Assessment of Augmented Reality Mobile Application for Educational Purposes

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ABSTRACT

Augmented Reality (AR) is among the advanced technology accessible worldwide, which constantly noticeable in the entertainment industry. However, there is no universal nor accessible augmented reality to be found offering in Malaysia higher education. This research intends to apply augmented reality application within an educational perspective and evaluate its effectiveness based on four (4) criteria that comprises: performance, usefulness, learnability, and accuracy. An augmented reality application, Floristic was developed to cooperative in teaching plant material at Tropical Park of Universiti Teknologi Malaysia (UTM), Skudai. A pilot study has conducted within a limited period where the participants had responded to collect and evaluate several flora species using the median score system. Based on the results, the Floristic 'performance' scored four (4) out of five (5), the 'usefulness' scored five (5), the 'learning skill' 4.8, and the 'accuracy' scored four (4). Meanwhile, the questionnaires survey was analysed as a recommendation for further improvement. In conclusion, the implementation of augmented reality for teaching and learning purposes will make the learning process more engaging and exciting. AR technology is also very fast-growing, and there seems to be a great deal of potential in the use of augmented reality rather than in the choice of floral identification alone.

INTRODUCTION

Recent advances in mobile computing, computer graphics, wireless and sensor technologies allow for the fast development of Augmented Reality (AR) applications on smartphones. An augmented reality system enhances and augmented the surroundings of user with virtual information either in video, image, text, symbol and etcetera that is registered in 3D space and seems to co-exist with the real world. Conveying information has never been more interactive and fuller of experience with augmented reality compared to virtual visualization. Augmented reality is a technology of adding virtual objects to real scenes through enabling the addition of missing information in real life (El Sayed et al., 2011). At the same time, other researcher states it as a situation in which a real-world context is dynamically overlaid with coherent location or context-sensitive virtual information (Klopfer and Squire, 2008). Nevertheless, in this study, augmented reality is considered as a medium of conveying information or knowledge no matter in what form in a way that it is interactive to users and enhance the experiences gained from using it. One of the advantages of a mobile augmented reality application is that the application itself can exist anywhere in the world or reality setting. Eventually, in terms of hardware, the current existing smartphone carried by everyone is capable of housing the technology of augmented reality, which everyone does not aware of it (Craig, 2013).

The emergence of augmented reality and virtual technologies has influenced the need for higher skilled technology expertise. Currently, virtual reality is commonly used in the fields of medicine, engineering, education and a number of areas. However, although the development of augmented reality is advancing, the capacity to teach in the technology is disintegrated due to the lack of education that focuses primarily on revealing the prospect of augmented reality and virtual reality.

Previous study, Wagner, Schmalstieg and Billinghurst (2006) developed Virtuoso, a game related to education. This version of the game contains three versions which are an augmented reality programme, a version of the machine and a version of the paper. The game 's goal was to assemble virtual artworks using those three versions based on their produced date and compare them for performance. Findings indicate that as compared with using the third version, there were no significant differences. The users, however, display more interest in using the Virtual Reality application and paper as it helps them to interact rather than digital versions. Plus, because of its interface, the augmented reality technology has become the most exciting tools for them.

Furthermore, Klopfer and Squire (2008) partnered with the Faculty of Environmental Science to create an Augmented Reality framework which was used as a simulation, called Environmental Detectives. This game lets the students gain experience as an environmental engineer in performing reality-setting environmental investigation. The game is integrated with the role of GPS, as well as the application of assistance to navigate the students in order to learn the way of scientific investigation.

Other example, Juan et al., (2011) launched an Augmented Reality smartphone game, ARGreenet with the purpose for increasing recycling awareness. The research was carried out by comparing ARGreenet to an established standard recycling programme among children. Evaluation was based on the information gained for both applications, degree of interaction, interactivity, ability to change behaviour. Findings from comparing both applications indicate no relevance, but the kids prefer ARGreenet because of the reason they were easy to use and more entertaining and enjoyable to use. It was also found that their desire to improve their habits is positively influenced by the test.

With the advent of current technologies, educators are always seeking to improvise their way of teaching to the students in a more engaging and enriched way. Augmented reality was viewed as one of the innovations that could understand it. The combination of both virtual and real setting together gave the possibilities of producing product variety, especially in the teaching and learning prospects. Augmented reality's usefulness seems to be going along with the way the new smartphone technologies are progressing. It is therefore to be inferred that, due to its portability, social interactivity, communication, context awareness, and creativity, mobile augmented reality learning-based framework in game and simulation is capable of delivering realistic learning experiences (Huizenga, 2009).

The idea of creating the mobile augmented application, namely Floristic is due to the problem among urban planning students that are lacking knowledge of plant material which in helping to create a suitable planting plan for a Landscape Master Plan efficiently. Knowing what type of trees to be planted on site are necessary either for planner or architect to comprehend tree planting guideline and local regulation that need to be followed. Not to mention that most of the medium or platform they have found are instead in articles or guideline books that are wordy which is considered out-of-date and tedious to read it. The information is often delivered in text or image form that is not interactive with people. However, with the help of technologies, those kinds of information can be conveyed and delivered to people wherever they are and interactively. Therefore, this study intended to develop and assess augmented mobile application namely Floristic in assisting teaching and learning process.

