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Be WISEr ! Using Collaborative Science Writing to Improve Taiwanese Students' Understanding of Evolution in Junior High School Classroom.

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Abstract

This research presents the feasibility of the application of Google docs, combined with Web-based Inquiry Science Learning Environment (WISE), to create a better collaborative e-learning environment. The results indicated a significant improvement in student learning outcomes. In addition, compared to "Single Writing Group", students in "Collaborative Writing Group" have better performance in evolution understandings. Thus, the present study implies that peer collaborative science writing is beneficial for students to co-construct knowledge in group project work.

Keywords: CSCL, WISE platform, Google Docs, Evolution Knowledge Building, Collaborative Writing.

Introduction

With the fast-developed technology, Computer-Supported Collaborative Learning (CSCL) has become a trend in education [1][2]. Unlike the traditional teacher-centered learning environment, CSCL enables students to engage in productive discourses online. While previous studies have shown that CSCL has the potential for collaborative knowledge building and individual learning [4], it still encounters a variety of difficulties and challenges. For instance, team members are required to coordinate among multiple individuals with unique perspectives to achieve shared learning Goals [1]. In addition, students' discussion is usually short, fragment, and easy to divergence, eventually unable to bring about knowledge advances [3].

Web-based Inquiry Science Learning Environment (WISE), an online platform developed by the University of Berkeley, is a common CSCL tool applied in current school education [5]. It provides procedural guidance for an inquiry project so that learners can predict results, check their ideas, and reflect on their progress [6]. On the WISE platform, students organize their ideas and cultivate the higher-order thinking and self-directed learning skills [7]. WISE enables teachers to monitor students' learning progress and provide timely feedback [7][8]. Students are encouraged to brainstorm ideas on an assigned scientific topic and finish a series of tasks together for collaborative problem solving and knowledge integration [6][9][10]. Nevertheless, it seems that WISE alone has a limited ability to train students' science writing skills since it focuses more on ideas exchanging and lacks follow-ups such as summarizing all these valued ideas to constitute a consensus view.

Google Docs, an online word processing application, enables students to co-edit a document synchronously, write comments and save the document at any time [11][12]. Getting information and sharing content with peers in a timely manner is useful for interactive engagement [16]. Google Docs supports students to handle shared tasks in groups without face-to-face contact [13]. Previous research reports indicated that students overall felt that using Google Docs is more enjoyable than using Microsoft Word, helping them write more efficiently and get longer essays [15]. In addition, Google Docs has the feature which allows users to revise articles together, resulting in a higher quality work [12] [14].

However, it was still unknown whether and how many Google Docs promoted students' learning outcomes when compared with Microsoft Word. Therefore, the current research proposed an instructional design model to compare the academic performance of students who use Google Docs and Microsoft Word to collaborate on writing assignments. Students using the former collaboration tools discussed, summarized and revised the ideas online while students using the latter one articulated their ideas face to face and had one group member summarize the discussion. Our primary goal was to find out if using Google Docs provides a better e-learning environment to enhance students' conceptual understanding of evolution and the inquiry ability in science.

Method

A. Participants and procedure

Participants were a total of 105 8-9th grade students from three public junior high schools in Taiwan. The curriculum was implemented in the context of a summer science camp, lasted for 3-4 hours. The students took the pretests and posttests of the unit assessment immediately before and after the course. The research group included two biological teachers and two teaching assistant, who have attended the training workshop before the camp. The curriculum included two parts of learning activities. In the first part, the evolution unit was taught for inquiry activities and the understanding of evolutionary mechanism on the Collaborative Web-based Inquiry Science Environment (CWISE) platform, a Chinese version of the WISE platform (http://cwise.gise.ntnu.edu.tw).

The second part was the writing activities and students were randomly assigned in two groups. Both groups were required to write arguments or scenarios related to evolutionary mechanisms proposed by Darwin and Lamarck. In the "Collaborative Writing Group", students co-edited the essay on the Google Docs. However, in the "Single Writing Group", one of the students was elected to write the essay on Microsoft Word, and other students were responsible for providing. "Collaborative Writing Group" consisted of 51 students and "Single Writing Group" was formed by 54 students. Throughout the writing process, the teachers circulate within the classroom to help the student reflect on

topics and interact with peers.

B. The instructional design model

The model includes a lesson plan on WISE, a writing activity, and unit assessment linked to the national science standard. In the lesson plan, student individually learned the evolution unit on the CWISE platform. Figure 1 displays the CWISE student interface, including the pop-up windows for reflection notes and brainstorming for forum community discussion. Students navigate step-by-step in the left-hand frame of the Web browser. The key steps included in the design model are shown in Table 1.

In the initial step, an evolution-related video was played to enhance student learning motivation (step 1-2). Next, the evolutionary mechanisms proposed by Darwin and Lamarck was introduced in the articles. In the meantime, students used the two theories to explain why the giraffe has a long neck (step 3-6). After understanding two evolutionary theories, the model introduced Weisman's famous mouse experiment (step 7). Students chose the evolutionary theory he supported and gave reasons (step 8). Finally, students integrated the evolutionary theories they have learned and applied them to explain the case of pesticide usage (step 9-10).

