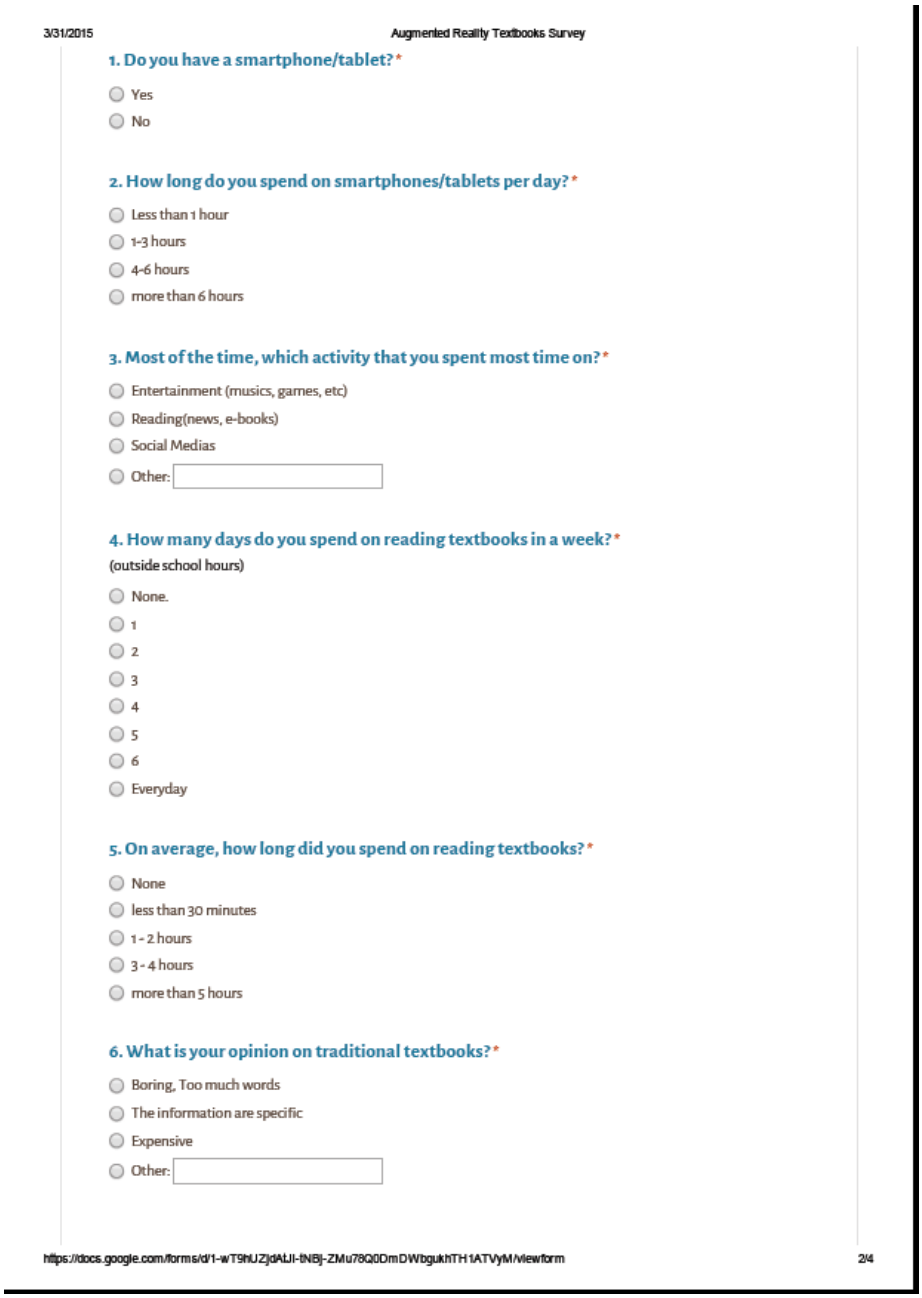
I am currently working on my Final Year Project named "Augmented Reality Textbooks" Augmented Reality (AR) is an enhanced version of reality created by the use of technology to overlay information on an image of something being view through a device(smartphones, tablets, computers and etc). In other words, AR can be described as digital display that blended virtual graphics onto a physical reality which means that the image of the object will pop-up in real environment when viewed using certain devices. The idea of the whole project is to create a whole new and better learning experience that would be able to captivate student's interest in study. This survey form is to collect your precious feedback and opinions for my proposed project.

