

# A Case Study of Online Project-Based Learning: The Beer King Project

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This study aimed to develop and evaluate its effectiveness of an online project-based learning (PBL) for elementary school students. A website entitled “Beer King” was established and supplied to nine sixth grade elementary school students in a southern city of Taiwan. Content analysis was used to analyze students’ experiences of online learning. The findings of this study are: 1) the most popular topics presented by students were the discovery and construction of the online project; 2) the co-designed website by students can promote students’ information literacy and learn to share attitude; 3) students were able to convert the outcomes of their project into a topic-based learning website through the online PBL. Ultimately, the students showed remarkable improvements in their research skills, decision making, and capacity of implementation and evaluation; and 4) online PBL can develop the students’ fundamental attitudes towards research, including their approaches to prepare and plan actual visits.

Keywords: online project-based learning (online PBL), elementary school students

## INTRODUCTION

Due to the pace of information technology development, the entire teaching environment has changed from a traditional to a more digital approach. Learners are no longer limited by nor stuck in their classrooms. They are able to learn anytime at their

convenience. This includes integrating their daily experiences, applying many different kinds of abilities, and strengthening their capacities to adapt to their environments and solve problems encountered therein. Ultimately, learners are expected to manage all the requirements of a continually changing social environment.

Along with the improvements in information technology and the popularity of the Internet, an online learning environment overcomes time barriers and space constraints as well as offers a superb medium for interactive communications. Like learning in general, e-learning can help and improve learning outcomes. It can extend the learning environment, integrating it with the real world, where authentic learning can occur, in actual situations and contexts (Silander, 2004).

Improvements in information technology and the popularity of the Internet have also facilitated the development of the teaching environment, from a conventional face-to-face mode to one framed by digital learning. Learners are no longer restricted to classroom learning. The fast pace of wireless communication development allows learners to read materials anytime and anywhere. Internet technology helps teachers develop curricula, provide varied learning opportunities, and obtain learning resources. It also offers a convenient means of evaluating student-learning outcomes. Thus, it would be beneficial if we learn to implement the Internet effectively at the primary education level.

In recent years, the mutual compatibility between the practice of PBL and curriculum reform has been increasingly recognized. Designing guiding questions and implementing technologies and key concepts are necessary to construct knowledge. In addition, for the sake of more efficient learning, students can also be guided to integrate academic knowledge with their hands-on experience (Berlin & White, 1998; Huang, Shen, & Mak, 2002; Murphy & Yakut, 2001).

Online PBL is a cutting edge learner-centered methodology, enabling a variety of learning styles. In addition, the students' self-identifications also contribute to a more profound grasp of knowledge. Online PBL and traditional education can both promote the development of e-learning. However, further research of online PBL is needed for elementary school students, especially students' performance and attitudes. Therefore, this case study was aimed to promote and develop an online PBL for elementary school students and to evaluate their learning outcomes. The three major purposes were:

1. To analyze the online PBL work of students;
2. To explore the online PBL associated with the students' website construction;
3. To explore students' learning and development as a result of their experiences with the online PBL.

## **LITERATURE REVIEW**

Project-based learning (PBL) is defined as a systematic teaching method that engages students in learning knowledge and skills through an extended inquiry process that is structured around complex authentic questions and carefully designed products and tasks (Markham, Mergendoller, Larmer, & Ravitz, 2003). As far back as the early 1900s, John Dewey supported "learning by doing" (Dewey, 1938). This sentiment is reflected in constructivism. The theoretical foundation of PBL is constructivist theory that learners construct knowledge through activity and learning experiences. Knowledge is socially constructed through structured interaction and collaboration by means of meaningful tasks (Ishii, 2003; Koch, 2005; Saxe et al., 2009). Individuals construct knowledge through interactions with their environment, and through conducting investigations, conversations or activities; an individual constructs new knowledge by building on their current knowledge (Hernández-Ramos & Paz, 2010).

PBL means learning through experience. PBL is a form of expeditionary learning that guides students through a structured investigation of activities, so they can solve important conceptual problems. Knowledge is acquired naturally, emerging from a student's participation within the structure of daily life situations. In PBL, students work in groups to solve challenging problem. Learners decide how to approach a problem and what activities to pursue. They gather information from a variety of source and synthesize, analyze, and derive knowledge from it (Solomon, 2003).

