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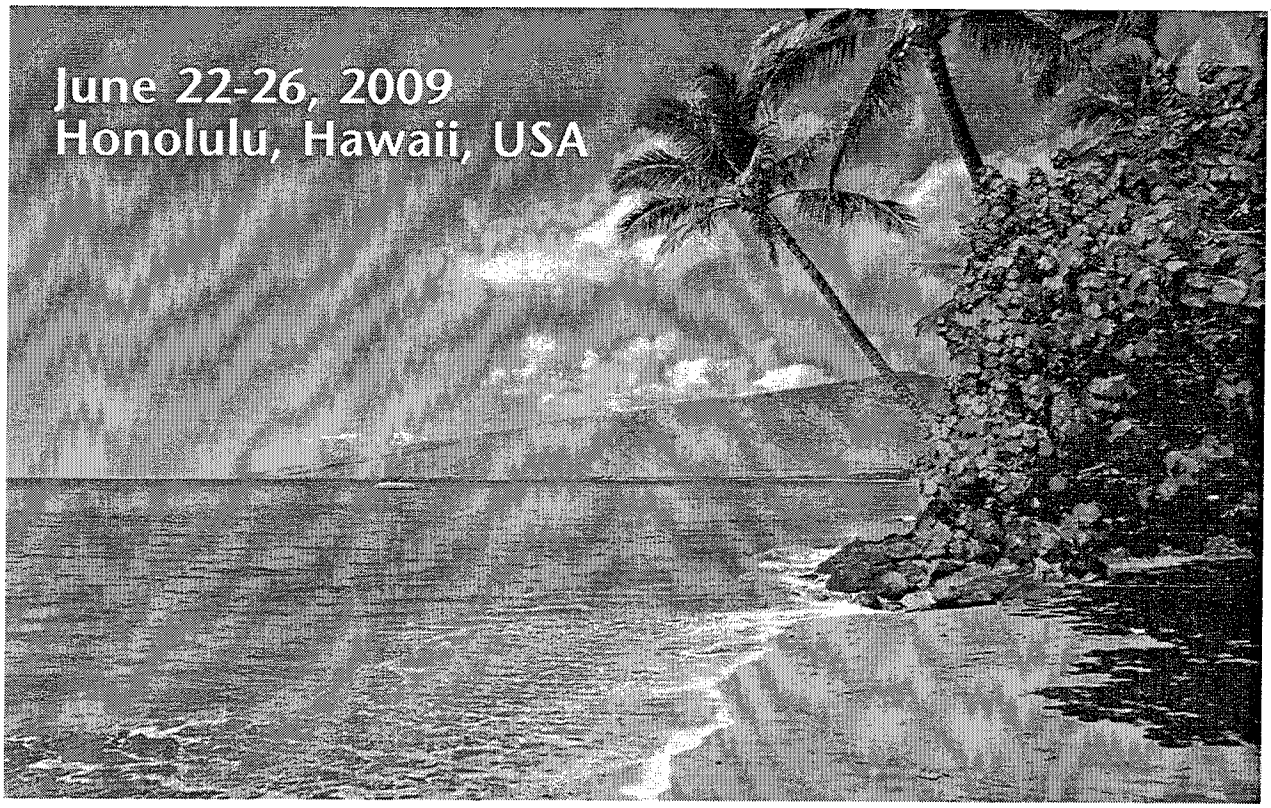

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Understanding by Design: An Investigation of Project-based Learning Implementation and Lesson Learned

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Abstract: PBL offers a context wherein students generate possible solutions to problems and apply relevant knowledge and skills. This study examined the effect of PBL on students' learning and the roles of teachers and peers in the completion of the project. Participants were college students in Taiwan to complete a project that involved designing, developing, implementing, and evaluating sound multimedia-based instruction. Data sources included think-aloud protocols, observation, surveys and interviews. Multiple case study approach was employed. The results showed that the project facilitated students' problem solving skills, allowed knowledge integration, and supported autonomy learning. Teacher was found to be instrumental to the completion of the project. The results contributed to the field of PBL in the context of Taiwan and provided a reference for other teachers who want to implement PBL. Further, this study provided implications on how to better design and implement PBL, and how teachers can promote students' learning through PBL.

