A Study of Uses of ICT in Primary Education through Four Winning School Cases in the Taiwan Schools Cyberfair

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ABSTRACT

The purpose of this study was to understand, describe and interpret the uses of information communication technology (ICT) in primary education in the Taiwan Schools Cyberfair as a means to expand and enhance student learning in an extra-curricular setting. Four winning schools, with 48 teachers and students involved, were purposefully selected for study. The research findings revealed that students in each group were highly motivated through the extensive use of ICT. Through long-term engagement with ICT, students were empowered to conduct both wider and deeper exploration of their selected topics of interest. We report and describe the effects of using ICT. In this study, three collaborative learning models for applying ICT in project-based learning (PBL) mode are identified in the specific contexts: the SCGP model (same class, grade, and project); the DCGSP model (different class and grade, same project) and the DCGP model (different class, grade, and project). In addition, we identify a new and important collaborative model, SPECS, which stands for school (intra), parents, enterprises, community, and school (inter). The SPECS model connects all the possible participants involved in the ICT-enabled activities that contributed to the success of the outstanding performances of the four winning schools at the Schools Cyberfair contest. In the conclusion we discuss some specific issues relating to PBL.

Keywords

Technology-facilitated learning in complex domains, Project-based learning (PBL), Web system supported learning, Online learning, Learning effects, Collaborative learning

Introduction

With the advent and pervasiveness of information communication technology (ICT), the Internet has been widely accepted as an important tool in life and education in recent decades. Active diffusion of information technology through investments in national information infrastructures and education has become a world trend (Halverson & Collins, 2006). In order to adapt to this technological innovation in education and to keep abreast of world trends, Taiwan's Ministry of Education (MOE, 1999; 2003) holds the diffusion of IT in education as one of its major tasks and has invested a great deal of money towards it since the early 1990s. Consequently, the availability of computer equipment is not a major problem in facilitating IT in education in Taiwan. As a result, the facilities in most of the computer labs and for teacher training have been greatly improved. It is anticipated that education reform can be further accelerated and learning opportunities increased.

However, in Taiwan the traditional goal of education and the prevailing social value of obtaining a high grade continue to dominate the core practices of schooling (Young, 1999a, 1999b, 2000a, 2000b, 2001, & 2006). Observations of school practices indicate that the national policies on implementing IT in education, such as the inclusion of supplementary digitized learning resources, have indeed had some impact on teachers and motivated them to change. In general, however, there is not much widespread use of technology practices in most schools' regular curricula.

Overwhelmingly, core instructional practice is still examination-oriented, and the use of ICT in teaching practice in schools remains marginal. Most of the time, the positive effects of applying IT arise from specially funded experiments during certain periods of time. Those teachers who were early adaptors of technology were more likely to adapt to the change by taking on projects such as providing additional alternative options for students (Young, 2006).

ICT in education is being promoted and studied in various countries and, in general, these countries' goals are similar: to provide more effective learning and competitive manpower in the international market. However, research conducted in any one country may not yield results completely applicable to other countries because of cultural

differences, educational traditions, economic status, or political priorities. Every country has its contextually specific problems (Belland, 1998). This study reports on an investigation of uses of ICT in primary education in the Taiwan Schools Cyberfair as a means to expand and enhance student learning in an extracurricular setting. It documents how ICT has been integrated into an alternative instructional setting through project-based learning (PBL) and cooperative learning. It puts forward the case that, ultimately, ICT enables learners to open up a new window to the outside world and bridge the information divide.

Literature review

Project-based learning (PBL) is a constructivist pedagogy and class-oriented learning approach. Unlike traditional learning which is short-term, subject independent, teacher-focused, and mostly constrained to classroom settings, PBL involves long-term, theme-based learning and student-centred activities that focus on daily life problems and allows learners to use an inquiry-based approach to engage with issues and questions that are real and relevant to their lives. When conducting PBL, teachers encourage students to choose topics of their own interest, and set specific questions in a well-planned framework that is wider than the immediate task at hand. Students can gain knowledge, ask questions, and find solutions during the research process (Curtis, 2001; GLEF, 2001).