The aim of PBL is to help students learn in daily life and solve real-world problems. Teachers play the role of curriculum designers and learner facilitators. They evaluate learners and their learning process (Delisle, 1997). Hence, PBL is a combination of curriculum, teaching, and evaluation. The ultimate goal is to help learners eliminate post-learning ossifications and enable students to become good problem solvers. Therefore, PBL has important benefits for today's students. It stands to achieve the following:

1. Overcomes the dichotomy between knowledge and thinking, helping students both to "know" and "do";
2. Supports students in learning and practicing problem solving skills, communication skills, and self-management;
3. Encourages the development of habits of mind associated with lifelong learning, civic responsibility, and personal or career success;
4. Integrates curriculum areas, provides thematic instruction, and addresses community issues;
5. Assesses performance on content and skills using criteria similar to those in the work world, thus encouraging accountability, goal-setting, and improved performance;
6. Creates positive communication and collaborative relationships among diverse groups of students;
7. Meets the needs of learners with various skill levels and learning styles; and
8. Engages and motivates students.

Online PBL methods were developed from the PBL model. These methods can be understood as a problem-solving-discovery process that is divided into six steps: "messing about;" asking and refining questions; finding information; planning, designing, conducting experimental work; analyzing data; and sharing artifacts (Krajcik, Czeniak, & Berger, 1998). These steps make a loop and are repeated until the problems are sorted.

PBL is generally a less structured approach than the traditional teacher-centered classroom learning. It is difficult for students to clearly identify project design-flow phases. Moreover, cooperation and collaboration levels are difficult to control, which leads to the lack in clarity of individual work mentoring and evaluation (Milentijevic, Ciric, & Vojinovic, 2008). Developing PBL courses in elementary school is always a tough task for teachers due to the fact that projects can be complex and demanding for supervision. Thus, on the heels of the Internet's popularity, many scholars (Moursund, 1999; Land & Greene, 2000; Thomas, 2005) treat Internet technology as a recognition tool. They suggest that information technologies play a crucial role in PBL. Not surprisingly, online PBL has become widely used in the field of online education. Since, teachers are able to employ internet support in managing, communication, supervision, or creating specialized functions for learning purposes.

In conclusion, online project-based learning not only entails teaching but offers a diverse set of evaluation methods. Evaluations can focus on high levels of recognition, skills, or attitudes. In addition, both students and teachers can conduct evaluations.

Finally, students' own self-assessments can be understood as a continual learning-from-correcting process.

## RESEARCH METHOD

### RESEARCH CONTEXT AND PARTICIPANTS

This research employed a case-study methodology. As an online project-based learning activity, participants of the study should possess basic computer skills, such as browsing websites, typing, and using search engines). Since the case study project was voluntary, the participants were mostly self-motivated. This research focused on nine sixth-grade students attending an elementary school in a southern city in Taiwan. The nine volunteers included four boys and five girls. The participants were from different classes. They used their spare time to form the project-based learning group and decided on their tasks. The table (Table 1) below shows each student's responsibility in the online PBL task.

Table 1: Study group's assigned responsibilities

| ID | Sex | Role               | Main responsibility                               |
|----|-----|--------------------|---|
| S1 | M   | web site developer | data collection and question finding              |
| S2 | M   | problem handler    | interviewing, audio recording, and photo shooting |
| S3 | M   | homework designer  | questionnaire development                         |
| S4 | F   | order maintainer   | <i>cocktail</i> design & poster making            |
| S5 | F   | diary keeper       | journal keeping                                   |
| S6 | F   | recorder           | arranging homework                                |
| S7 | F   | photographer       | marketing   |
| S8 | M   | web page designer  | web development                                   |
| S9 | F   | leader             | logo design and team management                   |

### PROCEDURES

#### Online Learning Environment

An online project-based learning website entitled "The Beer King Website Homepage" (see Figure 1) was developed for this study. This website provided team members with an online learning environment facilitating research, presentations, and discussion throughout this project (for more information about this project, go to <http://163.24.138.110/sir/lee/>).

