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A Project-based Digital Storytelling Approach for Improving Students' Learning Motivation, Problem-Solving Competence and Learning Achievement

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ABSTRACT

Although project-based learning is a well-known and widely used instructional strategy, it remains a challenging issue to effectively apply this approach to practical settings for improving the learning performance of students. In this study, a project-based digital storytelling approach is proposed to cope with this problem. With a quasi-experiment, the proposed approach has been applied to a learning activity of a science course in an elementary school. A total of 117 Grade 5 students in an elementary school in southern Taiwan were assigned to an experimental group (N = 60) and a control group (N = 57) to compare the performance of the approach with that of conventional project-based learning. A web-based information-searching system, Meta-Analyzer, was used to enable the students to collect data on the Internet based on the questions raised by the teachers, and Microsoft's Photo Story was used to help the experimental group develop movies for storytelling based on the collected data. Moreover, several measuring tools, including the science learning motivation scale, the problem-solving competence scale and the science achievement test, were used to collect feedback as well as evaluate the learning performance of the students. The experimental results show that the project-based learning with digital storytelling could effectively enhance the students' science learning motivation, problem-solving competence, and learning achievement.

Keywords

Project-based learning, Elementary education, Digital storytelling, Learning motivation, Problem-solving competence

Introduction

With the popularity of information technology and the rapid development of global knowledge, scholars and academia have started to pay more attention to technological instruction. Researchers have tried to develop various computerized systems or guiding strategies to assist students in improving their learning performance (Hsieh et al., 2011; Hwang, 2003; Panjaburee, Hwang, Triampo, & Shih, 2010). Chu, Tse, and Chow (2011) have indicated that effective instruction is required to cultivate the key competences of students; particularly, technological instruction which promotes student-centered learning presents a great difference from traditional direct instruction. Many scholars consider Project-Based Learning (PBL) as an excellent form of instruction to encourage the self-learning of students (Chang & Lee, 2010; Gerber, Cavallo, & Marek, 2001; Glover, 1993; Green, 1998; Moursund, 1999; Scott, 1994). David (2008) mentioned that project-based learning could provide students with more learning chances and interpersonal interactions, as it conforms to the requirements of technological instruction. Barrows (1996) indicated that students should look for more efficient learning methods based on their background knowledge and skills, and project-based learning, as a favorable learning strategy, could guide students to the application of knowledge and problem solving. Schmeck and Lockhart (1983) considered learning strategies as the methods applied in the learning process to assist learners in acquiring, managing, and integrating knowledge, as well as solving problems independently. It can be seen that project-based learning is such an approach that situates learners with higher order cognitive processes in the modified version of Bloom's taxonomy of educational objectives, such as "analyze", "evaluate" and "create" (Anderson, Krathwohl, Airasian, Cruickshank, Mayer, Pintrich, et al., 2001; Bloom et al., 1956).

Shih, Chuang and Hwang (2010) further revealed that project-based learning could be a student-centered learning model to promote the learning achievement of students. Moreover, Mayer (1987) considered that learning strategies

should be developed along with the students' increase in age, and that the optimal timing to develop learning strategies is with upper elementary school classes; that is, project-based learning is suitable for being applied to the learning strategies of these upper elementary classes. Nevertheless, researchers have pointed out several problems encountered while applying the project-based learning approach in large classrooms, including the difficulties in promoting students' learning motivation, having students concentrate on the learning tasks, helping the students connect the new content with their prior knowledge, and conducting the cooperative learning activities efficiently (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991; Gülbahar & Tinmaz, 2006; Marx, Blumenfeld, Krajcik, & Soloway, 1997; Lee & Tsai, 2004).

The advancement and popularity of computer and network technologies have resolved part of the problems. A technology-integrated PBL environment provides a real-world, constructivist, cooperative learning environment that has many advantages over the traditional PBL environment (Bottino & Robotti, 2007); that is, the difficulty in conducting the cooperative learning activities has been resolved. However, it remains a challenge to promote students' motivation and concentration on the learning tasks; moreover, it is also important to provide a way to guide the students to organize their knowledge. Therefore, the development of an effective instructional strategy for conducting project-based learning activities has become an important and challenging issue (Woods, 2010).