*Required

### Example of Augmented Reality

https://docs.google.com/forms/d/1-wT9hUZjdAtJI-tNBj-ZMu78Q0DmDWbgukhTH1ATVyM/viewform 1/4

Figure 44: Appendix I



3/31/2015 Augmented Reality Textbooks Survey

**1. Do you have a smartphone/tablet?** *

- Yes
- No

**2. How long do you spend on smartphones/tablets per day?** *

- Less than 1 hour
- 1-3 hours
- 4-6 hours
- more than 6 hours

**3. Most of the time, which activity that you spent most time on?** *

- Entertainment (musics, games, etc)
- Reading(news, e-books)
- Social Medias
- Other:

**4. How many days do you spend on reading textbooks in a week?** *

(outside school hours)

- None.
- 1
- 2
- 3
- 4
- 5
- 6
- Everyday

**5. On average, how long did you spend on reading textbooks?** *

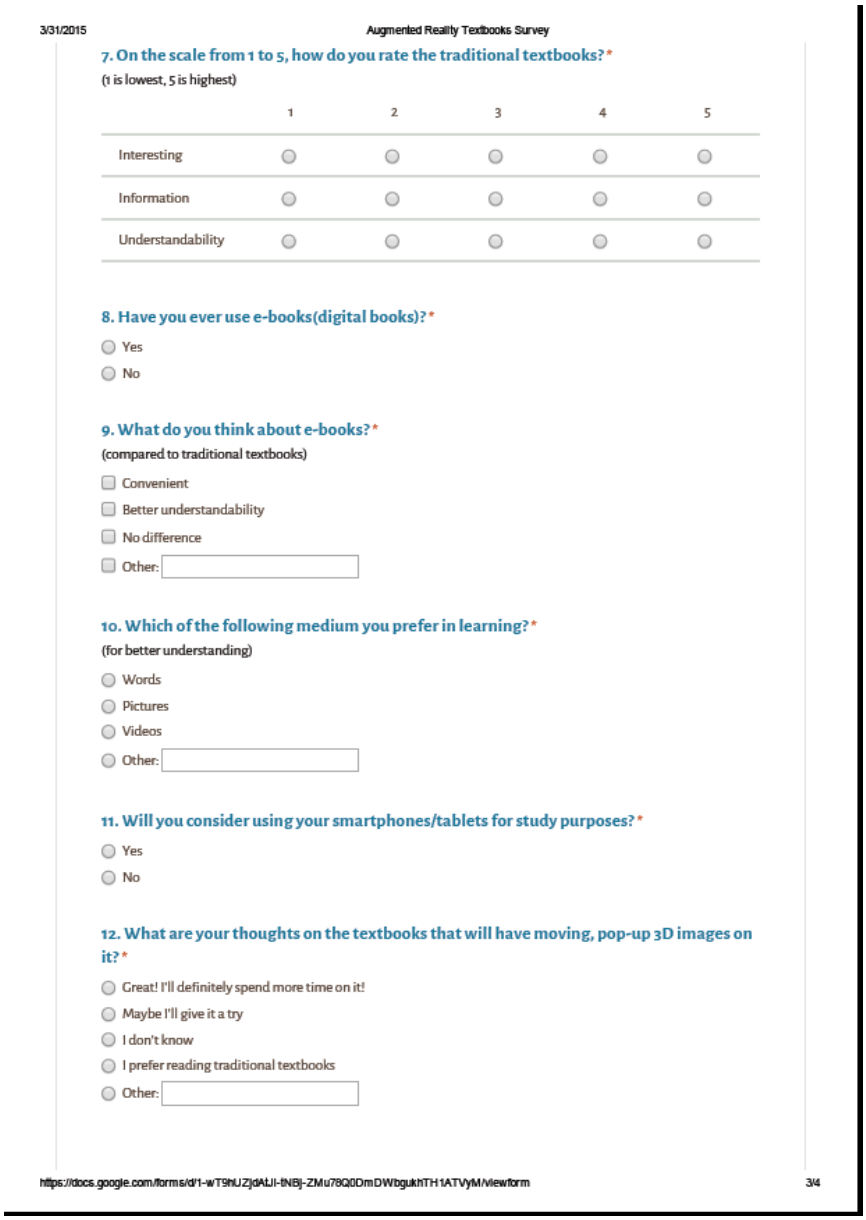
- None
- less than 30 minutes
- 1 - 2 hours
- 3 - 4 hours
- more than 5 hours