Throughout the learning process, teachers encouraged learners through notices, e-mails, evaluation sheets, teacher message boards, teaching profiles, and honor board. Students participated in interactive learning via a set of meetings related to the following: feedback on the website development, question and answer, backup-team inquiries, and homework discussions. In addition, journaling about website duties, creating technical documents, and searching for useful URLs were also important components of the students' interactive learning experience. Moreover, students were able to share their learning experiences with one another through journals, photos, advertisements, and exhibitions of exceptionally creative student work on the Internet (as shown in Table 2).



Figure 1: The Beer King Website homepage (Lee, 2006)

Table 2: Item glossary of Project-based learning and online project-based learning platform

| Project-based learning (PBL)      | Online project-based learning platform (Online PBL)   |
|-----------------------------------|---|
| Teacher's guidance                | Administrative board, news, message board, learning sheet, honor board  |
| Discussion and interaction of PBL | Discussion area (progress report, question and answer, backup team inquires), daily log, technical documents, useful linkages,      |
| Reflection and Product of PBL     | Exhibition of students' activities, exhibition of students' work, students' diary, advertisements, interesting photos and articles. |

### Project Based Learning Activities

In an effort to draw upon students' interests and local resources, three teachers designed the curriculum for this research. The topic chosen was titled "Taiwan Tsing-Tao Beer." Students were allowed to use the online learning activities anytime. Students can access the website freely. The following steps detail the procedures for the academic activities.

*Step 1: Initial discovery.* After the students explored the website, they decided upon a topic, gathered related information, and planned the learning activities.

*Step 2: Developing project activities.* In accordance with the project topic, teachers and students arranged three visits to a brewery together, shared and discussed ideas and reflection on the online project-based learning platform afterwards.

During the first visit to the brewery, students referred to previous research and asked questions. Next, they learned about instruments at a beer brewery, the functions of saccharification and fermentation, and the process of packaging. The staff also described the ingredients in beer and the different types of beer as well as explained the use of

liquid inclusions. Thus, students' questions and problems were solved. After the visit, students shared and discussed their experiences online.

The second visit was for bartending practice. The main task was to learn bartending practice and to understand the proportions of alcohol and water in beer. Calculations and discussions of the concepts surrounding alcohol percentages were conducted across several groups. By mixing different drinks in different proportions, the students also made various alcoholic beverages including: passion fruit, green tea, golden wheat tea, green, and tea with plums.

The third visit was for creative design activity of beer. The major tasks for this visit were about beer brewery and its creative design activities. The ingredients in beer jelly highlight the creative dimensions of beer making. Its ingredients include malt, Guilinggao (a Chinese medicinal dessert), coffee, and strawberry. Moreover, students designed and created their own concoctions, such as beer-flavored salted eggs, complete with containers. They also created other crafts and tools themselves from beer cans. Finally, all projects were photographed and uploaded onto the website for discussion.

There is also a project marketing activity for beer. Students work together to design marketing posters for beer and design interesting beer logo animations which was guided by the teacher.

*Step 3: Final presentations and feedback.* At the end of the semester-long learning activities, students made posters and animated presentations to promote their projects both at home and at school. Meanwhile, they collected the results from the online learning process, constructed a website, and presented outcomes from their experiences (either at home or at school). These included the students' learning experiences, their visits, their feedback, and the crafts they had designed.

#### *DATA COLLECTIONS AND ANALYSIS*

The data collections were mainly from online project-based learning platform and the beer king website based on the three main purposes of the study: (a) to analyze the online PBL work of students, (b) to explore the online PBL associated with the students' website construction, and (c) to explore students' learning experience and growth.

The collected data from the online project-based learning platform and beer king website were analyzed. First of all, information related to the research topic of the platform was identified and notes were taken regarding the data collected. The data was then coded into different categories based on the purposes of the study. Data analysis was mainly focused on the functions of the platform and framework induction. The results were presented in the section below.

### **RESULTS**

In the results section, data of the students' online PBL work and the construction of the Beer King Website were summarized along with some demonstrations of figures based on the research questions and three major purposes. In addition, qualitative data of student learning experiences and growth were analyzed and summarized as follows.