Scholars have identified that storytelling is an effective instructional strategy for promoting learning motivations and improving the learning performance of students (Schank, 1990). It can enhance memory by allowing learners to recall the prerequisite learning and help develop interaction among students (Bruner, 1996; Zull, 2002). Bran (2010) suggested that digital storytelling with a combination of images, sound, and texts could attract the students' interest and enhance their learning achievement. Clark, Hosticka, Schriver, and Bedell (2002) emphasized that instruction, as the key to promoting learning achievement, should be combined with the curriculum and developed with the cognition of students in mind in order to achieve the teaching objectives.

This study aims to propose a project-based digital storytelling approach, which combines project-based learning and digital storytelling strategies to conduct learning activities for elementary school students. Moreover, an experiment has been conducted to verify the effects of the proposed approach on enhancing the learning motivation, problem-solving competence, and learning achievement of the students. The research questions investigated in this study are listed as follows:

1. Will the project-based digital storytelling improve the students' learning motivation in science courses?
2. Will the project-based digital storytelling improve the students' problem-solving competence?
3. Will the project-based digital storytelling improve the students' learning achievement in science courses?
4. Will different genders have different learning outcomes with the project-based digital storytelling approach?

Literature Review

Project-based learning

Researchers have stated that project-based learning is an instructional strategy that, via participating in a project, appeals to students due to learning by way of problem solving, data collection, and discussion, as well as the presentation of the results as reports (Chu, Tse, & Chow, 2011; Howard, 2002; Koh, Herring, & Hew, 2010; Krajcik, Czerniak, & Berger, 1999; Polman, 2000; Wolk, 1994). Krajcik, Czerniak, and Berger (2003) considered that learners who participate in project-based learning would be encouraged to cooperate with their group members and to discuss and share opinions. Project-based learning aims to cultivate the capability of active and self-regulated learning of students who are the supporters as well as the learners in the process of interacting with teachers (Achilles & Hoover, 1996).

Project-based learning enhances the collaboration and the cooperation between group members, reinforcing learning cognition, and promoting learning achievement (Johnson, Johnson, & Holubec, 1994). Johnson and Johnson (1987) indicated that project-based cooperative learning develops trust among members so that, through face-to-face interactions, the effect of individual performance on the group is stressed and, by mutual supervision and reflection, the effect of collaborative learning is ensured. Johnson, Johnson, and Holubec (1994) proposed five elements for collaborative learning, namely active trust, face-to-face interaction, individual performance, interpersonal and group skills, and group process. These ideas originated from constructivism, and are based on the cognitive developmental

theory of Piaget (1950) and the social construction theory of Vygotsky (1978). Constructivism proposes that knowledge is actively constructed by individual minds and formed by interaction with the environment. Based on individual prior knowledge and previous experiences, new individual knowledge or new wisdom is generated by assimilation, adjustment, and organization of the environment in the process of interaction (Bodner, 1996).

To effectively conduct a project-based learning activity, it is necessary to design learning tasks that can promote the learning motivation and improve the learning achievement of the students. Brown, Collins, and Duguid (1989) considered interaction with the environment as the process of acquiring knowledge for human beings. Winn (1993) regarded knowledge as the learning content constructed in real situations, and argues that learners can actually obtain knowledge merely by participating in activities in a living situation. With actual activities involving the learning of knowledge and skills, learners could treat knowledge as a tool and further apply it (Brown & Duguid, 1993; Brown, et al., 1989). Effective learning requires learners to enter the social culture and meaningful situations so that they can actively interpret and comprehend the knowledge (McLellan, 1993). Situated cognition theory emphasizes the learning taking place in real activities during which students search for reasonable explanations of knowledge in the process of interaction to establish a complete knowledge system (Brown, et al., 1989; Hwang & Chang, 2011; Hwang, Chu, Lin, & Tsai, 2011; Lave & Wenger, 1991; McLellan, 1996). In this case, situations need to be established to guide students when designing project learning activities.

