Mobile Augmented Reality (mAR) blended learning application in animal cells learning

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Abstract. This paper develops the Augmented Reality (mAR) mobile application by combining augmented reality with mobile learning to exploit the characteristics of both elements using a blended learning approach, augmented mobile application (mAR) is designed to teach the structure and function of animal cells by combining virtual and real environments. The main contribution of this research is to enhance students learning experiences on animal cell material.

1. Introduction
Technology has developed very rapidly and is developing in various fields including education. In the industrial era 4.0 the rapid development and change of technology has influenced most aspects of education by providing technology as a means to obtain better results. The delivery method in gaining knowledge and skills in schools experiences constant change when face-to-face interaction and advances in new technology are used. Such developments are motivated by a desire to increase student involvement, student-centred learning and improvement in student learning experiences.

One of the advancements of the latest technology that can be used as a learning resource to improve learning experiences is Augmented Reality (AR), a technology that allows users to interact with virtual objects where users feel present in a real environment on one platform [1]. The use of AR in education provides a new colour as a source of learning in schools to become a more technology-friendly environment, with greater variety of learning opportunities for students [2].

Previous studies that adopted digital learning focused on adoption as digital learning aids [3]. However, the interaction between digital learning aids and the environment, the real environment need to be considered so that students can effectively manage and combine the knowledge acquired [4]. For example, it is hoped that students can choose virtual learning objects from the learning environment using mobile as a learning aid, which enables them to gain a direct understanding of the learning environment so that, it increases their motivation and learning experience [5]. For example, use of AR in learning environment can activate or inhibit different user behaviour at the context of a learning design review [6]. AR is proven capable to support learning activities in the current era of modern technology and can be adapted to all levels of age of learners for learning media [7].

AR technology is created and can effectively operate through a combination of several other technologies. The intended combination includes wearable computing technology, location tracking, wireless communication, visual graphics, and other supporting technologies. Mobile Augmented Reality (mAR) applies AR technology in mobile devices in certain fields which makes it more detailed
[8]. Other technological support applied in such as smart phones gives more value in its operation in life and special purposes.

In addition, the presence of mobile augmented reality (mAR) is able to provide to strengthen the value of learning. The existence of this mAR environment is able to make an equal position for all users in getting learning material and new knowledge, as well as encouraging interaction with each other, giving ideas and solving problems [9]. Of course, with the application of blended learning, it provides better learning outcomes. It provides a stimulus to the activity to emerge to the audience, open to each other, and the more detailed learning material, because it also provides a visual picture and learning models and forms that are very unique and interesting [10].

Therefore, blended learning can be seen as learning that combines the best components of online learning and face-to-face learning [11]. This means that blended learning is a conversion between online learning and face-to-face learning [12]. So blended learning is defined as a combination of learning from two historically different teaching and learning models, namely between traditional learning systems (face to face) and distributed learning systems [13].

Distributed learning systems occur because of the utilization of the extraordinary potential of mobile technology and the internet, so that anyone can learn anytime and anywhere. So, it can be said that blended learning basically combines the positive aspects of two types of learning environments, namely learning in class and mAR.

On the other hand, blended learning is seen as a merger (fusion) between online learning experiences and face-to-face [14]. This definition explains that the principle of blended learning in general is integrating oral communication that occurs in face-to-face learning with written communication on online learning so that the strengths of each can be combined appropriately to achieve learning objectives [15]. In this paper presents the development of mobile application framework with the use of mobile augmented reality (mAR) to enhance student learning experiences on animal cell material.

2. Methods

Looking for new techniques and new learning methods will motivate students to obtain fun new knowledge, we developed an augmented reality application by considering the frequent use of electronic devices for students, we have suggested constructive ways to use them for animal cell educational materials.

This study developed blended learning system design model that became a reference for teachers in learning blended learning biology in animal cell material. We will propose and develop mobile augmented reality application in a blended learning environment, using an open-source framework. With the use of the proposed method for blended learning inside the classroom [16-19], we using of smart devices (tablets, smartphones). Which uses appropriate, dynamic educational material (text and video), which is extracted from on-line search engines. Therefore, we do not develop new educational material, but utilizing existing ones from other sources.