**6. What is your opinion on traditional textbooks?** *

- Boring, Too much words
- The information are specific
- Expensive
- Other:

https://docs.google.com/forms/d/1-wT9hUZjdALJI-tNBj-ZMu78Q0DmDWbgukhTH1ATVyM/viewform 2/4

Figure 45: Appendix II



3/31/2015 Augmented Reality Textbooks Survey

**7. On the scale from 1 to 5, how do you rate the traditional textbooks?** *

(1 is lowest, 5 is highest)

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Interesting | ○ | ○ | ○ | ○ | ○ |
| Information | ○ | ○ | ○ | ○ | ○ |
| Understandability | ○ | ○ | ○ | ○ | ○ |

**8. Have you ever use e-books(digital books)?** *

- ○ Yes
- ○ No

**9. What do you think about e-books?** *

(compared to traditional textbooks)

- ☐ Convenient
- ☐ Better understandability
- ☐ No difference
- ☐ Other:

**10. Which of the following medium you prefer in learning?** *

(for better understanding)

- ○ Words
- ○ Pictures
- ○ Videos
- ○ Other:

**11. Will you consider using your smartphones/tablets for study purposes?** *

- ○ Yes
- ○ No

**12. What are your thoughts on the textbooks that will have moving, pop-up 3D images on it?** *

- ○ Great! I'll definitely spend more time on it!
- ○ Maybe I'll give it a try
- ○ I don't know
- ○ I prefer reading traditional textbooks
- ○ Other:

https://docs.google.com/forms/d/1-wT9hUZjdAtJI-tNBj-ZMu78Q0DmDWbgukhTH1ATVyM/viewform 3/4

Figure 46: Appendix III

# Augmented Reality Textbooks

I am currently working on my Final Year Project named "Augmented Reality Textbooks" Augmented Reality (AR) is an enhanced version of reality created by the use of technology to overlay information on an image of something being view through a device(smartphones, tablets, computers and etc). In other words, AR can be described as digital display that blended virtual graphics onto a physical reality which means that the image of the object will pop-up in real environment when viewed using certain devices. The idea of the whole project is to create a whole new and better learning experience that would be able to captivate student's interest in study. This survey form is to collect your precious feedback and opinions for my proposed project.