The advancement and popularity of computer and network technologies have provided a constructivist and cooperative learning environment (Bottino & Robotti, 2007). In the past decade, various studies have reported positive effects of the technology-integrated PBL environment on student achievement in science (Barab, Thomas, Dodge, & Carteaux, 2005; Barak & Dori, 2005; Barron, et al.,1998, Bottino & Robotti, 2007). Applying technology in PBL could support cooperative activities and constructivist approaches in learning. However, while conducting project-based learning activities in large classrooms, it is difficult to have the students concentrate on the learning tasks; moreover, for most students, it is challenging to connect the new content with their prior knowledge (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991; Marx, Blumenfeld, Krajcik, & Soloway, 1997; Lee & Tsai, 2004). Gülbahar and Tinmaz (2006) indicated that, without proper support, the students' cognitive load could be too high, indicating the need to develop or apply effect instructional strategies in project-based learning activities.

In the traditional approach, the teachers usually design a set of competition rules and a reward system when conducting project-based learning activities in large classrooms. Such a strategy can promote the learning motivation of the students; however, it is not helpful to the students in organizing their prior knowledge and the new learning materials. Consequently, in this study, we attempt to cope with this problem by integrating the digital storytelling strategy in the project-based learning approach.

Digital storytelling

Digital storytelling is an integrated application of multiple media and software that utilizes the art and techniques of digital storytelling with new methods, contributing to helping learners become involved in the learning situation (Haigh & Hardy, 2010; Lowenthal, 2009; Lowenthal & Dunlap, 2010; Reitmaier, Bidwell, & Marsden, 2010; Stacey & Hardy, 2011). Meadows (2003) regards digital stories as short, individual, and multi-media stories. Malita and Martin (2010) consider the knowledge, wisdom, and value sharing of storytelling, which is beneficial for connecting with previous experiences and enhancing memory (Schank, 1990). Grisham (2006) mentions the functions of establishing self-confidence and promoting learning motivation.

In the past decades, storytelling has been widely applied to learning, and presents a favorable effect on knowledge construction and motivation promotion. For example, Burmark (2004) has reported that digital storytelling is an effective approach for helping students collect information, create new ideas, and organize their knowledge, which can improve the students' comprehension of the learning content. Robin (2008) has indicated that digital storytelling not only engages students in discussing the topics presented in the story, but also helps them organize their findings and conceptions in a more understandable way. Lowenthal and Dunlap (2010) developed a Community of Inquiry framework based on the digital storytelling approach to provide a way for teachers and students to communicate and share knowledge on the Internet. Gyabak and Godina (2011) employed digital storytelling as an instructional

intervention for bridging the digital divide between rural and urban elementary school students to help those who have never had the chance to experience computer technology.

From previous studies, it is found that digital storytelling has been treated as an effective approach to promoting cooperation and knowledge construction in classrooms; however, the effects of integrating digital storytelling and project-based learning on problem-solving competence and learning achievement have not been investigated. In this study, digital storytelling has been employed to develop the learning tasks as a project-based learning activity, including taking pictures with digital cameras, developing the story based on the pictures taken, producing a film based on the pictures by adding subtitles and a background, and presenting the story.

Research Design

In this study, a pre-test and post-test-designed quasi-experiment with non-equivalent groups was conducted. The independent variables were the different learning modes; the experimental group participated in the project-based learning with digital storytelling tasks, while the control group experienced the conventional project-based learning approach, for a period of sixteen weeks. The dependent variables were the science learning motivation scale, the problem-solving competence scale, and the science course achievement test.

Participants

A total of 117 Grade 5 students in an elementary school in southern Taiwan constituted the participants. With S-type placement, two classes were assigned as the experimental group, while the other two were the control group, with student numbers of 60 (males 35, females 25) and 57 (males 31, females 26), respectively. The experimental group took part in the project-based learning with digital storytelling, while the control group experienced conventional project-based learning, including project tasks and the presentation of results in groups, as well as evaluation by and feedback from teachers. The students in both the experimental group and the control group were randomly assigned to subgroups, each of which contained 5 or 6 members.