METHODOLOGY

There are six (6) main phases of method that had carried out to understand the research on developing a mobile augmented reality application that helps in delivering floral information. It was

started with project planning, data collection for application, application development, data collection from respondent, result analysis, and conclusion (Figure 1).
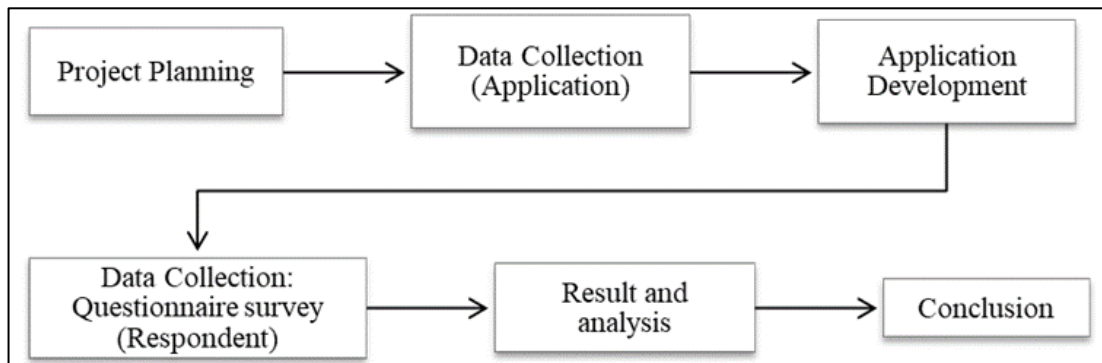

Figure 1. General flowchart of the research

Study Area

The study area is located at lakeside of UTM Tropical Park. The park existence of variety of plant species in Tropical Park is convenient and sufficient for conducting the research. The approximate study area of Tropical Park is 4.26 hectares. Figure 2 is the map for study area while Figure 3 shows the existing environment of the study area.
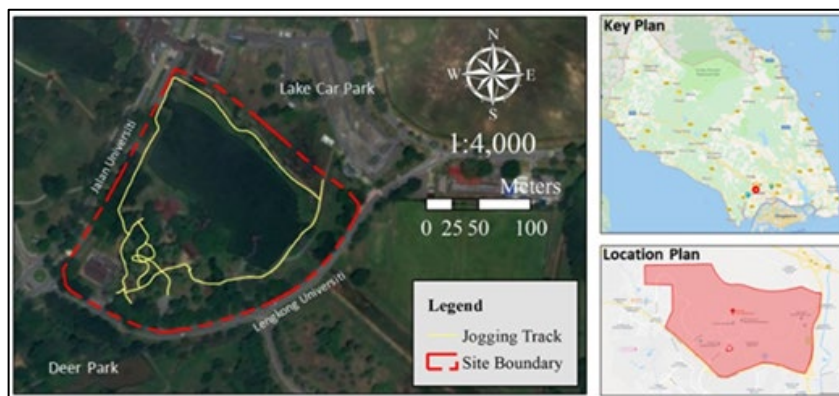
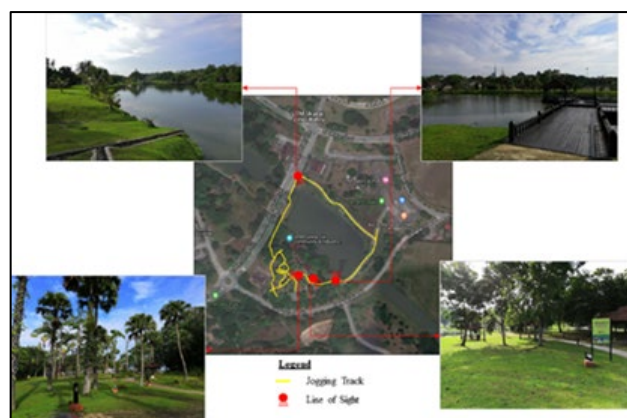**Figure 2**. Site boundary of UTM Tropical Park

Figure 3. Existing landscape feature of UTM Tropical Park

Data Collection and Processing

The first data collection is site visit and survey and the use of instrument or software. There are four software involved in this research, consist of SW Maps, ArcMap version 10.5, Unity version 2017, and Vuforia. SW Maps is a free software of GIS and mobile mapping application for collecting, presenting, and sharing geographic information. These applications can be assumed as a high precision instrument for a full-scale GNSS (Global Navigation Satellite System) survey, or for collecting large amount of spatial based data just using smartphone. Its use to record points, lines, polygons, and even photo and have them displayed over given the background map. These data can also be edited and attached with features including text, number, and videos. The most convenient feature of this application is that all the spatial data to be exported into shapefiles layer or KML format, which later can be used in another programme for further analysis.

Meanwhile, ArcGIS is a well-known geographic information system (GIS) software for producing maps and geographic information. It has widely used for the creation of maps, a compilation of spatial data, spatial data analysis, sharing and discovering spatial data between users, managing database and more. ArcGIS is convenient to use as the interface are simple and easily understood by everyone. This software was used in this research to refine the data collected from the site survey and then create a GIS database. Unity at first is an ultimate game development platform used by many game developers. It is widely used to build high-quality 3-dimensional and 2-dimensional games, then; deploy them across mobile, desktop, consoles and other gaming media. Up until now, it has proven that Unity was not only to be used in gaming creation, its accessibility, features, and tools allow the development of other related application such as virtual reality and augmented reality. Unity is considered the world's leading real-time creation platform that has collaboration with more than 25 industry multiplatform. It has a friendly user interface. However, knowledge and skills needed among user in creating applications. Unity was used in this study to develop the mobile augmented reality application, which namely Floristic.

Vuforia is widely known as the industry leader in industrial augmented reality application through its best-in-class computer vision technology, robust tracking capabilities, and breadth of platform support. It is an augmented reality software development kit or in short SDK for mobile devices that enable the creation and function of augmented reality. Vuforia is widely used to support a variety of 2-dimensional and 3-dimensional target types, including marker-less image target. The explanation of how its function lies on the uses of computer vision technology to recognize and track the intended image or so-called marker, then shows the 3-dimensional embedded objects in real-time. Vuforia in this study helps as an extension in Unity to allow the use and the development of augmented reality software.

