A Research on Integrating AR and Multimedia Technology for Teaching and Learning System Design

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Abstract Due to the great progress of information technology and the mature development of the multimedia technology, the computer and multimedia elements is involved in the learning materials. Recently, the due to the popularity of mobile devices, augmented reality development has become more sophisticated, more and more applications using augmented reality technology to attract the attention of the user or consumer. In this Paper, an interactive multimedia learning system with augmented reality technology is proposed to improve the effectiveness and efficiency of teaching and learning behavior.

1 Introduction

In these years, due to the improvement of information technology, the digitalized learning material become more popular. The computer, which including the mobile devices, and multimedia data are included in the material of teaching assistant systems. For student, the new type of teaching material not only increase the impression of the content but also enhance the learning interest and learning motivation. Furthermore, the game elements are included in the design of teaching material. The main purples of learning by game is the reinforcement of learning motivation. The students would like to play the game and learning while solving the

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problems designed in the game. Due to the population of mobile devices, they can be used as a virtual classroom in which the learning activities can be applied on. Moreover, the multimedia technology can be integrated into the mobile devices which make the student can learn anywhere anytime.

AR (Augmented Reality) technology combines the virtual 2D or 3D images with the actual shooting images. By using mobile devices and identification technology, image, text or audio-visual can be presented in front of the user. AR can be applied on many different fields such as medical, business, industry, entertainment and so on.

To design an AR application, the images should be analyzed and the corresponding 3D animation or the multimedia content will be shown on the sceen. That is, the virtual objects can be shown in the real 3D space.

In this paper, we develop a learning system for the course "General Biology Experiment" which integrate the AR and multimedia technology to enhance the effectiveness of teaching and learning.

2 Related Works

Rendering 3D objects in a VR application can be found in many applications. VisionLens develop an APP which shows the 3D model via AR technology. The 3D model can be combined with the product which will be helpful to attract the customer. There is another AR application in Japan which is used to promote a 3D cartoon. The App provides interesting interactions between the 3D cartoon characters and the users.

In UK, there is an App called Aurasma which apply the AR technology on newspapers and posters. Based on the identification and AR technology, the pictures in newspapers or posters will become videos which are easier for the reader to realize the content. In 2014, IKEA publish an APP of "IKEA Catalog" which applies the AR technology to put the 3D model of the product in a real environment such that the customer will image the situation after buying the product and put in a real environment. In addition to the commercial usage of AR technology, some researchers focus on different types of AR applications such as interactive tennis game [3], a desktop card game [6], Chinese phonetic alphabet learning materials, nine planets teaching system [5] and so on [1, 2, 4].

Since the AR technology can be used to combine the virtual information with the real environment, it can be used in various domain such as learning system. It can help the students to "virtual practice" by using the mobile device without go to the real classroom.

3 The Design of AR Integrated Multimedia Learning System

In this paper, a teaching and learning system with three steps for the course "General Biology Experiment" is proposed. Through the system, students can learn from the multimedia based learning material before the class. Moreover, they can interact with the applications including AR applications designed in the system to understand the detailed information of the experiments. At last, when the students actually experiment in the classroom, the system will provide some guideline for them to complete the experiment correctly. The system architecture of the proposed approach is shown as follows (Fig. 1).

3.1 Development of Learning System Based on AR and Multimedia Technologies

In this section, we focus on how the biological experiment teaching activities with AR technology and multimedia content can help students' learning. Different topic of the course may need different way to integrate the multimedia content. Table 1 shows the topic of the course "General Biology Experiment." In this section, we develop a multimedia assistant learning system including the interactive multimedia and AR applications corresponding to different topics.

3.1.1 The Establishment of the Virtual Learning Objects

For each course unit of "General Biology Experiment," we have to find the appropriate way to interactive with the students. Moreover, we will design the
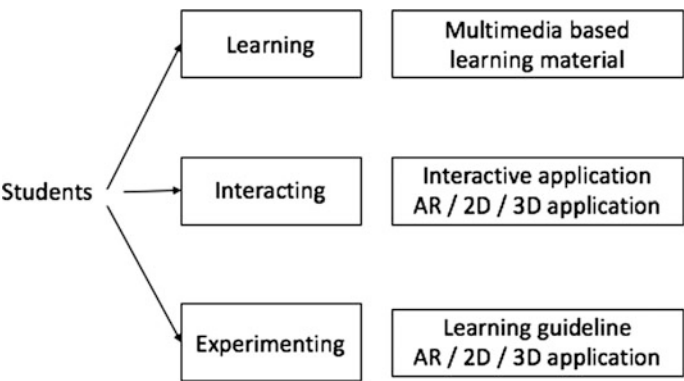

Fig. 1 The architecture of the 3 step learning system

Table 1 Course content of "General Biology Experiment"

Course content
DNA model
Microscope: animal and plant cell
Microbial culture
Bacteria stain and counting
Experimental observation of pool plankton pool
Experimental observation of fungi and lichens
Vegetative organs of angiosperms
Observed linear animals—and roundworm C. elegans
Observed annelid—earthworms and Nereid
Fish bones taxidermy
Frog anatomy and bone taxidermy
Fermentation
The plant cell mitosis
Water quality and freshwater biological field survey
Meiosis of plants
Coevolution of plants and insects
Purification of bacterial DNA
Electrophoretic analysis of DNA
Photosynthesis and plant pigment analysis
ELISA

2D/3D virtual objects which can be used in the multimedia and AR learning applications.