Tools

The science learning motivation scale, consisting of a total of 34 questions, was compiled by Chen (2007) and measured by a five-point Likert scale. In terms of reliability, the Cronbach's α is .93, showing the consistency of the scale.

The problem-solving competence scale, including a total of 30 questions, was compiled by Pan (2001) and is also measured using a five-point Likert scale. With regard to reliability, the Cronbach's α is .849, presenting the consistency of the scale.

The science achievement test was compiled based on the instructional objectives, covering 17 True-False questions, 17 multiple choice questions, and 7 gap-filling questions, worth a total of 100 marks. Four knowledgeable and experienced teachers were invited to examine and revise the contents, themes, meanings, numbers, and wording of the test corresponding to the science learning objectives.

The interviews of individual students were recorded with a digital recorder, and included the following questions: (1) Do you think such a digital storytelling approach is helpful to you in learning? Why? (2) Does such a digital storytelling approach for project-based learning change your attitude or motivate you in your learning? Why? (3) Is such a learning approach helpful to you in solving problems? Why? (4) Do you feel any difference between the new learning approach (integrating digital storytelling in project-based learning activities) and the previous learning approach (conventional project-based learning)?

The web-based information-searching system used by the students for collecting data on the Internet, Meta-Analyzer, was developed by Hwang, Tsai, Tsai and Tseng (2008), while the digital storytelling software adopted in this study was Photo Story 3, developed by Microsoft.

Learning activities

The unit of "I am the energy-saving master" was designed for the project-based learning activity. Five learning tasks, including "The factors of global warming", "How to save energy", "Comparing the energy consumption of household appliances", "Energy-saving actions", and "My house saves the most energy", are listed in Table 1. Within the 16-week experiment, both groups had identical learning contents, except that the experimental group applied project-based learning with digital storytelling to the instruction, while the control group took part in general project-based learning.

Table 1. Learning contents of the project-based learning activity "I am the energy-saving master"

Project-based activities	Questions
Task 1: The factors of global warming	1. Look for the factors of global warming 2. Share with groups
Task 2: How to save energy	1. Propose energy-saving tips and share with groups. 2. Collaboratively arrange and conclude feasible tips for energy-saving.
Task 3: Comparing the energy consumption of household appliances	1. Observe the brightness of bulbs with different wattages (W) and understand the meaning of W. 2. Examine the W of household appliances and sequence them by energy consumption, and complete digital records.
Task 4: Energy-saving actions	1. Discuss with the family plans to save energy and put them into practice by reminding each other. 2. Take pictures of energy-saving actions with digital cameras to complete the action record.
Task 5: My house saves the most energy	1. Edit the process into films and present the implementation of energy-saving actions. 2. Compare the energy receipts of the last two months with the same period in the last year. 3. Select and award the top three families which save the most energy.