Base Map of UTM Tropical Park

The data in this process was the primary source as it was collected real-time and personally during the site survey. With the use of SW Maps, real-time spatial data were easily collected. Figure 4 shows the interface of SW Maps and the data collected before being exported into ArcMap. After transferring the spatial data into ArcGIS, the process of refinement was conducted so that the data feature would not have an irregular form.
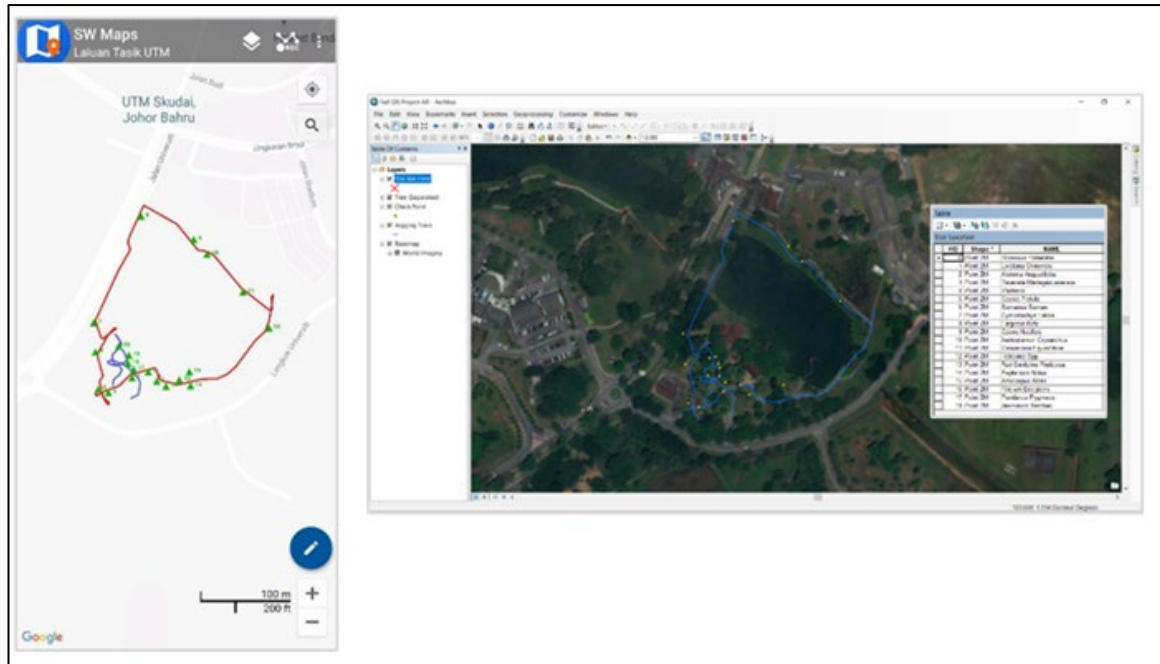
Figure 4. Data collected using SW Maps (left) exported to ArcMap (right)

During the site visit, all collected pictures of observed trees (shown in Figure 5) were taken to identify via plant encyclopaedia and assisted by professional expertise. This step is crucial in sorting out the types of plant available in Tropical Park to avoid redundancy in the database. The total number of identified 19 species of plant material at UTM Tropical Park have included in the development of Floristic list. These 19 plant species are Borassus Flabellifer, Livistona Chinensis, Alstonia Angustiloba, Ravenala Madagascariensis, Plumeria, Cassia Fistula, Samanea Saman, Cyrtostachys Lakka, Fargesia Rufa, Cocos Nucifera, Xantostemon Crysanthus, Casuariana Equisitifolia, Heliconia Spp, Red Cordyline Fruticosa, Esplenium Nidus, Artocarpus Altilis, Filicium Decipiens, Pandanus Pygmeus, and Jasminum Sambac.

Figure 5. Pictures of different type of trees in UTM Tropical Park

Development of Marker-based Augmented Reality Mobile Application

The development of mobile augmented reality has conducted using Unity and extension of Vuforia. This mobile augmented reality application applies the marker-based type of augmented reality, which means that the needs or requirement of a base indicator or sources to be used in identifying which information should be delivered to the user. The application was built in the android environment due to its availability of mass sharing and simple application file. The android platform itself is considered open and allowed the installation of unregistered or unknown application out of Google Play Store.

