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A Study on the Use of Information Technology to Enhance High School Students' Science Learning

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Abstract. The major purpose of this study was to investigate the learning outcomes of using information technology in high school students' science learning. A total of 31 high school students participated in this study. During the teaching and learning processes, students were guided to explore the topics of information technology and Earth science, with students instructed to operate a 3D imaging technology system in their Earth science learning. This study searched both quantitative and qualitative data as the sources for the analyses. A research instrument was used, namely a learning questionnaire (four-point Likert-type scale), to gather students' feedback on using information technology and the 3D imaging technology system. In addition, a rubric was used to evaluate the students' mineral and rock projects. The data underwent frequency and t-tests, and indicated that the integration of information technology into Earth science learning promotes students' learning outcomes. According to the rubric assessment results, the presentation of minerals and rocks in the students' projects fully represented the students' understanding of minerals and rocks and showed how they had introduced 3D photographic techniques into their projects. Therefore, it can be concluded that the teaching and application of 3D photography is beneficial for improving Earth science learning and the information technology literacy of high school students.

Keywords: earth science, educational technology, information technology, science learning

1. Introduction

In secondary education in Taiwan, the instruction of Earth science is generally included in the science and technology curriculum and is compulsory for all high school students. King (2008) pointed out that Earth science education focuses on cultivating learners' understanding of the Earth's materials, the effects of the Earth's activities, and the structure of the Earth, etc. Dal (2009) further pointed out the core content of Earth science education should, primarily, contain discussions on the following themes: (1) the structure of the Earth, (2) the dynamic evolutionary mechanism of every Earth shell, (3) the role and the movement of the Earth in the planetary system, and (4) organisms on Earth.

However, many researchers have discovered students have several misconceptions about Earth science. These include: (1) misconceptions about minerals, rocks, and fossils

(Dal, 2009; Dove, 1997, 1998; Ford, 2005; Kusnick, 2002; Sharp, Mackintosh, & Seedhouse, 1995); (2) misconceptions about geological processes and time (Dal, 2005, 2007, 2009; Trend, 1998, 2000, 2001; Zen, 2001); and (3) misconceptions about earthquakes, plate tectonics, and the structure of the Earth (Barrow & Haskins, 1996; Kali & Orion, 1996; Marques & Thompson, 1997; Rutin & Sofer, 2007; Sneider & Ohadi, 1998). Students in Taiwan also have misconceptions about Earth science (Chen & Hsiao, 2013; Chiu, Hou, & Tang, 1997; Jiang, 1993, 1997; Lai, 2010, 2015a; Lai & Wu, 2005). Therefore, a major teaching issue is how to use proper teaching strategies to correct the students' misconceptions, and establish the correct understanding about Earth science for high school students.

To improve the students' learning regarding the concepts of the different aspects of Earth science, and reduce their misconceptions, many researchers have proposed different teaching methods and strategies, and such teaching has demonstrated good results (Allison, 2005; Bereki, 2000; Gibson, 2001; Kali, Orion, & Eylon, 2003; Lai, 2010, 2015a; Semken & Freeman, 2008; Veal & Chandler, 2008; Wellner, 1997).

Educational technology has grown rapidly in tandem with contributions and support from information and internet technologies. Ho (2012) indicated that the impact of information and network technologies on education is very profound, and that teaching and learning were significantly affected by these changes. Ho (2012) further emphasized that the instructional use of new information and internet technologies should include not only diverse teaching methods, but also increasing teacher/student interaction and new ways of learning. Huang (2013) also indicated that primary and secondary school students' information technology literacy will be better prepared by information courses and by teachers who apply information technology in their teaching methods. Many researchers found that information technology has the potential to improve students' learning, Lai (2014) pointed out that knowing how to integrate information technology into education is the key to promoting students' learning. As the production cost of the 3D image has been greatly reduced due to the progress of technology, more and more people are willing to use 3D image production and application (Lai, 2015b; Lan & Chung, 2008). In addition, Lai (2014, 2015b) found that 3D photography was beneficial for improving students' learning with regards to course content and information technology literacy.