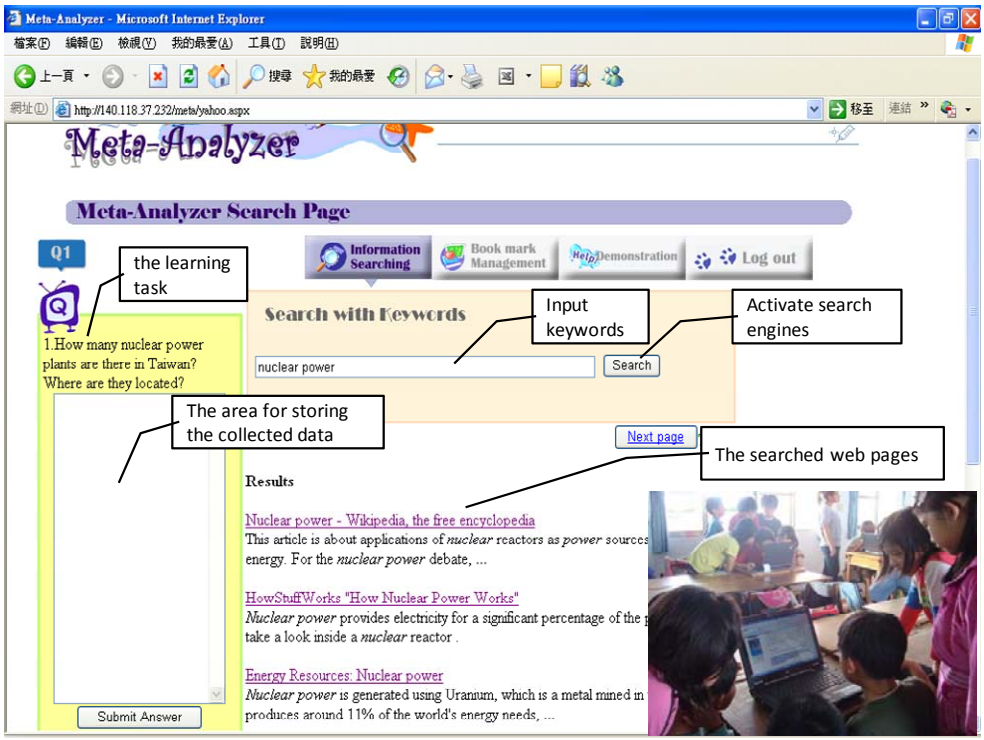

Figure 1. Students carrying out the task of "The factors of global warming"

During the process of the project-based learning, each subgroup in the experimental group and the control group was required to collect data for completing the learning tasks. Figure 1 shows the students working on the task of "The factors of global warming" via collecting data on the Internet using the information-searching system developed by Hwang, Tsai, Tsai and Tseng (2008).

After the data collecting stage, the students in the experimental group needed to take photos and operate the editing system to develop the digital stories. Figure 2 shows the task of carrying out the "Energy-saving actions" at home and taking photos; following that, the photos were uploaded to the editing system to develop the digital story. Figure 3 shows the process of composing the film and presenting the developed digital stories with Photo Story 3, which is a photo presentation program for Windows. The students only needed to drag the photos onto a window, and arrange them as needed. The scheduled photos can be presented with various visualization effects (e.g., transitions, zooms and pans) as well as narration and an audio soundtrack. After everything is arranged, the scheduled materials can be exported as a movie file.

Figure 2. Students carrying out the task of energy-saving actions and working on the editing process of digital storytelling

Figure 3. Students presenting the developed digital stories

On the other hand, the students in the control group learned with the conventional project-based learning approach in their classrooms. They were asked to summarize what they had found after collecting data on the Internet. Each

subgroup in the control group needed to prepare a PowerPoint file to present their findings and conclusions about the issues raised by the teacher in turn. The teacher gave feedback to the students for each presentation.

Experimental results

The effect of project-based learning with digital storytelling on science learning motivation

Using the pre-test of science learning motivation scale as the covariance, the analysis of covariance was carried out to eliminate the effect of the pre-test on science learning motivation. Since the analysis of covariance involved the regression coefficient and regression line, a basic hypothesis of the regression coefficient in the regression line of each group being the same was presented. As the interaction between the independent variable of science learning motivation and the dependent variable, $F=0.85$ ($p>.05$), did not achieve significance, the analysis of covariance could be carried out.

From Table 2, having eliminated the effect of the pre-test on the post-test science learning motivation scale, the variance resulting from different groups, $F=20.38$ ($p<0.001$), achieved significance, showing that the post test results would be affected by the experiment. In comparison with the experimental group, the moderated average presented as 4.10, and the moderated average compared with the control group appeared as 3.69. The score of the experimental group was obviously superior to that of the control group, showing that the project-based learning with digital storytelling could effectively enhance the science learning motivation of the students.