We showed that learning animal cells can be accomplished within a small-time frame when the learning process is enjoyable and interesting. Moreover, when the information obtained by the students is online and comes from Internet sources that are continually refreshed and enriched, it further increases the added value in the blended learning method.

2.1. Design principles of the application mAR

A very detailed and comprehensive process is needed when designing a mobile learning environment (MLE). There are known several principles of universal instructional design (UID) that are implemented in making mAR, including: fair in use, the existence of flexible operations, the level of tolerance in the presence of errors, and the atmosphere of the teaching climate [20].

The creation and formulation of making a content tree is a first step in carrying out an MLE design. After that, the story board will be made based on the previous content tree. This design activity must
be examined, checked and supervised in the whole process by observing various inputs by a team of experts in their fields, such as educational technology experts.

The codification process begins when the story board has been completed, especially on various mobile operating systems. Nowadays, the most popular are Android and iOS that can be developed by XAMARIN platforms [21]. The database plays an important role in the preparation of story boards that exist in the function and structure scheme. Pedagogical learning operational mechanisms are applied using expert systems approaches and blended learning. In addition, Augmented Reality as stated in the framework is always connected with various supporting application elements available on smartphones.

The technology experts will provide a feedback of each prototype that was built. Then the application is updated from every feedback input obtained. The results of the prototype that were built were shown randomly to students as users to get constructive feedback. The prototype results need to be tested, edited, improved and updated before being used until the best application format is obtained. The following figure is a description of the proposed system design process (Figure 1):

Figure 1. System design process.

Technical structure of the application focuses on the following aspects:

- The main features that use and application functions are adjusted to different environments of the Android and iOS operating systems. Each Android and iOS operating system is developed separately with the aim of getting a stable and error-free and user friendly version of the mobile application.
- Both the Android and iOS versions have the same database structure design with purpose to make it powerful to update and develop the display more easily, quickly, effectively and efficiently. Through careful design, the user interface has the dominate control when interacting with the system through a 3D virtual environment [21].
- The relationship between each element for a mobile application can be seen in Figure 2. These elements include several things including design, animal cell material, databases, and other important elements. Augmented Reality has a flexible application infrastructure design layout and it is also able to connect well with all application elements.
3. Result and discussion

In this context, there are four total phases. First prepared, second system design, third application, and Fourth Evaluation. The second phase of the entire project flow constitutes. Before that, there is a preparatory stage where all the pedagogical infrastructure needed for the project will be created. After the system design phase, the application will run using a lot of statistics to have an idea about the process. Finally, the application phase will be followed by an evaluation, mixed group discussion and an evaluation phase where students will have the responsibility to carry out an evaluation of animal cell material.

![Project flow](image)

**Figure 2. Project flow.**

Important components of applications designed by mobile augmented Reality will be another challenging factor for students. Interaction occurs in a learning environment where learning becomes fun. Blended learning-based cellular learning benefits students, there are some limitations that need to be considered. When designing learning tasks, teachers need to consider the size of the learning object from animal cells. In addition, to provide guidance and guidance to students, teachers need to spend time developing the learning process for evaluation purposes, and digital learning materials to provide comfortable learning environments for students.

4. Conclusion

Mobile augmented reality is one of the latest technologies in the field of Informatics. the world of education is one that is successful in implementing it by exploiting the characteristics of mobile learning and augmented reality we develop cellular augmented reality applications for mixed learning on animal cell subjects.

The purpose of the mobile Blended Learning Augmented Reality (mAR) model is to optimize the achievement of learning objectives. Optimization of mAR animal cells is carried out by combining face-to-face learning and online learning from the Blended Learning aspect model. The mAR model must have innovative characteristics, such as easy to use, logical and systematic so that students can experience a pleasant learning experience.
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