Exploring the effect of online collaborative learning on students' scientific understanding

Pei-Jung Li, National Chengchi University, Taiwan, 97102006@nccu.edu.tw
Chih-Hsuan Chang, National Center University, Taiwan, 99152005@nccu.edu.tw
Huang-Yao Hong, National Chengchi University, Taiwan, hyhong@nccu.edu.tw

Abstract: This study explored the impact of online collaborative learning on students' understanding of the nature of scientific theory. The participants consist of 52 college students who attended a course titled "Introduction to Nature Science". Data sources came from (1) a pre-post survey that assesses students' understanding of the nature of scientific theory, and (2) students' online interactions. Findings indicate that after engaging in online collaborative learning for a semester, students demonstrated a more informed understanding of the nature of scientific theory.

Introduction

We are entering into a technology-rich and knowledge-based age, in which education is expected to help learners develop more creative and adaptive skills. Gloor (2006) mentioned that many creative endeavors are not personal achievements, but the result of collaborative knowledge construction. Against such a background, how teachers can help foster students' capacity for more collaborative learning becomes an important learning challenge. To this end, in this study, we employ "knowledge building pedagogy" as an instructional approach (Scardamalia & Bereiter, 2006), to transform students' learning experiences in a course that aimed to improve students' understanding of nature of scientific theory.

Literature review

Nature of science

Studies have pointed out that helping students enhance their understanding of the nature of scientific theory is important. In general, there are two views of nature of scientific theory. Table 1 shows some different, selected features between the traditional and modern views of nature of scientific theory.

Table 1. Two views of nature of scientific theory.

	Traditional objectivist view	Modern constructivist-interpretivist view
Nature of scientific theory	1. Theories are based on observation. 2. New theories can improve old theories, because observations can improve and increase over time. 3. An entire theory is falsified if subject to a single contradictory fact. 4. A theory is a hypothesis that has been proven to be correct. 5. Old theories are of no use to scientists.	1. Observations are theory laden. 2. Theories are invented by scientists. 3. Theories are used to describe, explain, and predict scientific phenomena. 4. Theories are conformed by certain paradigms. 5. Observations are influenced by social factors.

Revised from Palmquist and Finley (1997)

Knowledge building

In this research, we use knowledge building pedagogy instead of textbook-based instruction to facilitate students to engage in reasoning about, understanding of, and improving scientific theories. Knowledge building is very different from traditional knowledge-telling pedagogy. Knowledge building practice focuses on improving ideas and collective knowledge in a community, capitalizing on collective responsibility for sustained knowledge construction, and for fostering self-directed learning. Moreover, knowledge building fosters a collaborative learning environment for students to freely discuss scientific theories. This is to help foster their abilities of collective problem-solving and knowledge construction

Method

Participants were 52 students who attended a course titled "Introduction to Nature Science". The course lasted for one semester (18 weeks). Instructional design was based on knowledge building pedagogy, with Knowledge Forum™ (KF) being used to complement student work with ideas and knowledge. All students' ideas and discussion were recorded in KF. Data mainly came from (1) a pre-post survey that assesses students'

understanding of the nature of scientific theory, and (2) students' online interactions. The questionnaire contains five open-ended questions as follows: (1) What is a scientific theory? (2) Is there a "better" or "worse" scientific theory? Why? (3) How does a scientific theory form? (4) Is a scientific theory invented or discovered? Why? (5) Why do we need science theory? The survey data were analyzed based on a coding scheme emerged during the coding process (see Table 2). Pair-sample t-test was performed to examine whether there were any significant differences between the pre- and post-test. As this was just a preliminary analysis, only analysis of pre-post survey was reported.

Result

Table 2 shows the overall results. It was found that after engaging in collaborative learning and knowledge building for a semester, the participating students' understanding of nature of scientific theory significantly changed in a more constructivist sense from pre-test to post-test ($t=-5.08$, $p<.01$). For example, there was a significant increase in understanding the origin of scientific theory from a more subjective, intrepretivist way ($t=-4.49$, $p<.01$). Moreover, students also tended to see scientific theory as invented rather than discovered ($t=-4.49$, $p<.01$; $t=-4.59$, $p<.01$). In brief, after a semester, students demonstrated a more informed understanding of the nature of scientific theory.

Table2. Understanding of nature of science.

Question	Code	pre-test		post-test		t-value
		M	SD	M	SD	
What is a scientific theory?	Subjective	0.33	0.73	0.92	0.90	-5.08**
	Objective	0.73	0.49	0.65	0.65	0.78
Is there a "better" or "worse" scientific theory?	Yes	0.65	0.84	1.33	1.10	-3.586
	No	0.83	0.62	0.77	0.90	0.425
How does a scientific theory form?	Constructivist progress	0.40	0.50	0.58	0.54	-4.491*
	Objective progress	0.63	0.49	0.62	0.57	0.191
Is scientific theory innvented or discovered?	Innvented	0.54	0.73	1.72	1.03	-4.491**
	Both	0.37	0.60	0.38	0.80	0.519
	discovered	0.63	0.69	0.37	0.69	1.756
Why do we need scientific theory?	Explanation	0.86	0.45	0.83	0.58	0.178
	Improvement	0.29	0.50	0.77	0.61	-4.599**

* p<.05 ** p<.01

Conclusion

In summary, the findings indicate that students changed their understanding regarding the nature of scientific theory after the study. In the beginning of the semester, students thought that theories were discovered and they regarded theory as a "truth" that cannot be changed. Also, students considered scientific theory as only objective explanation of phenomena in the world. However, after the semester, students thought that theories could be subjectively changed and improved and also was likely to be invented though personal imagination and collaborative innovation. In addition, students thought that theories not only can help explain the world but can help improve living technologies and human life. In conclusion, after engaging in collaborative learning for a semester, students' understanding of the nature of scientific theory changed from a more traditional view to a more constructivist-interpretivist way. In future research, we will focus on "how" students changed, and further analyze their collaborative learning process during this course.

References

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