*Required

1. What's your name? *

2. How many years of teaching experience? Which level? (Primary or secondary school) *

Figure 47: APPENDIX IV

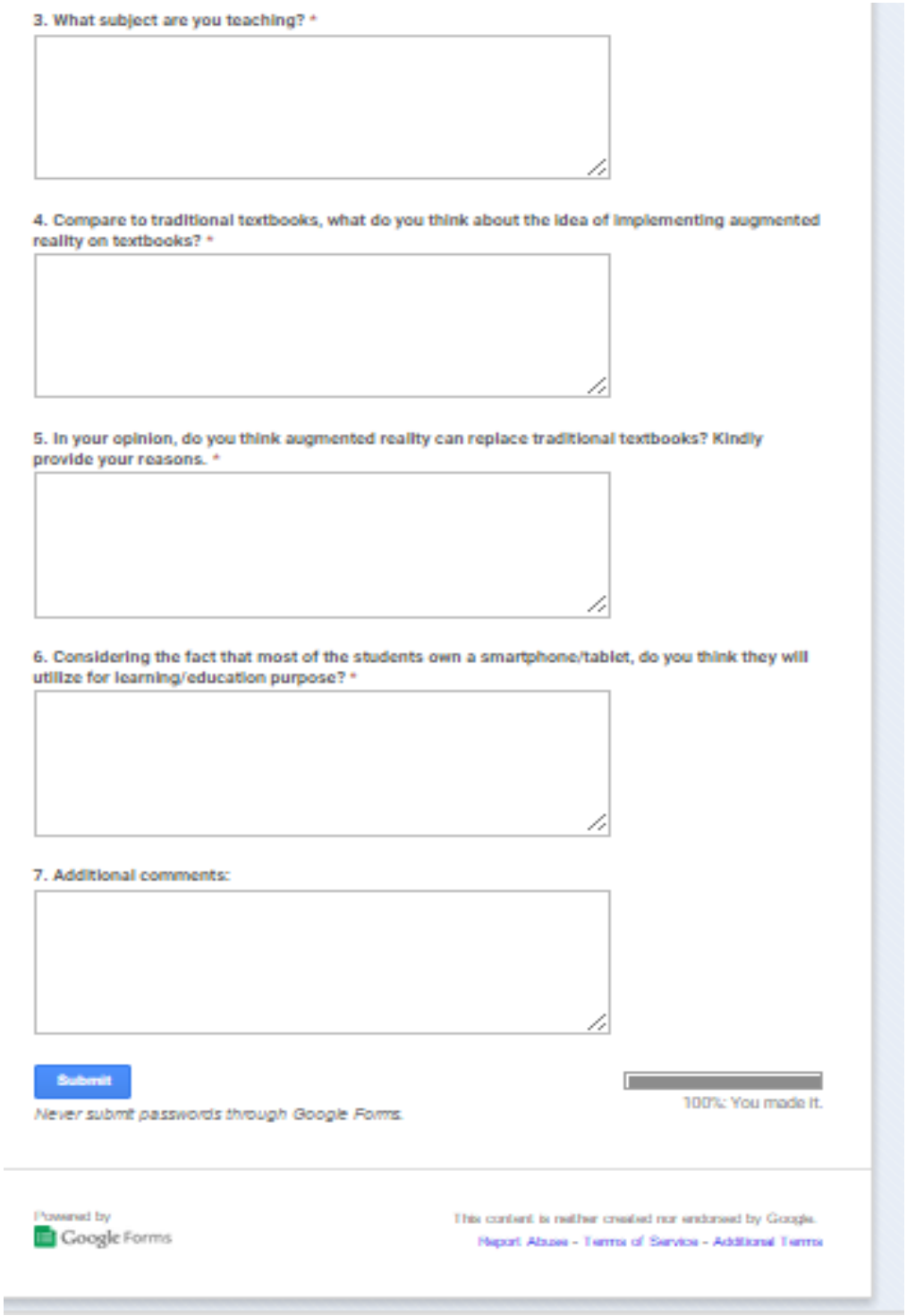



Figure 48: APPENDIX V

| | Mathematics | | | | Reading | | Science | |
|---|---|---|---|---|---|---|---|---|
| | Mean score in PISA 2012 | Share of low achievers in mathematics (Below Level 2) | Share of top performers in mathematics (Level 5 or 6) | Annualised change in score points | Mean score in PISA 2012 | Annualised change in score points | Mean score in PISA 2012 | Annualised change in score points |
| OECD average | 494 | 23.0 | 12.6 | **-0.3** | 496 | **0.3** | 501 | **0.5** |
| Shanghai-China | 613 | 3.8 | 55.4 | **4.2** | 570 | **4.6** | 580 | 1.8 |
| Singapore | 573 | 8.3 | 40.0 | **3.8** | 542 | **5.4** | 551 | **3.3** |
| Hong Kong-China | 561 | 8.5 | 33.7 | **1.3** | 545 | **2.3** | 555 | **2.1** |
| Chinese Taipei | 560 | 12.8 | 37.2 | 1.7 | 523 | **4.5** | 523 | -1.5 |
| Korea | 554 | 9.1 | 30.9 | 1.1 | 536 | **0.9** | 538 | **2.6** |
| Macao-China | 538 | 10.8 | 24.3 | **1.0** | 509 | **0.8** | 521 | **1.6** |
| Japan | 536 | 11.1 | 23.7 | 0.4 | 538 | **1.5** | 547 | **2.6** |
| Liechtenstein | 535 | 14.1 | 24.8 | 0.3 | 516 | **1.3** | 525 | 0.4 |
| Switzerland | 531 | 12.4 | 21.4 | 0.6 | 509 | **1.0** | 515 | 0.6 |
| Netherlands | 523 | 14.8 | 19.3 | **-1.6** | 511 | -0.1 | 522 | -0.5 |
| Estonia | 521 | 10.5 | 14.6 | 0.9 | 516 | **2.4** | 541 | 1.5 |
| Finland | 519 | 12.3 | 15.3 | **-2.8** | 524 | **-1.7** | 545 | **-3.0** |
| Canada | 518 | 13.8 | 16.4 | **-1.4** | 523 | **-0.9** | 525 | **-1.5** |
| Poland | 518 | 14.4 | 16.7 | **2.6** | 518 | **2.8** | 526 | **4.6** |
| Belgium | 515 | 19.0 | 19.5 | **-1.6** | 509 | 0.1 | 505 | -0.9 |