There are two main components involved in the development of the augmented reality mobile application which is the marker and the application itself, Floristic. The marker function as a base indicator for the application to identify and choose which information has given to the user. On the Marker itself, there are the name of the plant species, a map plants location, QR Code for the use of downloading the application Floristic, and an instruction manual on how to use the application Floristic (refer to Figure 6).
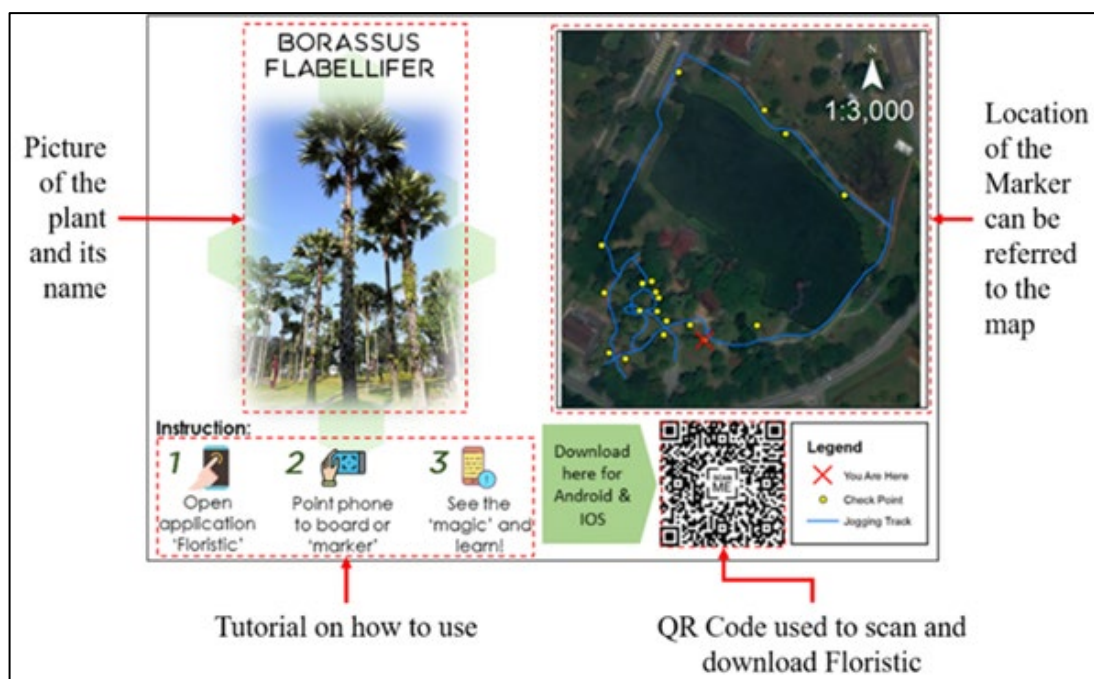

Figure 6. The function of a Marker

Floristic has three (3) functional buttons to be clicked (Figure 7). One of the buttons is the Description button which only appears when the application identified a Marker through camera interface (Figure 8), and then the user can click to retrieve the information. The users able to adjust their line of sight of the information as long as the marker is within the sight of their camera. As for the question on how the respondents' experiences of using Floristic, an interactive button for the questionnaires had added on bottom right side of Floristic. Respondents would only need to click the button, and then the application will link to a website using a web application, Google Form.
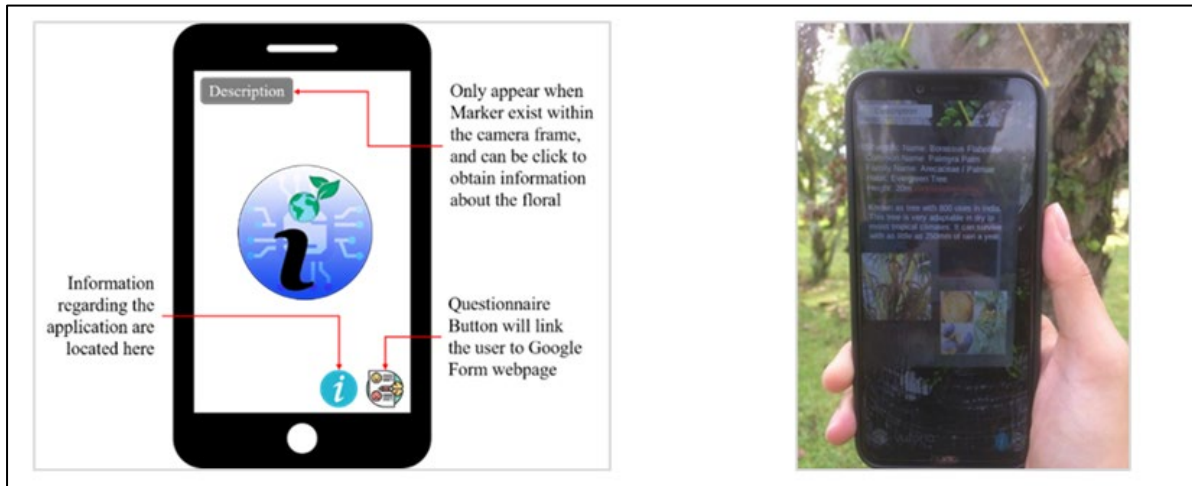
Figure 7. Interface of Floristic   **Figure 8**. Information of tree

Questionnaires Survey

The questionnaire consists of six (6) sections, which are user background, 'performance', 'usefulness', 'learnability', 'accuracy', and feedback. Among those six sections, four was considered crucial in assessing the effectiveness of mobile augmented reality application, Floristic in delivering information. The 'Performance', 'usefulness', 'learnability', and 'accuracy' are the criteria in assessing the application and were analysed through Likert scale method.

DATA COLLECTION AND PROCESSING

Respondents

In this research, a total of 56 respondents were gathered to test the Floristic. Among those respondents, the majority are female with the number of 43 respondents (77%) and male 13 respondents (23%) only. Having a floral-related educational background means that the person had or are studying on the plant-related subject such as in landscape architecture field based on Figure 9, it seems that about 59% of the respondents have floral-related educational background compared to the remaining 41% that does not have the related educational background.
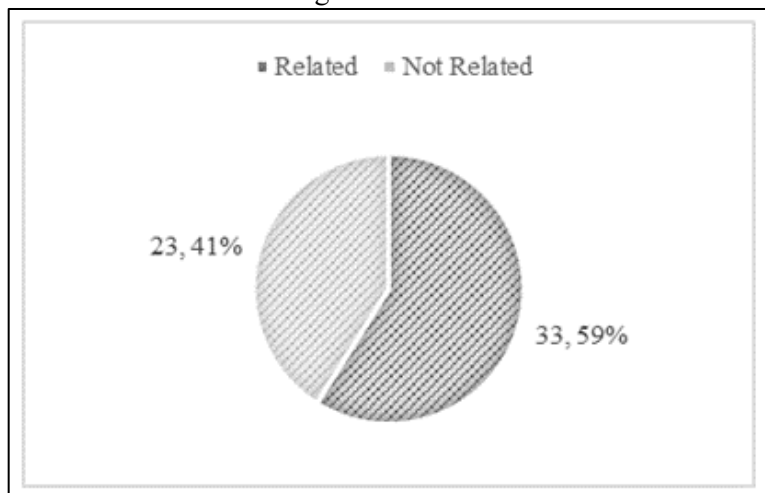