Since information technology has the potential to improve students' learning, this study attempted to integrate 3D photography into high school students' learning of Earth sciences. Therefore, the major purpose of this study was to investigate the learning outcomes when using information technology in high school students' science learning.

2. Methodology

The teaching activities of the teacher included instructing the students to explore topics related to Earth science and information technologies, and to operate a stereoscopic image technology system (3D photographic equipment) to display the characters of different minerals and rocks. The 3D photographic equipment used in this study included 3D scanners, digital cameras, and personal computers. During the filming, using an integration of 3D software, filmed images were immediately synthesized into 3D images. The obtained 3D images were then stored as different image formats, which could then be conveniently used in the post-production of a minerals and rocks project.

2.1. Target group

In total, 31 high school students participated in this study.

2.2 Methods of Inquiry

This study searched both quantitative and qualitative data as the sources for the analyses. This study also explored students' learning performances in information technology and how they incorporated it into their Earth science learning. The discussion emphasized students' 3D photography learning feedback and their minerals and rocks projects. The research evaluation included a rubric for students' minerals and rocks projects, feedback from the teacher, and learning feedback from the students. First, the rubric for the minerals and rocks project was used to assess students' learning performances regarding 3D information technology. The assessment focused on the quality of the 3D animation produced in the students' projects. Second, the feedback from the teacher was used to understand the teacher's teaching and feedback regarding the use of 3D photography, and students' learning performances related to information technology. Finally, with respect to the learning feedback from the students, based on the evaluation model of Kirkpatrick and Kirkpatrick (2007), this study adopted a learning questionnaire (four-point Likert-type scale). As the basis for the analyses, the learning questionnaire asked eight questions in order to collect students' feedback on the operation of 3D photography. The Cronbach's α reliability for the eight items of the learning questionnaire was .83, showing that the research instrument had good reliability. The validity of the research instrument was examined by three science educators, and it was confirmed that the research instrument had good validity.

3. Research Findings

3.1. Students' Performances in the Minerals and Rocks Project

The students who took part in the study were divided into groups, each with two to three students, to carry out 3D photography technology learning and production. After finishing the 3D image editing, they further compiled the mineral and rock content, and carried out a minerals and rocks project. A total of 31 students completed 14 3D minerals and rocks projects. Then, the teacher used the rubric and evaluated the students' projects based on the qualities of their 3D animation, the correctness with regards to the minerals and rocks, and originality.

According to the assessment results, with respect to the content of the students' minerals and rocks projects, all 14 projects fully displayed the special effects of 3D animation. The presentation of the 3D images of minerals and rocks, the composition of the pictures, the textures and colors, and the 3D animation fully displayed the delicate effect of the 3D images. In general the entire project on minerals and rocks was presented delicately and exquisitely with the use of the 3D effects and had rich information about the characteristics of minerals and rocks. All students had made an effort to emphasize the uniqueness and beauty of the minerals and rocks so as to draw the attention of the viewers. It is revealed that the presentation of minerals and rocks in the students' projects fully represents the students' understanding of minerals and rocks and how they introduced 3D photographic techniques into their projects.

3.2. Students' Feedback on the Application of 3D Photography

After the high school students had completed the 3D photography technology learning and their minerals and rocks projects, this study carried out an investigation using a learning questionnaire. A total of 31 high school students gave effective answers. The background of these high school students consist of 9 males and 22 females. The summary of the results for the students' learning questionnaires is shown in Table 1.