Introduction

Learning is an active process which involves building new knowledge upon the previously existing ones (Wittrock, 1974). Project-based learning (PBL), an instructional approach which situates students to develop products or to solve problems (Moss 1998), provides a learning context which allows this active construction of knowledge. It encourages meaningful learning through student-directed investigation (Blumenfeld et al, 1991) and promotes students' autonomy of learning to produce authentic products or presentations (Jones, Rasmussen, & Moffitt, 1997). In addition, PBL enables students to broaden their knowledge base and professionalism, and through PBL, students' metacognitive skills can be nourished (Seo, Templeton, & Pellegrino, 2008). With the opportunities to integrate and apply their prior experiences or knowledge while also constructing new knowledge, students may be

able to reach the extended abstract level of learning (Biggs & Collis, 1982) and expand their cognitive domain (Bloom, 1956). Grounded in constructivism, PBL also promotes social interaction between and among teachers, students and group members, and which amplifies and expands students' learning (Duffy & Jonassen, 1992).

While Information and Communication Technology (ICT) is getting more popular, combining technology into teaching is also growing. For example, Microsoft has partnered with the International Society for Technology in Education (ISTE) to train teachers how to integrate technology into their teaching using a PBL approach (Weatherby, 2007). However, the attempt to integrate technology in education is still limited as it is evident that language learning is not being emphasized. Nevertheless, technology enhanced PBL was found to have positive effect on students' learning, especially cognitive development (Foulger & Jimenez-Silva, 2007), so it could as well be beneficial to learners in a language learning classroom.

This study sought to investigate how completing a project of language-based instruction utilizing multimedia technology helped students' cognitive and affective learning. Such study can help shed light on how PBL affect tertiary learners in Taiwan go about utilizing their learned knowledge in an authentic context. The following are the two research questions that are focused:

1. How did the project-based learning facilitate students' cognitive and affective learning towards technology and subject area?
2. What was the role of teacher and peers in the completion of multimedia-based language instruction?

Method

Participants

The participants in this study were 56 junior and senior college students (47 females and 9 males) in the Department of Foreign Language Instruction in a college in south Taiwan, enrolled in "*Designing Multimedia-based Language Instruction*", an elective course, in the Fall semester of 2008. At the beginning of the course, the participants were randomly assigned into groups of five or six by the instructor (the first author) and were pre-surveyed about their prior experience related to teaching and instructional design and their level of self-efficacy on the use of different computer software (see Table 1). They were homogeneous in ethnic background, but varied in prior knowledge and experience in instructional design and the use of technology. The survey results showed that most of them were not familiar with material design. Some had taken courses in teaching and technology, and some were taking an instructional design course while doing the study. Each group was studied as an individual case and analyzed for similarities and differences by referencing an existing theory-based pattern (Yin, 1994).

Procedure

Each group of participants was assigned a project in which they needed to design multimedia-based English as a foreign language (EFL) instruction for local elementary level children. The project was designed according to the

assumptions of PBL (Blumenfeld et al., 1991): (a) the context supports extended, student-directed investigation of a complex problem; (b) doing and learning are inextricable; and (c) technology is used to support learners in collecting, analyzing, and integrating information, and it required the participants to analyze, design and develop, and implement and evaluate. During the course, design principles and various technological skills such as using Dreamweaver, PhotoImpact, and Flash were taught.

To carry out the project, first, each group observed and analyzed a classroom of elementary students. Next, utilizing different technology applications they designed instructional materials for the target students and developed a learning website based on their analysis. Then, to implement their developed projects, they launched the website for the students to use, and finally they evaluated their own work with the assistance of the instructor and elementary school teachers.

Think-aloud protocol was used during the process of the project and follow-up interviews were conducted at the end to gather information how the participants went about completing the project. The think-aloud and interviews were videotaped by the researcher or research assistants. During data analysis, the data from the think aloud and interviews were transcribed and further coded by both of the researchers. First, initial analysis and coding of individual cases were done. Then, the codes were indexed and put into themes, and meta-themes and patterns were induced (Miles & Huberman, 1994). Agreement of the coding was made by both of the researchers. To ensure validity and accuracy of the findings, triangulation among different data sources and external audit were employed.

Findings

Research Question 1

The data from this study showed that the process of the PBL facilitated the participants' cognitive learning especially problem solving and knowledge integration and facilitated affective learning towards technology and subject area. The major findings are summarized below.

Facilitating Problem Solving Skills

In the first task where each participant group analyzed a classroom of elementary students, they encountered a problem with the analysis guidelines provided by the instructor. They were required to identify the learners' cognitive, affective, social and physiological characteristics and they had difficulties understanding what they meant. Our data analysis found that the participant groups sought ways to solve this problem on their own. For example, Group 1, 2 and 7 searched the Internet for definitions, but when it still did not meet their needs, they resolved to their own subjective thinking. Some groups like Group 3 and 9, on the other hand, they reviewed their textbooks for answers. Although some groups were still confused about the terminology, the problem-solving process elicited their prior knowledge and raised their awareness of their present knowledge and what they lacked. Furthermore, it

facilitated their cognitive and metacognitive skills.