Figure 9. Floral-related educational background of respondents

35

Knowing whether the respondents had any experience in handling augmented reality application is crucial as it will affect the score given on following questions regarding the performance, usefulness, learnability, and accuracy of Floristic. The statistic shows that 41 persons (73%) are first time in using augmented reality application, while 15 persons (27%) had experiences in using augmented reality application before being introduced to Floristic (refer Figure 10).
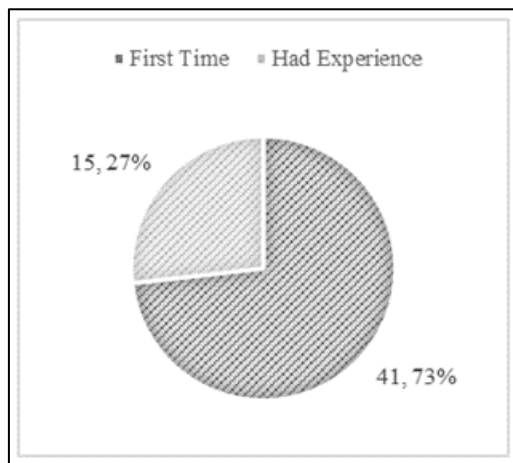

Figure 10. Experience using augmented reality application among respondents

Performance

In criteria of performance, it involves two (2) aspect which are; the agreement on whether Floristic works well, and the list of problems faced by respondents while handling it. For the agreement of Floristic's functionality, most of the respondents; 25 persons (45%) strongly agreed, following with the number of 23 persons (41%) agreed that Floristic works well when they are using it. On the other hand, only three (3) respondents reject the agreement as two (2) persons (3%) disagree and one (1) person (2%) strongly disagree that Floristic works well during their testing phase. The median for this argument is four (4), meaning; the weightage is on the level of agreement that Floristic works well as intended (refer Figure 11).
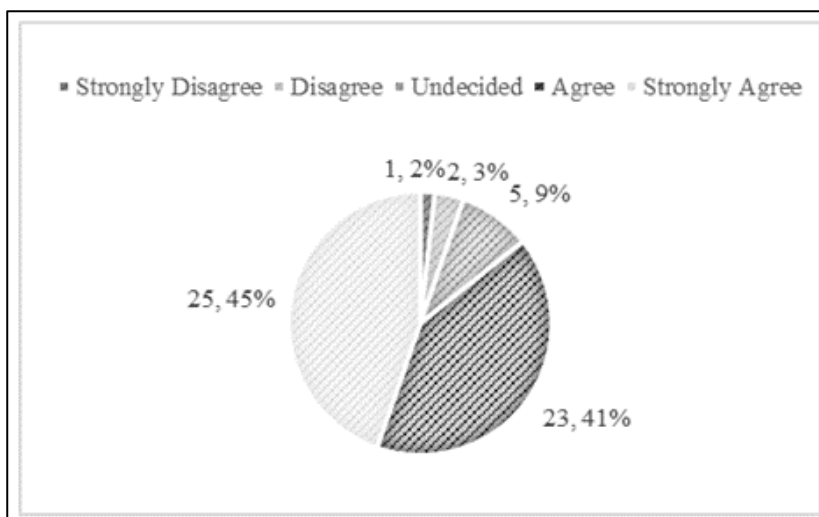

Figure 11. Agreement whether Floristic works well when respondents are using it

The next question is on the list of problems encountered by respondents during the testing phase. Although the majority of respondents with the number of 38 persons have no problem while using Floristic, it is worth to mention that about 11-person response that they are facing camera blurring and

focusing problem while using Floristic. Furthermore, six (6) respondents said that the digital information took time to load, and they faced a lagging issue during the testing phase. It is also important to mention that five (5) respondents have a problem in the appearance of digital information when using Floristic (refer Figure 12).
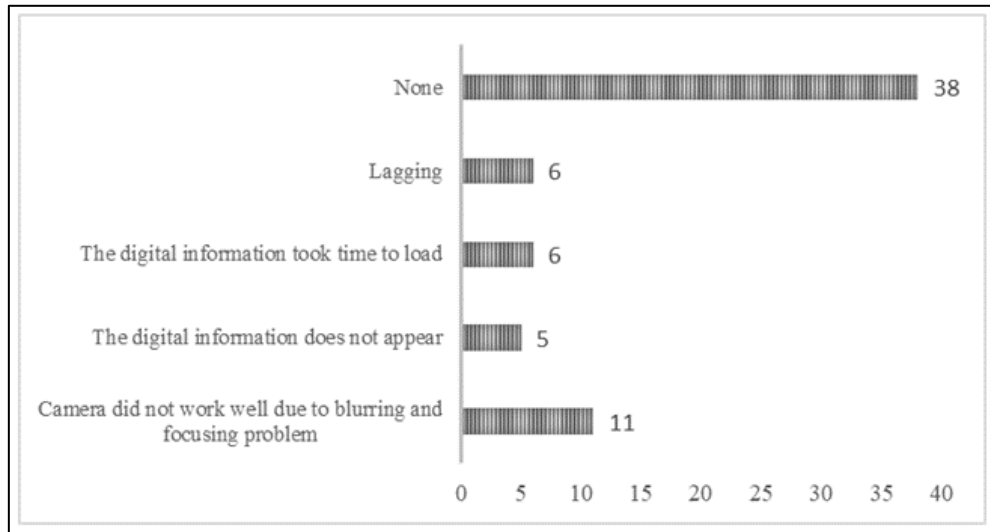