Table 2. Post test results of science learning motivation and analysis of covariance

Variable	Group	N	Mean	S.D.	Adjusted Mean	Std. Error.	*F*
Post-test	Experimental group	60	4.12	0.64	4.10	0.062	20.38***
	Control group	57	3.66	0.77	3.69	0.064	

***$p<.001$

The effect of project-based learning with digital storytelling on problem-solving competence

With the pre-test result of the problem-solving competence scale as the covariance for the analysis of covariance, the interaction between the independent variable of problem-solving competence and the covariance $F=1.77$ with $p>0.05$ did not achieve significance. The analysis of covariance could therefore be carried out.

From Table 3, having eliminated the effect of the pre-test on the post-test problem-solving competence scale, the variance resulting from different groups, $F=17.73$ ($p<0.001$), achieved significance, revealing that the post test results would be affected by the experiment. In comparison with the experimental group, the moderated average presented as 4.16, and the moderated average compared with the control group appeared as 3.77. The experimental group was obviously superior to the control group, presenting that the project-based learning with digital storytelling could effectively enhance the problem-solving competence of the students.

Table 3. Post test results of the problem-solving capability and analysis of covariance

Variable	Group	N	Mean	S.D.	Adjusted Mean	Std.Error.	*F*
Post-test	Experimental group	60	4.24	0.68	4.16	0.06	17.73***
	Control group	57	3.68	0.81	3.77	0.07	

***$p<.001$

The effect of project-based learning with digital storytelling on science learning achievement

With the pre-test result of the achievement test on science as the covariance for the analysis of covariance, the interaction between the independent variable of the science achievement test and the covariance $F= 0.821$ ($p>0.05$) did not achieve significance. The analysis of covariance could therefore be carried out.

Table 4. Post test results of science learning achievement and analysis of covariance

Variable	Group	N	Mean	S.D.	Adjusted Mean	Std. Error.	*F*
Post-test	Experimental group	60	89.07	6.12	88.05	0.58	9.32**
	Control group	57	84.42	6.81	85.49	0.59	

**$p<.01$

From Table 4, having eliminated the effect of the pre-test on the science achievement post-test, the variance resulting from different groups, F=9.34 ($p<0.01$), achieved significance, showing that the post test results would be affected by the experiment. In comparison with the experimental group, the moderated average presented as 88.05, while the moderated average compared with the control group appeared as 85.49. The performance of the experimental group was obviously superior to that of the control group, revealing that the project-based learning with digital storytelling could effectively enhance the science learning achievement of the students.

The effect of gender on participation in the project-based learning with digital storytelling

Gender was further compared and analyzed for the effect of project-based learning with digital storytelling on science learning motivation, problem-solving competence, and science learning achievement.

From Table 5, having eliminated the effects of the pre-test on the science learning motivation post-test, problem-solving competence, and science learning achievement, the variance resulting from gender did not achieve significance. The project-based learning with digital storytelling could therefore effectively promote the science learning motivation, the problem-solving competence, and the science learning achievement of both genders.

Table 5. Post test results by gender and analysis of covariance

Variable	Group	N	Mean	S.D.	Adjusted Mean	Std.Error.	*F*
Science learning motivation scale	male	35	4.19	.53	4.08	.08	.50
	female	25	4.03	.77	4.18	.10	
Problem-solving competence scale	male	35	4.24	.56	4.18	.08	1.44
	female	25	4.25	.83	4.32	.09	
Science achievement test	male	35	88.97	6.75	89.03	.61	.01
	female	25	89.20	5.24	89.12	.72	

Interviews with the experimental group after the project-based learning with digital storytelling

After completing the learning activities, 30 students in the experimental group were randomly selected for interview. The feedback of the students to the four interview questions can be summarized into four aspects, that is, "Enhancing achievement", "Improving learning attitude", "Promoting problem-solving competence" and "Providing a more interesting way of learning".

In terms of "Enhancing achievement", nine students mentioned the application of digital storytelling to project-based learning as giving them better achievement in learning. For example, A02 stated, "There was a real sense of achievement after completing the digital storytelling, which is like a film showing each piece of the well-organized content"; and A26 stated, "(We) used to report with PowerPoint; we now have digital storytelling to replace the dull presentations, and have become more confident."

