ARTitser: A Mobile Augmented Reality in Classroom Interactive Learning Tool on Biological Science for Junior High School Students

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ABSTRACT
The authors implemented an Augment Reality (AR) to develop a mobile application called ARTitser that was utilized for Junior High School students as a supportive tool to learn Biological Science. The said application runs in iOS that integrates AR technology education which may help the teachers in facilitating delivery of the daily lessons using a realistic representation of objects for a better learning experience. It may also assist the teachers to monitor the performance of the students when using AR lesson. Moreover, the students may enjoy ARTitser application because they will see 3D objects associated to biology lesson. Based on the result of the survey, the respondents highly recommended the ARTitser with a grand mean of 4.52 which is highly acceptable. Thus, the said tool can be implemented in the Junior High School students which may motivate as well as improve the performance of the students.

CCS Concepts
Computing methodologies→Computer graphics→Graphics systems and interfaces→Mixed / augmented reality

Keywords
Mobile Augmented Reality; Interactive Learning Tool; Mobile Learning; Biology.

1. INTRODUCTION
Technology-enhanced learning or TEL research has increasingly focused on new technologies such as games and learning analytics which has become in-demand opportunities for users' satisfaction to enrich their multimodal learning environment [1]. Growing popularity of using mobile devices among people specifically students, has made such researches to take benefit of the technological revolution in hardware and software. This phenomenon has brought the idea of using mobile devices as tools in improving learning process to make it more beneficial to the students. Among the rising technology and software related to teaching-learning process, researchers are more and more interested in applying Augmented Reality (AR) to create distinctive education settings [2]. AR technology is an advanced technology that facilitates interaction between virtual and the real world in a real time application [3] to enhance the learning experience.

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AR is an extension of virtual reality (VR) [4]. Scenes and existing items are introduced for all intents and purposes in VR applications, though in AR applications, data or virtual articles are displayed in genuine scenes after calculation [5]. [6] AR is the combination of computer-generated materials with an actual scenario and display this material as if it was real. [3] Stated that AR has three vital characteristics: virtual objects combined with real environment, immediate interaction, and 3D environment which operated by AR.

AR has particular prerequisites in view of fluctuated situations or conditions. [6] It characterized two strategies for showing AR. In the first place, screen-based AR, where every one of the scenes are yielded by a projector or screen, is the most straightforward methods for show and has the least equipment necessities. Second, AR might be actualized with a [7] head-mounted transparent video, which requires a head-mounted show board equipped for catching and restricting outside pictures. Pictures are shown on the head-mounted show board after they are made by superimposing pictures produced by the computer [8]. Thus, this study receives screen-based AR and utilizes the comfort of webcams; in this manner, the proposed technique is easy to use under any conditions. Hardware costs are insignificant, and the setup is straightforward, enabling AR to be an attainable device in learning situations.

AR upgrades a client's impression of and cooperation with this present reality. The virtual articles show data that the client cannot straightforwardly distinguish with his own senses. The data passed on by the virtual articles enables a client to perform true undertakings [9]. At the season of composing this paper, at least 12 particular classes of AR application areas have been distinguished. These classes incorporate entrenched spaces like medical, military, manufacturing, entertainment, visualization, and robotics [10]. They additionally incorporate unique and new areas, for example education, marketing, geospatial, navigation and path planning, tourism, urban planning and structural designing [11]. The accompanying sub-segments depict ongoing research project that have been done in each field. While these do not thoroughly cover each application area of AR innovation, they do cover the zones investigated up until now.

At present, little research has been conducted that can be utilized by the Junior High School students for classroom interactive learning. Thus, this study focused on providing educational tool

using Augmented Reality that can be utilized by students of Biological Science which may encourage learners in understanding the topics covered in the biology course and facilitating learning effectively through interaction.

Specifically, it addressed the following sub-problems: (1) what are the issues encountered by the respondents in using existing materials for biology course; (2) what are the appropriate features of the system that can be developed to answer the identified issues; (3) what is the level of acceptance of the respondents on the developed application in terms of: (a) functionality; (b) reliability; (c) usability; (d) efficiency; (e) maintainability; and (f) portability.

2. RESEARCH METHOD AND TECHNIQUES

The researchers developed an interactive module in Augmented Reality for classroom interactive learning on Biological Science for Junior High School Students. Two (2) faculty members teaching Biology course and one (1) class adviser were requested to validate the course contents of the AR applied in Biology course. They personally deliberated and disclosed to the researchers a few points which they considered of most extreme significance. Their suggestions and direction filled in as bases for further updates and enhancement of the learning tool. However, the students served as the experimental group. Students were randomly selected based on their availability where the developed interactive module was installed. A purposive sampling technique was used in selecting the available participants.