#### *ANALYSIS OF THE STUDENTS' ONLINE PBL WORK*

For this project, each participant published their learning outcomes online. Table 3 shows the percentages of different kinds of topics selected. The most popular topic type was online project discoveries and constructions (110 times, 51%), followed by project

marketing and investigation (54 times, 26%), topic-based visits and feedback (41 times, 19%), and project learning and feedback (9 times, 4%).

Table 3: Record of Student Project Topics

| Topic Type                          | Project Name                                     | Number | Percentage | Number/ Percentage subtotal |
|-------------------------------------|--|--------|------------|-----------------------------|
| Online Project Topic                | Discovering online exhibitions                   | 23     | 10.75      | 110 times<br>51 %           |
|                                     | Studies of print media topics                    | 35     | 16.36      |                             |
|                                     | Discovering and visiting online topic            | 24     | 11.21      |                             |
|                                     | Studies of online exhibition topics              | 18     | 8.41       |                             |
| topic-based visits and feedback     | Structure of research                            | 10     | 4.67       |                             |
|                                     | Questionnaires                                   | 10     | 4.67       | 41 times                    |
|                                     | Introduction of beer making visit and facilities | 21     | 9.81       | 19 %                        |
| Project marketing and investigation | Experience sharing after the visit               | 10     | 4.67       |                             |
|                                     | Super hacker mission                             | 9      | 4.21       | 54 times<br>26 %            |
|                                     | Logo & poster                                    | 16     | 7.48       |                             |
|                                     | Questionnaire design for Beer Making King        | 9      | 4.21       |                             |
|                                     | Design of the product                            | 11     | 5.14       |                             |
|                                     | Statistics (3D bar chart)                        | 4      | 1.87       |                             |
| Project learning and feedback       | Statistics (3D pie chart)                        | 5      | 2.34       |                             |
|                                     | Project research plan "influences & impacts"     | 9      | 4.21       | 9 times<br>4 %              |
| Total                               |  | 214    | 100        |                             |

*Students were mostly interested in online project discoveries and constructions.* After having conducted research using newspapers, journals, magazines, online exhibitions, and websites, students gradually discovered what topics interested them. After discussions with the three teachers, the students ultimately settled on Beer King as their topic. The decision making involved here revealed sixth-grade students' curiosity

about and motivation to learn about beer brewery. This is the critical beginning part of a project-based learning approach.

*Project marketing and investigation involved the design and production of animations and provided the opportunity for students to share their projects and express their creativity via the Internet.* While students made posters as a group, each individual also made marketing animations and environmentally friendly items constructed from used bottles and cans. Figure 2 shows the marketing animation logos created by the students. Figure 3 demonstrates the Beer King posters. Figure 4 shows a CD and a cell phone holder made of recycled beer containers. Figure 5 shows an aluminum dipper made from aluminum beer cans, and an ecological system constructed within a beer bottle. Thus, students demonstrated their designs and their creativity through a PBL approach that is capable of leading to a diverse set of outcomes.



Figure 2: Website for Marketing the Making of Beer (Lee, 2007)



Figure 3: Beer King Posters Designed by the Students



Figure 4: CD and Cell Phone Holders Designed by the Students



Figure 5: An Aluminum Dipper and an Ecosystem Beer Bottle

#### *THE CONSTRUCTION OF BEER KING WEBSITES*

Following an online project-based learning approach, the students gathered information about beer-brewing, and as a team, they published their projects and all related information on the web pages they had constructed. Therefore, students were both able to implement what they had learned from the project and have a hands-on experience through the development of the Website. Figure 6 illustrates the sitemap of the website. It includes an introduction to beer, special features, a beer manufacturer's visit, marketing, learning, and sharing.

To share the results of their learning experiences, the team developed websites during their winter break. Throughout this project, the students had learned more about information technology, and they also took advantage of online learning opportunities. Figure 7 displays the main page of the Beer King Website.



Figure 6: Sitemap of the Beer King Website



Figure 7: The Beer King symbol (Lee, 2007)

### STUDENT LEARNING EXPERIENCES

In this section, results from students' project-based visits and feedbacks are reported based on the themes emerged from qualitative data analysis.