For example, in the course unit "Microscope: Animal and Plant Cell," we design a 3D virtual object of microscope for student to observe and understand the usage and function of microscope before they use it in the real classroom. Moreover, with AR technology, when students hold a mobile device and facing the microscope in the classroom, a 3D microscope with explanations will be shown in the screen. The students can rotate or move 3D objects to observe and learn the structure of microscope. In addition, each part of the microscope can also be separated to provide more detailed instructions. Unlike ordinary textbooks with static 2D images, the students' learning interest may be enhanced by using the 3D dynamic objects. Moreover, since the 3D objects can be manipulated by students, the students' learning effectiveness may be also improved.

Furthermore, for the course unit of "Frog anatomy and bone taxidermy." 2D virtual objects are designed and integrated in the system for student to learn the structure of frog bone taxidermy before the class. Moreover, we create 3D virtual objects using AR technology to allow students to learn more with the detailed description of each structure in the real classroom.

3.1.2 The Design of the Identification Patterns

In AR applications, the design of identification pattern will affect the timing of AR object appears. It becomes an important research issue to design an appropriate identification pattern which can fit the real environment. In this section, the identification patterns are designed based on the real class environment or the characteristics of the topics. The designed patterns are used in the AR applications to invoke the 3D virtual objects in the screen while the students learning by using the application.

3.2 The Development of AR Integrated Multimedia Learning System

This section focus on how the teaching activities of the course "General Biology Experiment" with the multimedia integrated application can be used to enhance the students' learning effectiveness. Since there are different characteristics for different course topics, we design different multimedia interaction applications for each topic. The interaction style for each course topic is shown in the following table.

The multimedia based teaching and learning system integrates different interaction styles for different topics in which the student can learn the content by himself before the class and also can learn the content during the class (Table 2).

Table 2 Interaction style of each course topic

Course content	Interaction Style
DNA model	AR with 3D objects
Microscope: animal and plant cell	AR with 3D objects
Microbial culture	Interactive 2D applications
Bacteria stain and counting	Interactive 2D applications
Experimental observation of pool plankton pool	Video with 2D animation
Experimental observation of fungi and lichens	
Vegetative organs of angiosperms	Interactive 2D applications
Observed linear animals—and roundworm C. elegans	Video with 2D animation
Observed annelid—earthworms and Nereid	
Fish bones taxidermy	AR with 3D objects
	Interactive 2D applications
Frog anatomy and bone taxidermy	AR with 3D objects
	Interactive 2D applications
Fermentation	Video with 2D animation

(continued)

Table 2 (continued)

Course content	Interaction Style
The plant cell mitosis	Video with 2D animation Interactive 2D applications
Water quality and freshwater biological field survey	Video with 2D animation
Meiosis of plants	Video with 2D animation
	Interactive 2D applications
Coevolution of plants and insects	Video with 2D animation
Purification of bacterial DNA	Video with 2D animation
Electrophoretic analysis of DNA	
Photosynthesis and plant pigment analysis	Video with 2D animation
ELISA	Video with 2D animation

4 Experimental Results

The proposed system is used in the classes of Asia University to help the students to learn the course "General Biology Experiment." 100% students indicate that the proposed system is interesting and would like to use it while learning the course. Although more than 80% students indicate that the proposed system is helpful while they learn the course, but more than 60% students indicate that they learn more in the real class. It is acceptable since the virtual objects is used in the proposed system which are differ from the real objects the students used in real class. The experimental results shows that the proposed system is helpful while the student learn the course. However, it can also be improved to integrate more learning activities such that the student can interact and practice with the system and learn something which may not be obtained easily in the real class.

5 Conclusions

Due to the great progress of information technology and the mature development of the multimedia technology, the computer and multimedia elements is involved in the learning materials. Recently, the due to the popularity of mobile devices, augmented reality development has become more sophisticated, more and more applications using augmented reality technology to attract the attention of the user or consumer. In this Paper, an interactive multimedia learning system with AR technology is proposed to improve the effectiveness and efficiency of teaching and learning behavior. The experimental results shows that the proposed system is helpful while students learn the course. We will improve the proposed system by integrate more learning activities to enhance the learning effectiveness of the students.

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