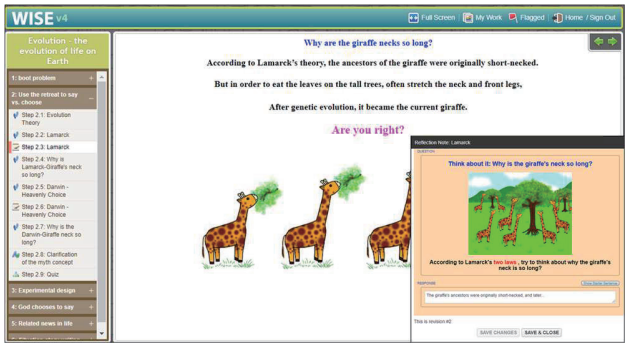

Fig. 1 CWISE student interface.

Fig. 2A Fig. 2B

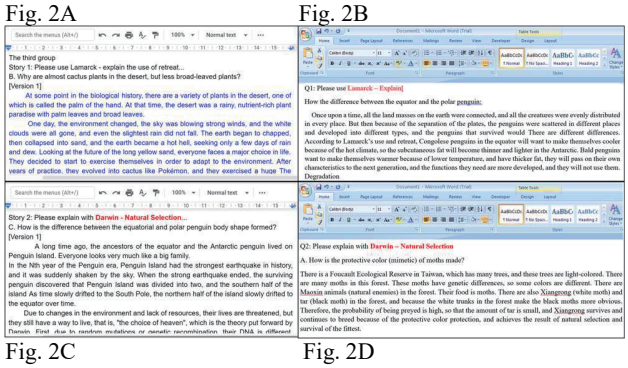

Fig. 2C Fig. 2D

Fig. 2 Students' essays about Lamarck's theory (Fig. 2A, Fig. 2B) and Darwin's theory (Fig. 2C, Fig. 2D) on Google Docs (Fig. 2A, Fig. 2C) and Microsoft Word (2B, 2D).

In the writing activity, all students were randomly divided into two groups, named Collaborative Writing Group and Single Writing Group. Each group was then divided into 10 groups, each consisting of 5-6 students. Students on the same team were required to accomplish a writing project together. These projects included the support or objection of evolutionary theories proposed by Darwin or Lamarck, and the creation of scenarios to explain the mechanisms of "natural selection" and "use and disuse". Figure 2 displays the writing articles on Google Docs or Microsoft Word (Figure 2).

TABLE I
KEY STEPS IN THE DESIGN PROCESS

Step	Context
1	Playing a YouTube video: The Simpsons Homer Evolution.
2	Q: Why do you think the fish in the video will later evolve into reptiles?
3	Article reading: Introduction to Lamarck's theory, use and disuse.
4	Q: Can you try to use Lamarck's use and disuse to explain why the giraffe's neck is so long?
5	Article reading: Introduction to Darwin's theory, natural selection.
6	Q: Can you try to use Darwin's natural selection to explain why the giraffe's neck is so long?
7	Introduction of Weismann's mouse experiment.
8	After watching Weismann's mouse experiment, can you try to talk about which theory you support? what is the reason?
9	Article reading: when pests are sprayed with pesticides, the number of pests will initially decrease, but then it will increase slowly.
10	Q: Why do you think the number of pests is initially reduced after the pesticide spraying, but increasing slowly despite the follow-up spraying of pesticides?

C. Instruments

To evaluate the student learning outcomes, the study developed a unit assessment which was in accordance with the national curriculum standards. The unit assessment was designed by the experienced teachers, composing of multiple choice questions, short description questions, and essay questions. Were reviewed for validity by the science education researchers and revised before the project implementation.

The scoring rubric was developed by two biological teachers to measure student performance of the conceptual knowledge and the inquiry ability. Multiple choice questions were scored 1 or 0, according to the right or wrong answer. Short description questions and essay questions were scored 2, 1, or 0 respectively according to the scoring rubric. The score of 2 was given for the high quality and the complete answer. The score of 1 was given for the moderate quality and the partial response. The score of 0 was given for the irrelevant or missing answer. All student responses were marked by two independent raters.

In order to enrich and clarify the quantitative results of the above unit assessment, semi-structured interviews were administered after the summer camp. These questions were designed by researchers and focused on students' perceptions of this biological curriculum.

Results

A. The Unit Assessment

In order to evaluate the effects of the collaborative writing, comparisons were made between students taught using Google Docs and one with Microsoft Word. Table 2

shows comparisons of differences between pre-test and post-test scores regarding student evolution understanding and scientific inquiry. The results indicate that students in both groups have significant improvement in learning outcomes, including knowledge acquisition and the inquiry ability.