*Improvements in Problem Solving Ability.* The students solved problems throughout the project, whether it was through on-line or off-line search, discussions on the Internet, making hypotheses, conducting experiments, or engaging in reflection. Students realized that the Internet provides an effective learning environment for discussions, observations, reflections, and ultimately problem solving. Therefore, independent thinking and problem solving skills can be acquired through project-based learning.

As for how I handled this difficulty, my solution was to search for help online. (December 19, 2006, S9)

As for how I handled this problem, my solution was to keep asking my family and my classmates, to do online searches, and to search through books. (December 19, 2006, S1)

As for how I handled this difficulty, my solution was to think harder and start from the most obvious parts. Then, I thought deeply about what I wanted to achieve after this project, and then I drew some conclusions... There you go! It's finished! (December 19, 2006, S5)

As for how I handled this difficulty, my solution was to search online, first to check if there was any reference or information available...If no luck, I turned to my parents, but unfortunately they didn't know either...While I went hiking with my family, an idea suddenly came to mind. I felt a little embarrassed come away with a solution so easily after but I wanted to start designing immediately when I got home. (December 19, 2006, S8)

As for how I handled this difficulty, my solution was to understand that I had made many assumptions and hypotheses when designing, but I still continued doing experiments. (December 19, 2006, S4)

As for how I handled this problem, I kept thinking what to design...I was thinking before I went to sleep, while shopping, taking a bath and even in the bathroom. (December 19, 2006, S6)

As for how I handled this difficulty, my solution was to check out other people's work and then I picked out a suitable style. Then after some changes, it became my own creation. (December 19, 2006, S7)

*Active and Enthusiastic Cooperative Learning.* Through the online learning environment, students motivated each other. Accordingly, it fostered active learning attitudes that promoted effective and active learning. Furthermore, this learning experience helped improve their collaborative learning skills. Through the interactive and collaborative learning afforded by the Internet, students were stimulated and enthusiastic, their attention was focused, and their communication and social skills improved.

I learned a lot of things. I not only learned to play a role in teams, but I also realized how to interact with team members. My abilities in various roles have improved a lot. Also through other people's work, I discovered my own shortcomings. I was very inspired after seeing everybody working so hard. (November 6, 2006, S6)

It was a hard training and a difficult personal-growth experience. I learned how to get along with my companions, and how to work hard in a team. We now also understand the profound meanings of the proverbs "No pain, no gain." or "There is no free lunch." (November 6, 2006, S2)

I got to know many classmates and also learned more about computers. My Chinese also improved, as we left messages including some quotations and proverbs every day to cheer up each other...It was a challenge...it also enabled me to understand how to work tightly in a team. Like the proverb, "Hard work involves bitter roots but leads to delicious fruit." As long as we try our best, we'll definitely end up with harvests. (November 6, 2006, S1)

It's excellent experience to join this computing project. I made many new friends, improved my teamwork skills and learned how to encourage people. (November 6, 2006, S5)

*Enhanced Comprehensive Skills.* The students applied and developed multiple skills that included the following: reading, writing, web development, animation making, data analysis, presentation ability, and chart making. Throughout the course of the project, their knowledge and self-confidence grew.

Even my computing skills have improved! I type fast. I improved my reading skills, and even my writing ability! I'm so happy because I didn't expect to learn so much knowledge after joining this project. (February 5, 2007, S6)

I also learned a lot about computers and improved my skills. I've changed from a basic computer user to an advanced-level user! The growing process involves sorrow and happiness so that it can become full. (February 5, 2007, S8)

I learned so much more knowledge about computers, about Internet usage and Chin-dao Beer. I didn't know how to make animations before, but now I know both programming and animation production. Moreover, I also know how to analyze data, how to make and manage presentations slides and how to produce charts in Microsoft Excel. (February 5, 2007, S2)

With my teacher's help, I learned a lot of computing skills. I have become a computer software climber, when before I was the person who didn't know how to use software at all. (February 5, 2007, S1)