Regarding "Improving learning attitude", seven students regarded the project-based learning with digital storytelling as having changed their learning attitude. For example, A01, A02, A06, and A09 revealed, "With the digital storytelling activity, (I) make more effort to learn and search for data."

With regard to "Promoting problem-solving competence", five interviewed students indicated promotion of their problem-solving competence in the process of digital storytelling. For instance, A02 indicated, "Digital storytelling would enhance our team cooperation, work capability, and thinking capacity"; and A30 revealed, "The results gave us achievement; we would unite our efforts to solve problems in group discussions."

When asked about the differences between the project-based learning conducted in this study and that which they had previously experienced, it was found that the students in the experimental group shared a consistent point of view, that is, they considered the project-based learning with digital storytelling as being a "more interesting way of learning". In all, 11 students considered that such a strategy made the lessons more interesting and made them prefer the classes. One of them mentioned that he did not favor project-based learning, but his interest increased after the strategy of digital storytelling was introduced; another student indicated that “I did not like the original way of instruction; however, after participating in the instructional activities, I started to enjoy the class with digital storytelling.”

From the interview results, it is concluded that the project-based digital storytelling approach not only enhanced the students' learning achievement and problem-solving competence, but also improved their learning attitude and motivation. Such satisfactory results are due to the lead-in of the digital storytelling strategy in the project-based learning activity, which enabled the students to solve problems cooperatively in a more interesting manner.

Discussion and Conclusions

In this study, project-based digital storytelling was employed to develop a learning activity for an elementary school science course. Each group of students was asked to complete a digital storytelling project via taking pictures with digital cameras, developing the story based on the pictures taken, producing a film based on the pictures by adding subtitles and a background, and presenting the story. From the experimental results, it was found that this innovative approach improved the learning motivation, attitude, problem-solving capability and learning achievements of the students. Moreover, from the interviews, it was found that the students in the experimental group enjoyed the project-based learning activity and thought it helpful because of the digital storytelling aspect.

The experimental results and the feedback from the students conform to what has been indicated by researchers, namely that project-based learning can engage learners in cooperating with their group members and help them improve their learning achievement (Johnson, Johnson, & Holubec, 1994; Krajcik, Czerniak, & Berger, 2003). On the other hand, the findings also conform to what has been reported in previous studies, that the lead-in of computer technologies can promote the learning interest of students (Hwang & Chang, 2011; Shih, Chuang, & Hwang, 2010) and hence help them become involved in the learning situation (Haigh & Hardy, 2010; Lowenthal, 2009; Lowenthal & Dunlap, 2010; Reitmaier, Bidwell, & Marsden, 2010; Stacey & Hardy, 2011).

More importantly, as mentioned by Robin (2008), the students employed the digital storytelling software to organize the collected data based on the knowledge learned in the class in a more interesting and understandable way. Consequently, it is reasonable to owe the success of this project-based learning activity to the digital storytelling approach since it provides not only an interesting way for the students to present their findings, but also an opportunity for them to conduct active learning and organize their knowledge. The process of collecting, abstracting and organizing data has been recognized by researchers as being an effective way of engaging students in higher order thinking, which is helpful in fostering students' problem-solving competence (Chu, Hwang, & Tsai, 2010). Several studies concerning digital storytelling have also supported this viewpoint (Chung, 2006; Sadik, 2008). For example, Ring, Weaver and Jones (2008) conducted a learning activity that employed digital storytelling to help students organize their learning portfolios, and found that the students had actively made reflections and engaged in peer discussions.

Although the present approach seems to be effective, there are some limitations in generalizing the findings of this study. First, the findings were from an experiment on an elementary school science course; therefore, it could be difficult to generalize the findings to other courses or subjects. Moreover, the digital story software adopted in this study guided the students to produce the movies using a step-by-step procedure; consequently, more experiments are needed to investigate the effectiveness of using other software with more flexible functions. In the future, it is expected that more experiments can be conducted to further evaluate the effectiveness of this approach in other courses. In addition, it would be interesting to investigate the learning performance of the students with different cognitive styles or learning styles.

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