| Germany | 514 | 17.7 | 17.5 | **1.4** | 508 | **1.8** | 524 | 1.4 |
| Viet Nam | 511 | 14.2 | 13.3 | m | 508 | m | 528 | m |
| Austria | 506 | 18.7 | 14.3 | 0.0 | 490 | -0.2 | 506 | -0.8 |
| Australia | 504 | 19.7 | 14.8 | **-2.2** | 512 | **-1.4** | 521 | -0.9 |
| Ireland | 501 | 16.9 | 10.7 | -0.6 | 523 | **-0.9** | 522 | **2.3** |
| Slovenia | 501 | 20.1 | 13.7 | -0.6 | 481 | **-2.2** | 514 | -0.8 |
| Denmark | 500 | 16.8 | 10.0 | **-1.8** | 496 | 0.1 | 498 | 0.4 |
| New Zealand | 500 | 22.6 | 15.0 | **-2.5** | 512 | **-1.1** | 516 | **-2.5** |
| Czech Republic | 499 | 21.0 | 12.9 | **-2.5** | 493 | -0.5 | 508 | -1.0 |
| France | 495 | 22.4 | 12.9 | **-1.5** | 505 | 0.0 | 499 | 0.6 |
| United Kingdom | 494 | 21.8 | 11.8 | -0.3 | 499 | 0.7 | 514 | -0.1 |
| Iceland | 493 | 21.5 | 11.2 | **-2.2** | 483 | **-1.3** | 478 | **-2.0** |
| Latvia | 491 | 19.9 | 8.0 | 0.5 | 489 | **1.9** | 502 | **2.0** |
| Luxembourg | 490 | 24.3 | 11.2 | -0.3 | 488 | **0.7** | 491 | 0.9 |
| Norway | 489 | 22.3 | 9.4 | -0.3 | 504 | 0.1 | 495 | 1.3 |
| Portugal | 487 | 24.9 | 10.6 | **2.8** | 488 | **1.6** | 489 | **2.5** |
| Italy | 485 | 24.7 | 9.9 | **2.7** | 490 | 0.5 | 494 | **3.0** |
| Spain | 484 | 23.6 | 8.0 | 0.1 | 488 | -0.3 | 496 | 1.3 |
| Russian Federation | 482 | 24.0 | 7.8 | 1.1 | 475 | **1.1** | 486 | 1.0 |
| Slovak Republic | 482 | 27.5 | 11.0 | **-1.4** | 463 | -0.1 | 471 | **-2.7** |
| United States | 481 | 25.8 | 8.8 | 0.3 | 498 | -0.3 | 497 | 1.4 |
| Lithuania | 479 | 26.0 | 8.1 | -1.4 | 477 | 1.1 | 496 | 1.3 |
| Sweden | 478 | 27.1 | 8.0 | **-3.3** | 483 | **-2.8** | 485 | **-3.1** |
| Hungary | 477 | 28.1 | 9.3 | **-1.3** | 488 | **1.0** | 494 | -1.6 |
| Croatia | 471 | 29.9 | 7.0 | 0.6 | 485 | 1.2 | 491 | -0.3 |
| Israel | 466 | 33.5 | 9.4 | **4.2** | 486 | **3.7** | 470 | **2.8** |