I have learned a lot of knowledge and improved my skills. I could only barely use the computer before, but now I can even make web

pages...My Chinese improved a lot from all the report writing. Meanwhile, I also learned to make animations...Both my computing skills and language ability have improve a lot. (February 5, 2007, S3)

In addition, I learned a lot more about computers and I improved my Chinese ability. Each of the tasks assigned by the teacher also helped to improve different aspects of our abilities. (February 5, 2007, S5)

*Improved Independence and Responsibility.* The beer brewery demonstrated their own organizational culture and the significance they place on environmental issues. After a semester of teamwork, the students had become more responsible and had learned through hands-on experiences. The project taught them how to be more independent, and it gave them the courage to try things without the help of their parents.

During this Tsing-tao beer brewery research, I realized the importance of recycling. We can't make the earth sick by throwing garbage around and we need to recycle as much as possible. So I'd like to promote recycling around Taiwan. We need to reuse recycled garbage and turn it into great creative products so that garbage can become gold too! (February 5, 2007, S8)

We visited Tsing-tao beer...We appreciated that lots of money and people were invested into the business to produce good quality products to customers. Cheating on the ingredients can only result in customers' spurn. Therefore, I want to practice Tsing-tao beer's mission in my own life, that I must try my best to succeed at things instead of cheating and being dishonest. (February 5, 2007, S2)

I learned not only curriculum related knowledge but also some philosophies. I learned teamwork concepts, and that members should help and cheer each other up. I'm more independent now that I don't depend on other people. I become braver to try new things because you never know when you will actually do them! Most importantly, I learned to be responsible for my own things and not leaving them up to others. I have really developed a lot after this half-year training. (February 5, 2007, S5)

After having gone through so many difficulties, I finally realized that a team must work together to succeed at a goal. I have grown up a lot and become more independent. I am not as dependent on my parents as before, I sort out my own things by myself. If I experience any problems, I then ask for my teacher's or my parents' advice. I really have grown up and many thanks to everyone for their encouragement and suggestions. (February 5, 2007, S4)

During this study, I learned that it'd only be more efficient when everyone is responsible for a particular part. (February 5, 2007, S9)

I have grown up a lot and become more mature. The knowledge I learned doesn't only include such static stuff from textbooks, like Chinese or

Math, but includes practical knowledge and experience in the real-world.  
(February 5, 2007, S7)

Over all, the above qualitative data indicated that these project-based learning experiences improved their problem-solving abilities, their collaborative learning skills, their comprehensive skills, and their senses of independence and responsibilities.

### CONCLUSION AND SUGGESTIONS

According to the results of data analysis in the previous section, the following conclusions are made. First of all, this online project-based learning experiences enhanced students knowledge in information technology as well as their hands-on skills. In their work with the online learning medium, the most popular topic was *the discovery and construction of the online project*, followed by *project marketing and investigation* and *topic-based visits and feedback*. These activities enabled the students to become active in their learning and research and develop their abilities to complete a project. Secondly, the students expressed creativity in their designs and the diverse handcrafts they produced and the marketing and investigation activities they undertook. The online medium afforded team members the opportunity to interact frequently and share knowledge, thus maximizing the learning experiences. Thirdly, the students were able to turn the outcomes of this project into a project-based learning website. They showed marked improvements in their research skills, decision making, and capacity to implement and evaluate (as evidenced in their web page design and website construction). They also enhanced their capabilities of using information technology in learning. Finally, project-based learning developed the students' fundamental attitudes towards research, including their approaches to preparation, planning, and conducting research. Thus, through online learning, students developed a sense of independence and responsibilities and became active learners.

For future research and practice in project-based learning, three suggestions are presented by the researchers. First of all, information technology should be integrated in the curriculum at primary education level. The participants for this project were all very interested in online project-based learning; however, they were not technically prepared at first. Students will become more efficient in their use of online project-based learning if they receive more technology literate. Secondly, more child-friendly websites should be carefully designed and incorporated in primary education. Finally, teachers should be encouraged to put more time and effort into project-based learning. By combining learning with the flexibility of online project-based approaches, we can improve the efficiency in teaching. Therefore, in order to enhance students' learning outcomes, online project-based learning should be promoted more vigorously.

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