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Drawing-based learning using imagination in science class

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Abstract: In science education, researchers and educators have highlighted the significance of scientific imagination. However, little literature has been done on exploring the influence of using imagination in drawing-based scientific explanation on learning science. Hence, this follow-up study designed a drawing-based scientific explanation activity using imagination and investigated the impacts of scientific imagination on students' conceptions of learning science. The results showed that compared with the findings of our previous study, the drawing-based scientific explanation using imagination demonstrated significant effects on students' conceptions of learning science.

Keywords: Conceptions of learning science, scientific explanation, Tablet computers, drawing

1. Introduction

Didactic instruction results in passive learning science in which students acquire science knowledge by memorizing or reciting scientific concepts and definitions. Such a phenomenon may demotivate students to learn science and students may adopt surface strategies to learn science (Bell & Linn, 2000). To cope with the problem, constructing scientific explanation may be a potential approach to improving students' conceptions of learning science (Bell & Linn, 2000; Tsai, 2004). This may be because students have to apply and connect scientific knowledge they acquired with scientific evidences instead of merely memorizing and rote learning (McNeil et al., 2006). Hence, such a constructing process may prompt students to apply deep approaches to acquiring meaningful understanding.

Scientific explanation is beyond description of a phenomenon, and should provide logical reasoning between claims and scientific evidences (McNeill et al., 2006). Although previous studies have designed various instructions to help students construct scientific explanations, different instructions may lead to different influences on students' science learning. In particular, the nature of scientific question designed by previous studies mainly focused on specific questions about an existing fact or a scientific concept. For example, whether fat and soap are the same or different substance (McNeil et al., 2006). Although such a conventional question enhances students' understanding of scientific concepts, students may be hardly motivated further apply knowledge they have learned to solve or explore a new scientific question.

Several studies indicated that scientific imagination plays a vital role in science education (De & De, 2010; Hadzigeorgiou, 2012), because scientific imagination may trigger learners' intrinsic motivation and learners may gradually reconstruct knowledge to solve a new problem. However, how such scientific imagination is designed in scientific explanation activity and what such scientific imagination may influence students' conceptions of learning science are still scant.

Hence, this study attempts to design a drawing-based scientific explanation activity using imagination and conducts a pilot experiment to investigate the effect of such activity on students' conceptions of learning science.

2. Method

2.1 Participants and procedure

This study is a follow-up study of our previous work (Chang & Liu, 2015). The participants in this study were in their first year of a private senior high school in Taiwan. 18 participants were females and 24 males. Before the activity, the participants were asked to fill out a questionnaire. The researcher demonstrated how to use the drawing tool and each student practiced using the drawing tool for 30 minutes. Then, a scientific question was assigned and the participants were asked to construct logical scientific explanation independently. Before and after the 100-minute activity, the participants were also asked to fill out the questionnaire.

2.2 The imagination-based POE activity

An imaginative scientific question was designed to motivate students' scientific imagination. The question was "Would there be four seasons in Taiwan if the axis of the earth did not tilt?" The purpose of the question is to enable students to apply prior knowledge to solve a new problem. To guide the students in how to construct scientific explanation, the Prediction-Observation-Explanation (POE) model (White & Gunstone, 1992) was used in the drawing-based explanation activity. Firstly, the students were asked to write down individual prediction according to the question and logically explain their reasons. Next, they were allowed to observe the animated simulation, and to collect appropriate data as scientific evidence. Finally, they had to logically generate the relationship between previous prediction and the collected evidence.

A drawing tool, which is developed by Liu et al. (2011), was used in this study to support students construct scientific explanations using multiple representations, including text, drawing, and vocal narrations. The tool was mainly used to be an analysis tool which displayed the construction process of scientific explanations (Fig. 1).