The developed ARTitser was evaluated using a qualitative approach. A questionnaire was prepared which consisted of statements that were adapted from the ISO/IEC 9126. The respondents of the study were 3 teachers, 2 IT administrators, and 30 Junior High School students of King Solomon Christian School International who were enrolled in Biology course for the School Year 2018-2019. They were asked to respond to the statements in the survey questionnaire with regards to their level of acceptance towards the developed system in terms of functionality, reliability, usability, efficiency, maintainability and portability.

The proponents used the Likert Scale to address the measurement of the perception of the respondents about the developed system. Specifically, a five-point Likert Scale was used to measure the opinions of the respondents. It is a psychometric response scale often used in questionnaires and is the most widely used scale in survey research. When responding to a Likert questionnaire item, respondents specify their level of acceptance to a statement. The researchers used ranks from one to five: five being the highest and one being the lowest rank.

2.1 The Developed ARTitser

ARTitser is a system for managing and creating interactive educational supplemental learning tool which makes use of certain affordances of AR, based on quiz. It is a system accessible via iPhone or iPad running on iOS 11 or higher version, powered by A9 processor or newer, and connected to the Internet via Wi-Fi. It was created utilizing Xcode with the help of some native frameworks, such as ARKit, SceneKit, and SiriKit. ARTitser connects to a RESTful API built using Vapor and with MySQL as its database management system (DBMS). Additionally, the researchers used Swift as the main programming language for the development of ARTitser.

Figure 1 outlines the framework design of ARTitser. It caters for three (3) distinct kinds of users namely: (1) the administrator (IT administrator); (2) the lesson creator (teacher); and (3) the student.

Any user who wishes to get entry to ARTitser ought to have a well suited mobile device with them. The user may use iPhone or iPad with iOS11 or later version. The said gadget should be powered by A9 processor and must be connected with the Internet either by Wi-Fi or Cellular Data.

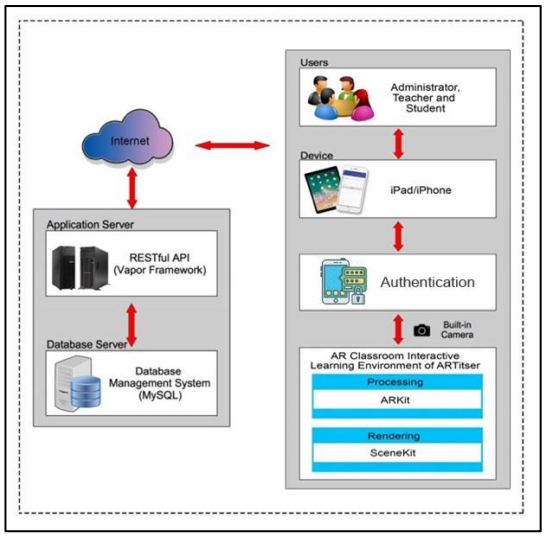

Figure 1. System Architecture of ARTitser

ARTitser provides an Authentication module to identify the user of the system whether he/she is the administrator, teacher, or a student. It requires the user to provide his/her assigned username and password. The system validates the parameters entered by the user and compares it to the records available in the database. Only those who are registered and have records in the database can proceed and use the system.

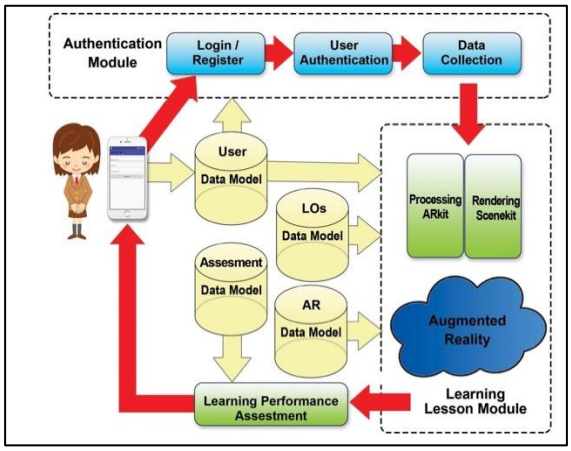

Figure 2. AR Classroom Interactive Learning Environment of ARTitser

Figure 2 shows the System Architecture of the interactive learning environment of ARTitser. In the login module, the user should enter student ID and password. The server will load and display the user data model to access the personal information of the user such as user profile, section, course, grade level and so on to achieve the User Authentication. Otherwise, they will be