TABLE 2 STUDENT LEARNING OUTCOMES

	Group	*Pretest*	*Posttest*	*Significance*
Knowledge	A	16.04	17.63	.008
	B	12.50	13.98	.043
	Total	14.22	15.75	.001
Inquiry	A	17.80	19.27	.019
	B	12.28	14.63	.002
	Total	14.96	16.89	.000

Group A: Collaborative Writing Group; Group B: Single Writing Group. p***<.001, p**<.01, p*<.05

TABLE 3 DIFFERENCE BETWEEN TWO GROUPS

		Mean		*ST.D*			
Group	*N*	*Pre*	*Post*	*Pre*	*Post*	*F*	*p*
A	51	16.04	17.63	5.06	4.30	6.065	.015*
B	54	12.50	13.98	4.31	4.66		

*F, p: F- and p- Values of analysis of variance between posttest scores in the Collaborative Writing Group (Group A) and Single Writing Group (Group B).

A. Semi-structured interview

Table 3 showed comparisons of students' scores on conceptual knowledge of evolution between Collaborative Writing Group and Single Writing Group. The results showed that students working on Google Docs together have a significantly higher average score on conceptual knowledge of evolution than those working on Microsoft Word together. Despite this, there was no significant difference in the average scores of inquiry ability between the two groups (data not shown).

According to the interview transcripts, students generally showed a positive attitude towards the curriculum. Besides, students in the Single Writing Group reported that teamwork was beneficial for them to accomplish the scientific writing task. For example:

Kevin：Through cooperation, the task becomes easier, we are able to listen to each other's ideas and learn things that we were previously unfamiliar with.

Susan：The activity is very interesting. We can see the creative thinking from different classmates and we are encouraged to brainstorm throughout the process.

Nevertheless, the students also mentioned that there were some limits in verbal communication, which reduced the willingness to discuss and the learning efficiency.

John: The opinions discussed seem to be more impressive when written down.

Jane: Only focusing on the discussion without writing them down at the same time reduce my willingness of continuing discussion.

Kevin: I was not the person who was in charge of summarizing the discussion, so some of my ideas were not accepted and recorded.

Leo：Being the one who is responsible for summarizing the whole group's ideas is quite stressful because it's quite difficult to integrate everyone's ideas and some details might be accidentally missed.

Students in the Collaborative Writing Group overwhelmingly felt that the co-editing writing style improved their writing skills.

Marisa: In the process of co-editing, I have the opportunity to practice writing and learn how to write better from others' words.

Furthermore, collaborative writing seems to help students overcome the challenges more easily and focus more on group discussion than writing alone.

Jennifer: Teamwork allows students to gather ideas easily and choose the best one to be written down. However, if we are told to do this by ourselves, it will be much harder for us to complete the task.

Lisa: The ideas pointed out by every team member are all included in the discussion, thus all of us pay full attention to it.

Students also mentioned that this writing method can strengthen their memory of the learning target.

Lee: Through the process of storytelling, the memory of the learning materials will be unconsciously enhanced.

David: I am capable of absorbing knowledge more than usual.

However, there still some demerit. For instance:

Peter: It's possible that some misconception will be written down.

Discussion

This study demonstrated an instructional design model to enhance students' academic performance in the evolution unit. The results indicated that the curriculum contributed to students' scientific learning of evolution unit, not only on conceptual understanding but also on inquiry ability. In

addition, students who use Google Docs in writing activities are more likely to understand the concepts of the evolutionary theories than those use Microsoft Word. It implies that the writing tools and the learning methods we choose impact much on the student's knowledge building.

Furthermore, based on the interview records, students overall gave positive feedback to this biological course. Students in Single Writing Group and Collaborative Writing Group both expressed the importance of teamwork, which not only reduced the difficulty of the writing task but also stimulates more ideas. Moreover, students in the Cooperative Writing Group emphasized the benefits of co-writing such as helping them develop their writing skills and deepen their understandings.

Summary

Previous studies have shown that although CSCL has the potential to enhance student learning, it still confronts many challenges such as coordinating the unique perspectives of individuals and integrating different opinions into a well-organized article [1][3]. In this research, we combined the WISE platform with computer-based word processing applications, Microsoft Word and Google Docs, to address the limitations of CSCL. WISE has been reported to assist students to organize ideas and integrate learned knowledge [10]. Besides, a series of step-by-step guidance allows students to develop the abilities of self-directed learning and scientific inquiry [6]. It also provides the brainstorming function for students to discuss a common issue [9]. Nevertheless, WISE seems to be less capable of facilitating students organizing various perspectives into a well-structured article. Therefore, this study applied the word processing tools to resolve the limitation. According to the research results, Microsoft Word and Google Docs can both help students bring different ideas together and generate consensus. However, using Google Docs for collaborative scientific writing tends to better enhance students' understanding of evolutionary theories. It suggests that a teaching pedagogy which combines Google Docs with WISE is possible to establish a better CSCL environment in Taiwanese junior high school classroom.

Future Research

In the study, all participants were 8-9th grade students and have already took related courses in the 7th grade. We suggest the future research can be extended to students in different academic levels and scientific themes in order to figure out more possible potentials and challenges when applying the teaching method in real classrooms.

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