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The Application of Augmented Reality Technology on Gear Instructional Module for Indigenous Culture

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Abstract

The problem of educational resources and urban/rural learning achievement for indigenous students living in remote areas has become significant. Some scholars proposed that the teaching material based on indigenous culture can improve the learning performance. In addition, indigenous students prefer using the senses to help learning, especially dynamic, visual image, informal, and lively learning methods. Augmented reality (AR) is a technique for visual sensation of virtual objects combined with the real environment, using image processing technology to interact with virtual objects, also allowing users to blend into a situational virtual reality. It has been comprehensively applied to various fields, and its importance has also been recognized in education. To motivate the learning interest, this study developed the gear instructional module using AR. The trial teaching and observational records from the instructional activity were used to show that the developed module can promote the learning interest and the learning motivation.

Keywords

Indigenous Culture; Scientific Education; Augmented Reality; Interactive Instruction

Introduction

After the trend of thought of multiple cultures, global indigenous education is in better environment, in comparison to the past. However, the academic gap with mainstream groups still exists (Beavon, 2009). Taiwan encounters the same situation in educational environment (Kuo, 2001). As to courses and instruction, Tan (2011) suggested that courses and instruction in schools spread culture and values of mainstream groups. Thus, indigenous students are less advantageous in academic achievement. Due to cultural asset difference of education, social , economic backgrounds and they have inferior factors of learning.

From the perspective of science, science is originated from human beings' lives and part of human beings' life culture. Different cultural groups have unique world view and form the methods and theories to explore natural knowledge. Many examples show the difference between western scientific knowledge and indigenous culture. For instance, as to the explanation on scientific terms, children of different cultures are extremely different, although they use the same official language (Allen & Seumptewa, 1993). In traditional indigenous culture of Taiwan, judgment on life phenomenon is different from biological science. Many studies have demonstrated that science knowledge and technology knowledge development is influenced by cultural backgrounds and it reflects the society, religion, economy and environment. Introduction of local culture in instruction will enhance the development of science knowledge and technology knowledge.

Besides introduction of indigenous culture in instruction, customized teaching materials can be designed according to indigenous characteristics. Some research suggested that indigenous students prefer learning by senses, particularly dynamic, visual, informal and interesting learning (Tang, Liu, & You, 2008). Thus, by replacing traditional rigid instructional methods by interactive teaching materials, students will be more involved in science concepts instructed in teaching materials and be interested in science.

Currently, there are the digital teaching materials upon indigenous culture and mice and keyboards are usually the computer interactive tools. However, according to some medical study, long-term use of mice and keyboards by improper postures might cause physical burden (Karlqvist, Hagberg, & Selin, 1994). If the problem is solved, the usefulness of digital teaching materials can be enhanced. Augmented reality is the technique which combines reality and virtual world. Many studies suggested that the

application of augmented reality in education will enhance students' learning motivation and learning interest (Mark, 2001). In addition, augmented reality technique can transform digital teaching materials into sensory and interactive ones. It is expected to solve the problems with mice and keyboards and increase learning motivation and learning interest.

This study used unit of gear wheel of Nature and Life Technology of elementary school as an example, applied augmented reality in indigenous learning characteristics and virtual environment of Atayal legend of sun shooting, developed and designed interactive gear wheel instruction module upon indigenous culture. By analysis of pretest, posttest and questionnaire, with the aims to enhance indigenous students' learning motivation and scientific cognition.

Research Design

Research Subjects

In order to explore indigenous students' learning motivation and cognition change on interactive teaching materials, 40 students of Yi-Lan Perng-Lai Elementary School were treated as subjects in this paper.

Experimental Design

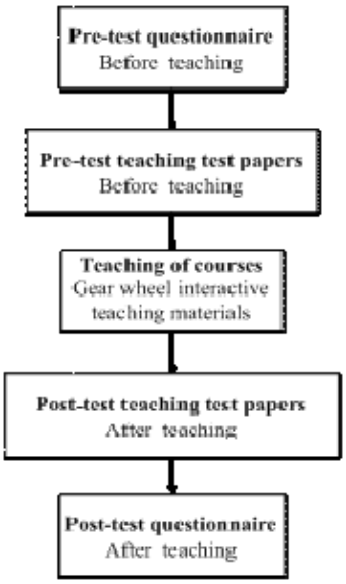

FIG. 1 RESEARCH PROCESS

Research process is shown in Figure 1. Before the instruction, students filled in questionnaires and tests in order to show their learning motivation and cognition of gear wheel concepts. After the instruction of interactive teaching materials, by tests and questionnaires, this study explored their learning motivation and change of cognition.

Design of Teaching Materials

This study designed teaching materials of indigenous culture regarding unit of gear wheel of dynamical machine. By augmented reality, students could interact with virtual gear wheel and enhance concept of gear wheel. The students were mostly Atayal. Thus, this study included Atayal mythology "legend of sun shooting" in teaching materials of gear wheel in order to allow students to be involved in teaching materials and increase learning motivation. Besides indigenous culture, this study designed interactive instruction by indigenous characteristics. Students interacted with virtual objects in video camera and learn the concept of gear wheel. In unit of gear wheel based on Atayal legend of sun shooting, students touched virtual gear wheel, control movement and shooting of bow and arrow and shoot the sun. Large and little gear wheels triggered another gear wheel in order to control movement of bow and arrow and it showed that the size of gear wheel will influence the movement speed of bow and arrow,as shown in Fig 2.

FIG. 2 INTERFACE OF TEACHING MATERIALS

Design of bow and arrow was based on concept of gear wheel. Movement of the bow and arrow designed was observed by three gear wheels in mesh. Thus, students found that rotation of pair gear wheels are in opposition directions, when gear wheel (1) turned clockwise, gear wheel (2) will turn anticlockwise. Thus, bow and arrow moved to the left. By the characteristic of gear wheel, students can ponder on the concept of gear wheel in the games.