asked to provide their personal information as detail as mentioned above. After logging on to the system, the student will be asked to press the AR button to launch the lesson module. Learning contents in each of the lesson are provided by the teacher. The teacher will provide the 3D model to the programmer to code this 3D on the backend. This 3D will be process by ARKit and render by Scenekit to have asset output. Assigned lesson by the teacher for the particular day will be given to the students. The system aims to provide learning contents created by the teacher. The system will act as virtual teacher where the students be able to view the augmented object and listen to the augmented voice.

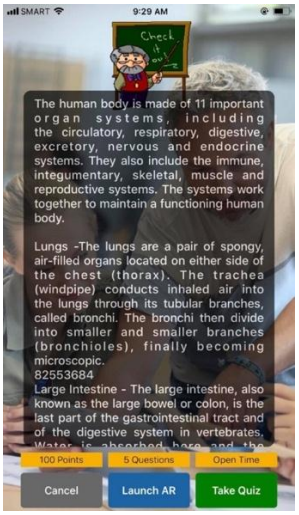

Figure 3. Lesson Discussion

Figure 3 presents the Lesson Discussion View of ARTtitser. In this view, student can listen to its text to voice (siri) speech while narrating the discussion content of the selected lesson which is part of its learning content. Some important details of the lesson are also displayed in this view such as total number of points, number of questions, and time limit.

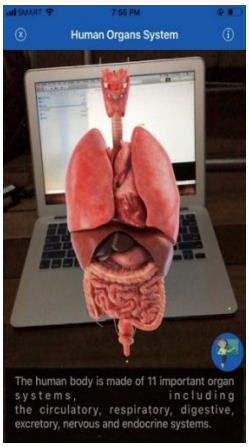

Figure 4. AR View

Figure 4 shows the 3D Model Visualization in AR Environment View of ARTitser. In this view, students can view the actual image which is like a real-world environment. They can also listen to the voice over discussing the information about the lesson.

To evaluate the students' learning outcome, a quiz module comes next after the discussion of the lesson proper. This module is intended to give a multiple choice type of examination where the students can be assessed based on the scores he can obtain per lesson provided by the teacher. The system also provide a module for the teacher where he can create the quizzes. It has a setting where the teacher can decide of the number of items to be given for each lesson and also, whether the quiz can be accessed for a limited time or open time. If the teacher opted to create an open time quiz, the students will be able to answer all of the questions without a definite time to finish the quiz. On the other hand, if the teacher chooses a time limit, the students should be able to answer each question within a definite period of time depending on the selected time of the teacher. Unanswered questions due to the time duration will automatically be treated as incorrect answers.

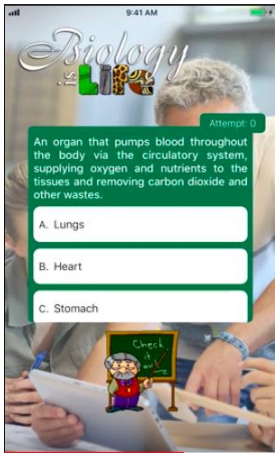

Figure 5. Quiz View

Figure 5 contains questions and multiple choices. After reading the question they will choose the correct answer proceed to next or go back to the previous question.

The computation used to solve the equivalent of the students' scores is averaging. The formula applied in the system is (Score/ No. of items x 50 + 50), where in the passing score is 75% and the perfect score is 100%. A dedicated module for the teacher is also provided where he/she can view the overall scores, as well as the ranking of each of his/her student per assessment.

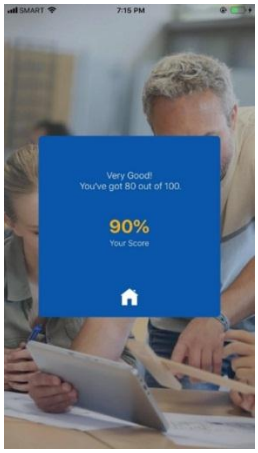

Figure 6. Quiz Result View

Figure 6 shows the number of correct answer and total number of quiz. It shows also percentage and the verbal interpretation of student score.