| Greece | 453 | 35.7 | 3.9 | **1.1** | 477 | 0.5 | 467 | -1.1 |
| Serbia | 449 | 38.9 | 4.6 | **2.2** | 446 | **7.6** | 445 | 1.5 |
| Turkey | 448 | 42.0 | 5.9 | **3.2** | 475 | **4.1** | 463 | **6.4** |
| Romania | 445 | 40.8 | 3.2 | **4.9** | 438 | 1.1 | 439 | **3.4** |
| Cyprus[1,2] | 440 | 42.0 | 3.7 | m | 449 | m | 438 | m |
| Bulgaria | 439 | 43.8 | 4.1 | **4.2** | 436 | 0.4 | 446 | 2.0 |
| United Arab Emirates | 434 | 46.3 | 3.5 | m | 442 | m | 448 | m |
| Kazakhstan | 432 | 45.2 | 0.9 | **9.0** | 393 | 0.8 | 425 | **8.1** |
| Thailand | 427 | 49.7 | 2.6 | 1.0 | 441 | **1.1** | 444 | **3.9** |
| Chile | 423 | 51.5 | 1.6 | **1.9** | 441 | **3.1** | 445 | 1.1 |
| Malaysia | 421 | 51.8 | 1.3 | **8.1** | 398 | **-7.8** | 420 | -1.4 |
| Mexico | 413 | 54.7 | 0.6 | **3.1** | 424 | **1.1** | 415 | 0.9 |
| Montenegro | 410 | 56.6 | 1.0 | **1.7** | 422 | **5.0** | 410 | -0.3 |
| Uruguay | 409 | 55.8 | 1.4 | **-1.4** | 411 | **-1.8** | 416 | **-2.1** |
| Costa Rica | 407 | 59.9 | 0.6 | -1.2 | 441 | -1.0 | 429 | -0.6 |
| Albania | 394 | 60.7 | 0.8 | **5.6** | 394 | **4.1** | 397 | 2.2 |
| Brazil | 391 | 67.1 | 0.8 | **4.1** | 410 | **1.2** | 405 | **2.3** |
| Argentina | 388 | 66.5 | 0.3 | 1.2 | 396 | -1.6 | 406 | 2.4 |
| Tunisia | 388 | 67.7 | 0.8 | **3.1** | 404 | **3.8** | 398 | **2.2** |
| Jordan | 386 | 68.6 | 0.6 | 0.2 | 399 | -0.3 | 409 | **-2.1** |
| Colombia | 376 | 73.8 | 0.3 | 1.1 | 403 | **3.0** | 399 | 1.8 |
| Qatar | 376 | 69.6 | 2.0 | **9.2** | 388 | **12.0** | 384 | **5.4** |
| Indonesia | 375 | 75.7 | 0.3 | 0.7 | 396 | **2.3** | 382 | -1.9 |
| Peru | 368 | 74.6 | 0.6 | 1.0 | 384 | **5.2** | 373 | 1.3 |

1. Footnote by Turkey: The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish

Figure 49: PISA 2012 result