Table 1: Summary of the results of learning questionnaire on 3D photography (N = 31)

Item	Strongly agree		Agree		Disagree		Strongly disagree	
	N	%	N	%	N	%	N	%
1	11	35.5	16	51.6	4	12.9	0	0
2	7	22.6	24	77.4	0	0	0	0
3	15	48.4	16	51.6	0	0	0	0
4	19	61.3	12	38.7	0	0	0	0
5	21	67.7	10	32.3	0	0	0	0
6	15	48.4	16	51.6	0	0	0	0
7	17	54.8	14	45.0	0	0	0	0
8	12	38.7	18	58.1	1	3.2	0	0

According to Table 1, the results from the learning questionnaire are as follows: (1) 87.1% of the students indicated that 3D photography was easy to operate while 12.9% of the students indicated that they disagreed; (2) 100% of the students indicated the functions of the 3D photography were sufficient for use; (3) 100% of the students indicated that 3D photography was charming; (4) 100% of the students indicated that 3D photography could help increase students' comprehension of Earth science content; (5) 100% of the students indicated that 3D photography could help students conduct Earth science experiment exploration; (6) 100% of the students indicated that they loved to apply the 3D photography in their Earth science learning; (7) 100% of the students indicated that, after using 3D photography, they were willing to use the technique in other learning activities. Finally, overall, 96.8% of the students indicated that they loved producing and using 3D photography, while 3.2% of the students indicated that they disagreed.

In addition, in order to find out if there was any difference between boys and girls with regards to 3D photography and Earth science learning, a t-test was performed. The results from the t-test indicated that there was no difference between boys and girls for 3D photography and Earth science learning ($t=.629$, $p=.534$). The results showed that both boys and girls had the same positive opinions of 3D photography learning and Earth science learning.

The study results showed that high school students highly praised the qualities and functions of 3D photography, indicating that the students agreed that 3D photography could help students with their learning. Finally, overall, 96.8% of the high school students indicated that they liked producing and using 3D photography. This means that a large proportion of the students approved of the introduction and use of 3D photography in Earth science learning.

3.3. Teaching Feedback

In addition to discussing the learning feedback from the students, this study also used a teaching feedback questionnaire to collect the teacher's opinions with regards to teaching Earth science and 3D photography. According to the results of the teaching feedback questionnaire, the teacher indicated, "hands-on learning activities can really stimulate students' learning motivation and also reduce the cost of mineral and rock hand specimens." Secondly, with respect to the benefits of 3D photography for the students, the teacher further pointed out, "3D images could provide more opportunities for students when practicing and producing minerals and rocks projects. Meanwhile, interactive mediums and 3D photography can provide students with experience and enhance their creativity." Finally, the teacher stated, "In general, the learning and teaching of 3D photography is quite simple and easy, but the time spent on filming can be too long and this would usually mean the post-production time is insufficient.

Fortunately, students didn't mind spending extra time after class to complete their minerals and rocks project." To summarize the teaching feedback from the teacher, the teacher positively confirmed the 3D photography teaching and the students' learning effects. This suggests that the feedback from the teacher is consistent with that of the students, indicating that both the teacher and the students support and approve the application of 3D photography in the teaching and learning of Earth science and information technology.

4. Conclusion

As 3D images are more and more commonly used in educational settings, when we are promoting students' learning, efforts should be made to find ways to improve the application abilities of 3D technology for students, enabling them to strengthen their knowledge of information technology. This study applied 3D photography to Earth science learning activities, and discovered that most of the participating students had a clear understanding of the functions of 3D photography, and were satisfied with using 3D photography in their Earth science learning. Evaluation of the minerals and rocks projects of these students demonstrated that most of them were able to properly use 3D animation skills to enrich the presentation of the characteristics of the minerals and rocks. The learning feedback from the students indicated that 3D photography met the requirements and expectations of high school students. They highly approved and supported the fact that 3D photography can enrich their learning of Earth science, and promote the demonstration of minerals and rocks. They were willing to apply this technology to other subjects. To summarize, this study believes that the teaching and application of 3D photography is actually beneficial for improving Earth science learning and the information technology literacy of high school students.

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