Another challenge that the participant groups faced was how to integrate multimedia into their instructional design. The data showed that they made use of their analysis from the observation and the instructor's guidelines in the process of developing their instructional materials, but frequently they needed prompts from the instructor to engage in deeper cognitive process to determine the needs of the learners and to develop their materials. Moreover, low proficiency of some software applications of some participants created problems when developing their learning websites. For example, Group 1 spent a lot of time on exploring one of the effects in Flash. Nevertheless, the participant groups used different angles, such as looking at the learners' English level or the learners' interest in English, to determine the needs of the learners and used various rationales (e.g. putting emphasis on listening and speaking skills or reading skills) in their design.

Allowing Knowledge Integration

In order to effectively design a multimedia-based instruction for the target students, the participants needed to integrate their knowledge of instructional technology and principles of language learning and teaching which they had learned previously. However, the participants found it difficult to integrate their previous knowledge into this project because most of them could not recall relevant information. Again, some of them then search on the Internet or reviewed their textbooks to refresh their mind of the necessary information. More often, they consulted their instructor and relied on their group members' input.

Supporting Autonomy Learning

The interview data revealed that this project enhanced participants' autonomy and motivation of learning and induced positive attitude towards designing multimedia-based instruction. This project forced the participants to take control of their learning and to carefully examine and evaluate factors that are salient to effective instruction. For example, in order to successfully complete their project, some groups took their own initiative to learn a software program called Hot Potatoes. Some participants expressed that they like this project because they perceived the relatedness of their previous knowledge to this project. They also indicated that this project allowed them to understand multimedia technology and instructional design more in depth, and which promoted their interest.

Research Question 2

The Role of the Teacher

This study found that the instructor served different roles in different times throughout the process. At the

beginning, the instructor acted as a facilitator to promote information search, question generation and group discussion of the participants. In the design and development stage, the instructor became the resource person to offer the participants assistance on necessary information and skills, especially those related to technology. In other times, the instructor acted as a coach to provide them guidelines on how to complete the project and a monitor to supervise their progress.

The Roles of the Peers

The participants in their groups relied heavily on each other, especially those who were more knowledgeable in the related field. The peers, like the instructor, were also acted as the resource persons. Furthermore, they were collaborators. The participants shared their work, helped check each other's work and collaborated to complete the project in their group.

Discussion

The qualitative findings claimed that PBL supports students' cognitive and affective learning. Most students had little hands-on experience where they were in charge of both designing and developing a project. Going through this experience, students were able to consolidate their knowledge, which helped them develop a solid knowledge base. Learning by doing allows students to activate their prior knowledge and apply their new knowledge. To effectively integrate technology into teaching, students had to make use of their knowledge of teaching methods and strategies. The project-based learning also served to stimulate students' autonomy and encouraged them to better understand or find out solutions on their own. Additionally, our qualitative findings showed that asking students to put the pieces together was challenging and cognitive levels varied across groups. It could be that the students did not learned effectively in their previously courses so that their knowledge was still on a shaky ground and their understanding of the subject was not mature. Learning through doing a project requires higher cognitive skills. For students who sought to activate their prior knowledge and made an effort to consolidate with new knowledge were able to design and develop better products.

This study found that the students were not able to skillfully apply and integrate previous subject knowledge into the projects. Therefore, it is important for the instructor to engage the students' previous subject knowledge when assigning projects. It would be beneficial to let students collaborate in groups so that students can learn from each other, complement each other and learn to value others. In groups, students will be able to discuss and negotiate with each other, which can help student develop their cognitive and metacognitive skills.

This study also yields important implications for teachers who would like to integrate project-based learning. The study found that the guidelines for project requirements should be clear and straightforward. Teachers who like to implement project-based learning should also be aware of the necessary knowledge students should already

possess before starting the project. To better help students complete the project, the roles of teachers and peers are essential. Although teacher plays an instrumental role in the project direction, peers learning is important resource for project completion. In addition, teachers should play different roles in different stages of students' project-based learning. For the phase of project planning and designing, our results suggest that prior knowledge activation is a key that our teachers should scaffold. To foster prior knowledge activation, the students could be asked to recall everything they can about the topic being learned, prior to beginning the learning task. Teachers' supports are particularly crucial to learning. Prompts and feedback are examples that teachers can use to encourage their students effective strategizing.

Table 1: Percentage of Efficacy Level towards Different Technology Application and Performing Tasks Related to Technology among Groups

Level	Percentage of efficacy level toward different technology applications		Percentage of efficacy level toward performing tasks related to technology
	Web page design, graphic editing and animation	PowerPoint editing and text editing	
Low	70%	20%	10%
Low to Intermediate	0%	0%	50%
Intermediate	30%	70%	40%
High	0%	10%	0%

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