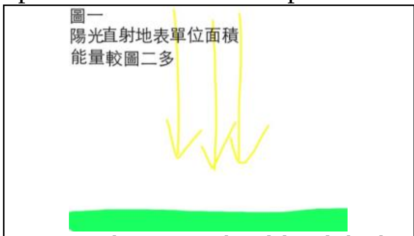
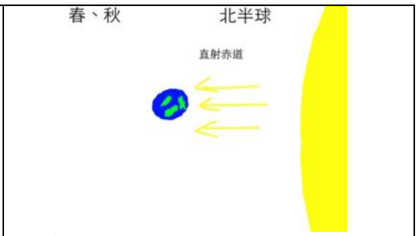
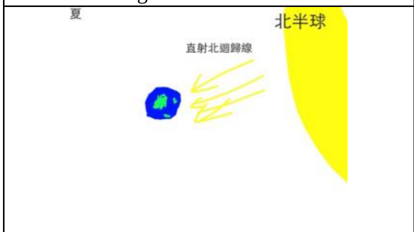
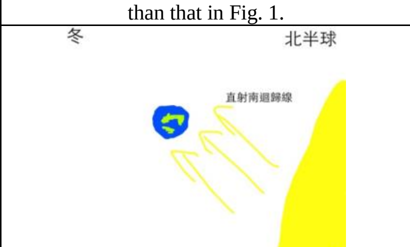
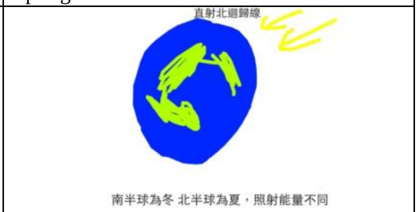
Figure 1. The unit area shined directly by the sun. The received energy in Fig. 1 is more than that in Fig. 2.	Figure 2. The unit area shined obliquely by the sun. The received energy in Fig. 2 is less than that in Fig. 1.	As far as northern hemisphere is concerned, the sun shined on the equator directly in spring and fall.
As far as norther hemisphere is concerned, the sun shined on the tropic of Cancer in summer.	As far as northern hemisphere is concerned, the sun shined on the tropic of Capricorn in winter.	When the sun shined on the tropic of Cancer, due to the different energy recceived, the northern hemisphere is in summer while the southern hemisphere in winter.

Figure 1. An example of construction process of a students' scientific explanation

The Conceptions of Learning Science (COLS) questionnaire, developed by Lee et al. (2008), was used to obtain the students' conceptions of learning science before and after the activity. The COLS questionnaire was presented in a five-point Likert scale, which consisted of seven dimensions, including memorizing, testing, calculating and practicing, obtaining knowledge, applying, understanding, and seeing in a new way. A paired-t test was used to understand the influences of the drawing-based scientific explanation on the students' COLS.

3. Results and Discussion

Table 1 showed that the result of the students' pre-and-post questionnaires. Compared with the pre-questionnaire, the participants had a lower extent of perceiving using memorizing ($t=3.96$, $p<.001$), testing ($t=4.82$, $p<.001$), and calculating and practicing ($t=4.20$, $p< .001$), and held higher level perceptions of using applying ($t=-2.22$, $p<.05$) in the post-questionnaire. The possible explanation was that, instead of memorizing scientific definitions or knowledge, the participants had to not only organize scientific evidences they collected but further reason and articulate what they have learned with collected evidence to solve a scientific question. During construction process, students must accommodate or assimilate their existing scientific knowledge when they encounter conflict between their predictions and observations. Such conflict may facilitate students' reflection on and reconstruction of their scientific knowledge (Piaget & Vonèche, 2007). It is suggested that the drawing-based scientific explanation activity using imagination may be effective to improve the participants' conceptions of learning science.

Table 1: The results of students' conceptions of learning science before and after the activity

COLS	Stage	N	Mean	S.D.	t-value	p-value
Memorizing	Pre	42	3.35	.68	3.96	.000***
	Post	42	2.89	.73		
Testing	Pre	42	3.11	.86	4.82	.000***
	Post	42	2.55	.88		
Calculating and practicing	Pre	42	2.82	.74	4.20	.000***
	Post	42	2.37	.74		
Increase of knowledge	Pre	42	3.92	.72	-.51	.612
	Post	42	3.97	.60		
Applying	Pre	42	3.42	.67	-2.22	.032*
	Post	42	3.64	.71		
Understanding	Pre	42	3.66	.64	-.831	.411
	Post	42	3.73	.49		
Seeing in a new way	Pre	42	3.93	.66	-8.14	.421
	Post	42	4.00	.67		

*<.05 **<.01 ***<.001

4. Conclusion

The purpose of this study is to investigate the effect of the drawing-based explanation activity using imagination on students' conceptions of learning science. The results showed that compared with the results of our previous study, the activity resulted in the different influences on students' conceptions of learning science. More specifically, this study found that such activity using imagination not only improved the students' stereotypical conceptions of learning science, such as using memorizing, practicing and the test-to-learn concepts to learn science, but also enhanced a higher level of using applying to learn science. Due to the limitation of scope of sample in a pilot study, the findings in this study may not be overgeneralized.

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