Figure 12. Problems encountered while using Floristic

Usefulness

Three (3) aspects assessed, including the agreement that Floristic helps in increasing knowledge, understanding, and as a better way of learning than reading. The agreement on whether Floristic helps in increasing knowledge shows that 34 respondents (61%) strongly agreed, and 19 respondents (34%) agreed that Floristic does help in increasing their knowledge of floral. The median for this statement scored five (5), which is on the strongly agree level that Floristic does help in increasing knowledge among respondents (refer Figure 13).
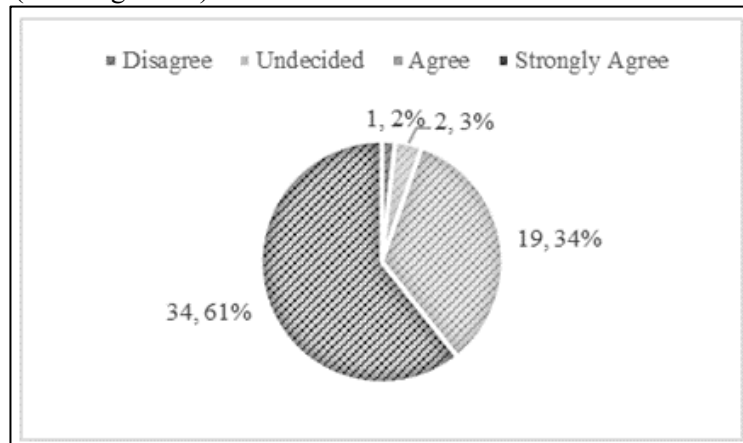

Figure 13. The agreement that Floristic helps in increasing knowledge

The survey indicated that 33 respondents (59%) strongly agreed that Floristic helps them in understanding more about floral, following with 21 respondents (37%) agreed on the given statement. Thus, this statement scored five (5) (strongly agree) as Floristic does increases understanding about floral among respondents (refer Figure 14).
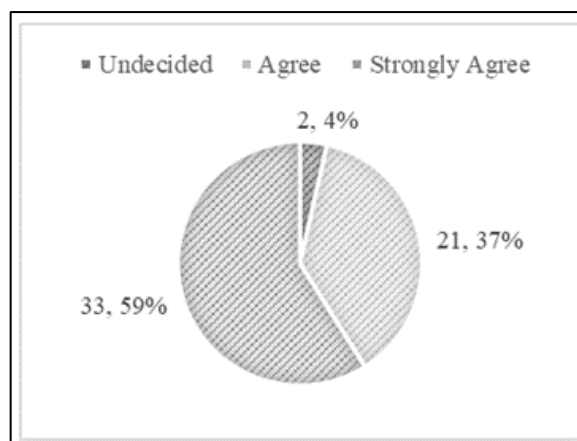
Figure 14. The agreement that Floristic increases understanding of floral

A statement of whether Floristic is a better way of learning than reading books were asked among respondents. The result shows that 40 respondents (72%) strongly agreed with the statement, following with 12 respondents (21%) agreed, and left with four (4) respondents (7%) undecided to fall under which agreement. The medium scored five (5) on the level of strongly agree suggesting that Floristic is a better learning platform than reading (Figure 15).
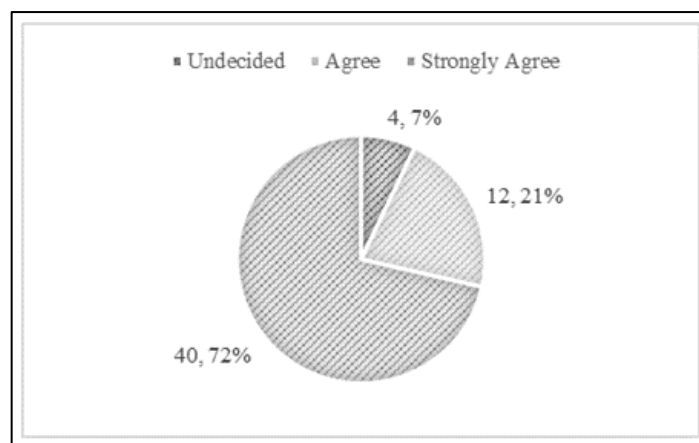

Figure 15. Agreement that Floristic is a better learning platform

Learnability

The criteria of learnability included three (3) important aspects which are the argument whether Floristic is easy to use, fun, and interactive to use. Based on Figure 16, 28 respondents (50%) voted on strongly agree, followed by 22 respondents (39%) voted on agreeing that Floristic is easy to use. Five (5) respondents (9%) were undecided and only one (1) respondent (2%) disagreed with the statement given. The median scored was four and a half (4.5), meaning the level of significance is between agree and strongly agree.
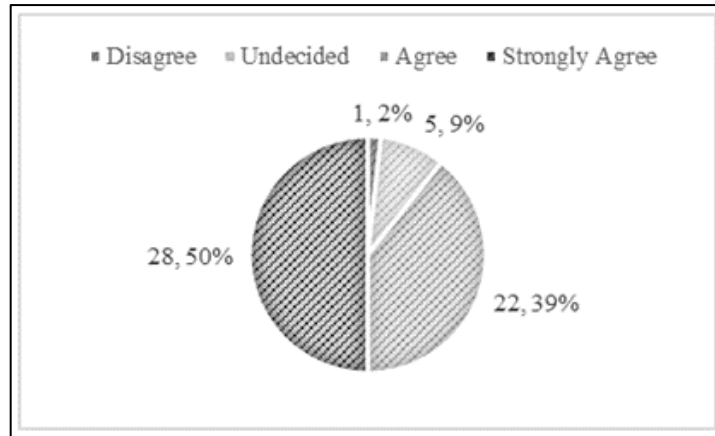
Figure 16. Agreement whether Floristic is easy to use