Research Tools

Besides courses and teaching materials, in order to explore students' change of academic cognition and learning motivation after interactive instruction, this study designed pretest, posttest and questionnaire. The purpose of tests was to find if students' scientific cognition of gear wheel is increased after the instruction. By questionnaires, the researcher analyzed the change of students' learning motivation and learning desire. In addition, by Cronbach method, reliability of questionnaire was tested as well.

Results and Discussion

Analysis of Tests

By SAS, this study analyzed the figures. According to test grades before and after instruction, the researcher tried to find if students' cognition of gear wheel course is enhanced after interactive instruction. The test was based on Paired-Samples T Test in statistical method. Based on the result of grades in Table 1, P value of posttest grades of gear wheel—pretest grades of gear wheel was below 0.01. Thus, grades of gear wheel course before and after instruction were significantly different.

TABLE 1 RESULT OF GRADES

Items	t value	Pr > |t|
Posttest grade of gear wheel instruction—Pretest grade of gear wheel instruction	6.08	<.0001**

Note:*denotes<0.05, **denotes<0.01

Table 2 is statistics of students' grades before and after interactive instruction. According to the table, before the instruction, students' average grade was 64.75. After the instruction, their average grade was increased to 88.9. In other words, after the instruction of unit of gear wheel, students' average grade has increased by 24, meaning that after instruction, students' concept of gear wheel is significantly enhanced.

TABLE 2 STATISTICS OF GRADES

	Before instruction	After instruction
Average grade	64.75	88.9
Standard deviation	23.977854	15.734993

By grade box plot in Fig 3, the researcher analyzed students' learning in unit of gear wheel. In unit of gear wheel, students with average grades 25~75% had grades as 50~80. After instruction, students with average grades 25~75% had grades as 79~100, indicating that after instruction, their grades are increased. Thus, students' absorption and comprehension of content in unit of gear wheel was satisfying.

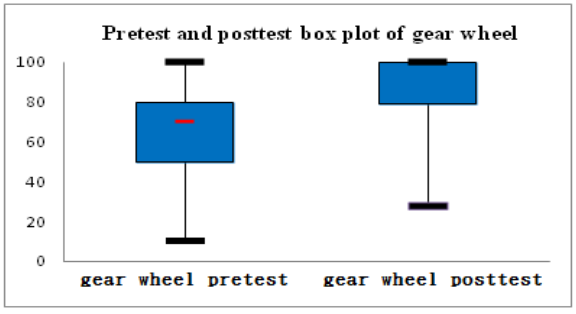

FIG. 3 BOX PLOT OF GRADES

Questionnaire Analysis

The questionnaire included 8 items. Questionnaire analysis was divided into two parts: 2 items for learning motivation and 6 items for learning desire. Total scores are 10 and 30. According to Table 3, P values of indigenous students' learning motivation and learning desire were 0.0236 and 0.0486 < α=0.05(* in the table). Thus, indigenous students' learning motivation and learning desire were significantly different before and after instruction.

TABLE 3 TEST RESULT OF LEARNING DIMENSIONS BEFORE AND AFTER INSTRUCTION

Items	t	Pr > |t|
Learning motivation after instruction --learning motivation before instruction	2.36	0.0236*
Learning desire after instruction -- learning desire before instruction	2.03	0.0486*

Note:*denotes<0.05, **denotes<0.01

According to Table 4, indigenous students' average total grade of learning motivation before instruction was 7.5. After instruction, average total grade of learning motivation was increased to 8.4. In other words, after instruction, average total grade of learning motivation was increased by 0.9. Thus, after instruction, students' learning motivation was enhanced.

TABLE 4 STATISTICS OF LEARNING MOTIVATION QUESTIONNAIRE

	Total in average	Standard deviation
Learning motivation average before instruction	7.5	2.66
Learning motivation average after instruction	8.4	2.41

According to Table 5, indigenous students' average total grade of learning desire before instruction was 22.4. After instruction, their average total grade of learning motivation was increased to 24.1. In other words, after instruction, students' average total grade of learning motivation was increased by 1.7, implying that after instruction, students' learning desire is enhanced.

TABLE 5 STATISTICS OF LEARNING DESIRE QUESTIONNAIRE

	Total in average	Standard deviation
Learning desire average before instruction	22.4	5.47
Learning desire average after instruction	24.1	5.70

Reliability of questionnaire was based on Cronbach. When alpha was lower than 0.35, it is low reliability.

Reliability of data was acceptable with Cronbach at least 0.7. According to Table 6, Alpha of pretest and posttest of learning motivation and learning desire were at least 0.7. In other words, reliability of the questionnaire was acceptable. Validity of questionnaire was based on and guaranteed by content validity.

TABLE 6 ALPHA COEFFICIENTS OF CRONBACH

	Alpha
Learning motivation of instruction pretest	0.887943
Learning motivation of instruction posttest	0.960708
Learning desire of instruction pretest	0.821822
Learning desire of instruction posttest	0.805309

Conclusions

This study used teaching material of gear wheel in Nature and Life Technology of elementary school as an example. Augmented reality was applied to virtual environment upon indigenous learning characteristics and Atayal legend of sun shooting; and then developed and designed interactive gear wheel instruction module by indigenous culture. Through pretest, posttest and paired-samples t test, a significant difference of students' grades was revealed after instruction. According to box plot of grades, after instruction, the grades were increased, confirming that students' absorption and comprehension of content of interactive unit of gear wheel are satisfying. Based on questionnaire analysis, students' learning motivation and learning desire were positively enhanced.

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