3. RESULTS AND DISCUSSIONS

Results were organized and presented according to the statements of the problem. The data gathered from the respondents was used to evaluate the most traditional existing materials in teaching biology course and the challenges encountered by the students in using traditional materials after learning the course. As the result of this evaluation, the top answers were used by the researchers as a guide in the development of the ARTitser System. After the development phase of the system, the researchers collected responses on the system's level of acceptance in terms of functionality, reliability, usability, efficiency, maintainability, and portability.

Table 1. Existing Teaching Materials Used for Biology Course

Existing Materials	Frequency	Percentage	Rank
Visual Presentations	33	94.29	1
Video Presentations	26	74.29	2
eBooks	3	8.57	4
Text Books	24	68.57	3
Visual Aids	24	68.57	3

Table 1 described the summary of the existing traditional materials used in teaching biology course. From among the items shown in the table, majority of the respondents with 94.29% were utilizing visual presentations, while a 74.29% used video presentations and 68.57 % integrated visual aids in their lessons. Notably, a handful of the respondents with 8.57% preferred ebooks as a teaching materials which indicates that this scheme is the least frequently used as a learning tool in teaching biology course. In the selected private school, teaching biology course to students is sometimes achieved through a traditional lecture where teachers use visual presentations software.

Table 2. Issues Encountered by the Respondents Using Existing Teaching Materials

Issues Encountered	Frequency	Percentage	Rank
Limited slides and graphic presentations	27	77.14	1
Playing video can use a lot of the bandwidth and may take time to load	16	45.71	3
eBooks screen make reading inconvenient it will cause eye strain and make difficult to focus	4	11.43	4
Text Books are outdated or insufficiently covers a topic / course area	17	48.57	2
Visual Aids that poorly designed are difficult to understand or see	17	48.57	2

Table 2 illustrated that 77.14% of the respondents find that there is limited slides and graphic presentations in the existing learning materials. This was followed by the text books are outdated or insufficiently covers topic or course area plus visual aids that poorly designed are difficult to understand or see with 48.57% of the respondents, while around 45.7% who said playing video can use a lot of the bandwidth and may take time to load. There were also around 11.43% who indicated that eBooks screen makes reading inconvenient and it will cause eye strain and make them difficult to focus.

Table 3. Respondents' Level of Acceptance of the Developed Mobile Augmented Reality for Biology Course

Criteria	Grand Mean	Verbal Interpretation	Rank
Functionality	4.50	Highly Acceptable	4
Reliability	4.43	Moderately Acceptable	5
Usability	4.62	Highly Acceptable	1
Efficiency	4.57	Highly Acceptable	2
Maintainability	4.48	Moderately Acceptable	6
Portability	4.53	Highly Acceptable	3
GRAND TOTAL	**4.52**	**Highly Acceptable**	

Table 3 described the summary of the level of acceptance of the developed Mobile Augmented Reality for Teaching Biology Course as perceived by the respondents. The ratings in this table indicates that the respondents rated ARTitser as "Highly Acceptable" with grand total mean response of 4.52 which signifies that it is functional, reliable, usable, efficient and portable which can be implemented in Junior High School.

4. CONCLUSION

Conclusions made in this study are based on the foregoing findings, they are as follow: (1) Majority of the respondents encountered challenges on visual presentations which are limited to slides and graphic presentations; (2) The features of ARTitser can address the challenges encountered by the respondents in the traditional learning materials in terms of visual presentations, video presentations, eBooks, text books and visual aids. Using ARTitser can surely assist students in perceiving learning in a more engaging and interactive manner through the utilization of their mobile devices, specifically, iPhone or iPad running on iOS 11 or newer and powered by A9 processor or newer. (3)There was an effect on the knowledge obtained in biology course of the students after using the developed interactive module. Experiencing the 3D image of the actual object has been more interesting to them; (4) It was concluded that the usability of ARTitser is highly acceptable to all users because of its functionality, reliability, usability and efficiency.

In view of the aforesaid findings and conclusions, the subsequent recommendations are presented: (1) In the assessment module after the lesson proper, it is recommended that the future researchers add quiz type like identification and fill in the blank questionnaires to better assess the leanings of the students; (2) In the Teacher's module, it is also recommended that there be a module where the teacher can upload her desired 3D image relevant to her topic/lesson without the help of the system developer; (3) In the Lesson proper module, it is suggested that the system display multiple 3D objects on the screen simultaneously; (4) For ease of convenience to the end-users, it

is highly recommended that the application also run on Android mobile phones or tablet.

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