It seems that approximately 31 respondents (55%) strongly agreed that Floristic is easy to use. To further strengthen this statement, another 21 respondents (38%) reported that they agreed too that Floristic is easy to use for them. However, only four (4) respondents remain undecided on this statement. Positively, the median identified was five (5), which on the level of strongly agree that Floristic is easy to use among respondents (Figure 17).
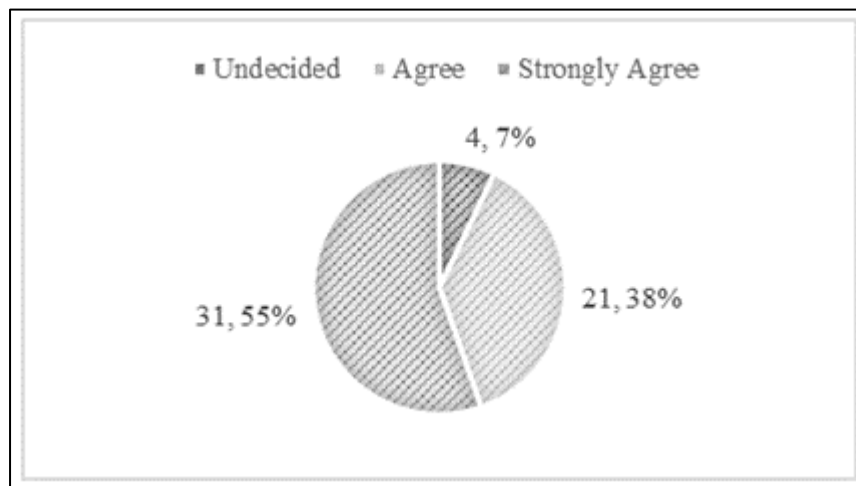

Figure 17. Agreement whether Floristic is fun to use

Majority of respondents strongly agreed (36 persons, 64%) that floristic is interactive. Another 15 respondents (27%) stated that they agreed that Floristic is interactive to use. Unfortunately, four (4) respondents remain undecided while one (1) respondent disagreed on the interactivity of Floristic. However, the median calculated was five (5), and it suggests that responses were on strongly agree level that Floristic is interactive to use (refer to Figure 18).
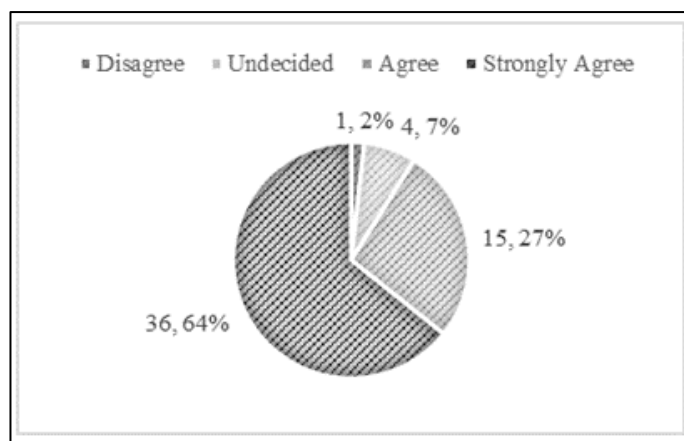
Figure 18. Agreement whether Floristic is interactive to use

Accuracy

The accuracy and reliability of information are the aspects that assessed in the criteria of accuracy. A questionnaire was asked whether the information provided through Floristic are accurate or not. Results shows that 27 respondents (48%) reported that the information was accurate, following with 16 respondents (29%) answering totally accurate, along with 12 respondents (21%) were undecided, and only one (1) respondent (2%) claimed the information was inaccurate. The median scored was four (4) shows that, the information given was accurate and might contain minimal error or mistakes (refer Figure 19).
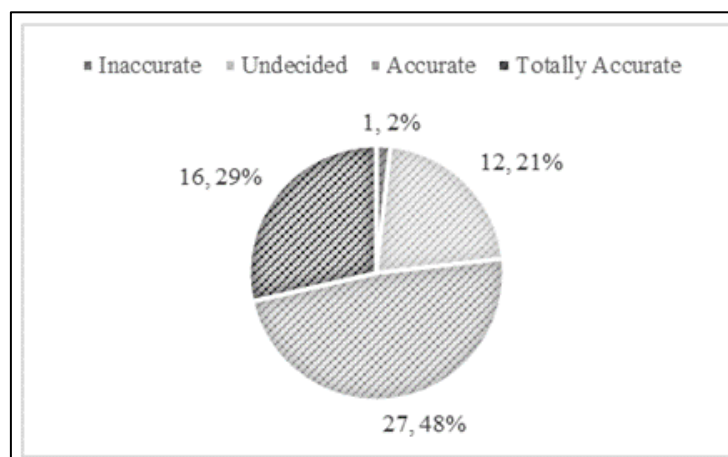

Figure 19. Accuracy of Floristic

As for the reliability of the information, it seems that the level of reliable and reliable have the same number of respondents, which are 23 persons (41%) each respectively suggesting that the information given were reliable for their use in academic purposes. However, nine (9) respondents gave the undecided answer and one (1) respondent said the information given is unreliable for him/her to be used for academic purposes. On the bright side, the median scored was four (4), means that the information given is reliable for the use of academic purposes among respondents (refer to Figure 20).
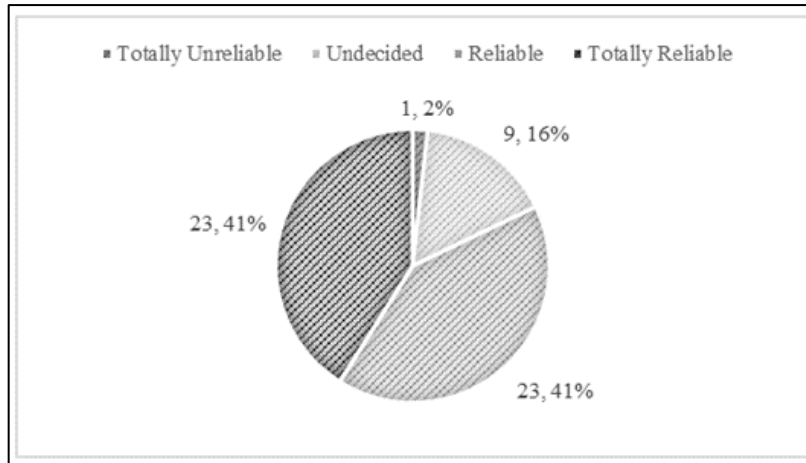
Figure 20. Reliability of information for academic purposes

Median Score

Based on the four (4) criteria listed out, median score obtained from each question. Then, an overall median score calculated to evaluate the effectiveness of Floristic. Findings from Table 1 shows that the range of the median score for every question was between four (4) to five (5), and the overall median score obtained was five (5). This result has proven that the mobile augmented reality application Floristic are efficient in providing information regarding floral species as the respondents are very satisfied with how the application work.

Table 1. Median score evaluation on the effectiveness of Floristic

Criteria	Median Score
Performance	
Floristic works well when using it	4
Usefulness	
Floristic helps in increasing knowledge on floral	5
Floristic helps in understanding more about floral	5
Floristic is a better way of learning than reading through books	5
Learnability	
Floristic is easy to use	4.5
Floristic is fun to use	5
Floristic is interactive to use	5
Accuracy	
Accuracy of information given through Floristic	4
Reliability of information to be use in academic purposes	4
OVERALL	**5**

Based on the questionnaire, the last section was on comment and feedback from respondents regarding the mobile augmented reality application, Floristic. From the data collected, there are 31 responses obtained from 56 respondents. Most of the feedbacks are based on their review and opinion on Floristic with the total number of 19 out of 31 responses. All of these responses analysed and identified to be positive feedback from the respondents.

Responses such as "It is a good idea to have this application because we can save time to find out the information about floral" by respondent number 5, "It is fun to use for academic purposes and effective for landscape architecture field" by respondent number 24, and "This application was developed successfully because it is very convenient to be used and sim ple yet informative" by respondent number 35. These responses show that the development of Floristic does benefit people, especially those involving with floral-related learning processes.

Moreover, four (4) responses from respondents urged and hoped that this type of application development to be included in future academia of students in all stages of education. Respondent number 14, questioning on why not this technology (mobile augmented reality application) been exposed in academia because the student could have much fun in learning new things.

On the other hand, the other 12 responses obtained from respondents were more focusing on the improvement of Floristic. Total six (6) respondents suggested improving the existing features of Floristic in terms of expanding information database, graphic quality, and interactivity. Then, three (3) responses urged the need for more features such as adding video or tutorial on how to use Floristic. However, respondent number 12 and respondent number 53 highlighted the need to fix the blurry problem of camera. Last but not least, respondent number 8 suggest that Floristic should also be available for the use on iPhone or IOS platform.

CONCLUSION

In conclusion, the engagement of mobile augmented reality in academic purposes does bring benefits impacts such as to provide resourceful information, enhance specialise in education, saving time and in navigating information. It seems that there is much potential in developing augmented reality application in education besides had been applied in floral identification per se. Therefore, with the hope of further studies, the implementation on augmented reality should be expand widely in the future to improve the current daily technology to the next level.

ACKNOWLEDGEMENT

REFERENCES

Craig, A. B. (2013). Mobile Augmented Reality. Understanding Augmented Reality. Elsevier Inc.

El Sayed, N. A. M., Zayed, H. H., & Sharawy, M. I. (2011). ARSC: Augmented reality student card. *Computers & Education*, *56*(4), 1045–1061

Huizenga, J., Admiraal, W., Akkerman, S., & Dam, G. T. (2009). Mobile game-based learning in secondary education: engagement, motivation and learning in a mobile city game. *Journal of Computer Assisted Learning*, 25(4), 332-344.

Juan, M. C., Furió, D., Alem, L., Ashworth, P., and Cano, J. (2011). ARGreenet and Basic-Greenet: Two mobile games for learning how to recycle. *In Proceedings of the 19th International Conference on Computer Graphics, Visualization and Computer Vision 2011*, 25–32.

Klopfer, E., & Squire, K. (2008). Environmental Detectives—the development of an augmented reality platform for environmental simulations. *Educational Technology Research and Development*, 56 (2), 203-228.

Wagner, D., Schmalstieg, D., and Billinghurst, M. (2006). Handheld AR for Collaborative Edutainment. *Advances in Artificial Reality and TeleExistence*, 85–96.