In project-based learning, teachers actively supervise students by taking the role of project facilitator instead of instructing them (Thomas, 2000; Curtis, 2001; Wong et al., 2006). Teachers support students not only as a source of knowledge, but also as co-learners/peers in their activities. In a PBL environment, teachers are no longer the centre of learning. Rather, students design their own activities and answer driving questions. Through the process of question-raising, cooperation, data collection, communication, and result demonstration, a highly engaging atmosphere and rich learning environment that focuses on students is thus created (Marx et al., 1997). Moreover, teachers in a PBL environment are not only leaders in the classroom but also do a more complex and important job. They are not only course designers or assistants in learning activities but also judges to evaluate learning effects (Delisle, 1997). In PBL, by asking questions, cooperating with others, analyzing data, and communicating with each other, students can create a student-centred learning environment or learning community (Blumenfeld et al., 1991; Marx et al., 1997; Erstad, 2002).

The long-term studies conducted by the George Lucas Educational Foundation (GLEF, 2001) conclude that PBL has many benefits for students, including:

- deeper knowledge of subject matter;
- increased self-direction and motivation;
- improved research and problem-solving skills.

According to the study of Challenge 2000 Multimedia Project by SRI (2000), the research findings indicate that student participation in learning activities changed through their involvement with PBL. Teachers reported that their students became more self-regulated learners, engaging more actively in classroom learning, taking responsibility for their learning, and becoming more skilled collaborators with their peers (SRI, 2000). In other words, the students' PBL activities displayed increased motivation, increased responsibility for their own learning, better peer collaboration, improved content mastery, better understanding of target audience, greater self-confidence and self-esteem, more peer teaching, better technology skills, more time on task, and more skill in analyzing and problem solving (SRI, 2000; Ullah, 2003).

In the information era, when ICT is used in a meaningful way in project-based learning, students work in teams to conduct research using a variety of sources, ranging from digital information on the Internet to interviews with selected interviewees. They explore real-world problems over an extended period of time and ultimately create digitized presentations to share what they have learned (Curtis, 2001; GLEF, 2001; Wong et al., 2006). Students' learning benefits include increased confidence in both written and spoken communication and ICT skills, as well as enhanced project skills. Students learn how to build, manage, and share their web-based resources within and across the project groups.

Johnson and Johnson (1994) point out that collaborative learning allows learners to work together to achieve mutual learning goals. Sharan and Shaulov (1990) suggest that collaborative learning increases interdependency and helps fulfil learning goals through cooperation and assistance among learners. Students can acquire the abilities of

communication and coordination. They are willing to comment on each other's work, share personal viewpoints, express their own opinions, and learn to accept views different from their own. Through organized and systematic teaching strategies, teachers are able to group students of different abilities, sexes, and backgrounds together to learn jointly, share experiences, and receive recognition from peers (Johnson & Johnson, 1994). Individual learning effects are upgraded by interesting activities and interaction among group members.

In sum, we know that collaborative learning is a well-arranged and methodical teaching strategy that improves student learning. In this cooperative model, students help each other in the learning activities. Also, students' self-esteem is enhanced in their academic establishment. Meanwhile, students learn how to respect others (Slavin, 1985). Therefore, with various learning activities, effective learning is obtained by improving students' motivation, academic performance, and problem-solving skills.

Project-based collaborative learning uses ICT to arouse students' motivation to learn, impelling students to participate actively in online discussions and deep research (Polman & Fishman, 1995; Erstad, 2002). They collaboratively investigate questions of daily life and work with peers or teachers for the solutions (Blumenfeld et al., 1991).

Although the Taiwan Schools Cyberfair events draw much participation and attention nationwide, not much related research work has been conducted on this basis. Therefore, through in-depth study of the four representative elementary schools that have performed outstandingly in the contest, we hope to shed light on the uses of ICT with PBL and try to identify the collaborative models employed in the extra-curricular educational settings supported by ICT.

Background to this study: About the Taiwan Schools Cyberfair

The Taiwan School Cyberfair is based on the International School CyberFair, a global contest in designing project-based learning (PBL) websites put on every year since 1995 by the Global SchoolNet Foundation. Winners selected by both peer evaluation and experts are awarded certificates, money, and prizes. Their achievements are displayed on the official website, available to other students all over the world. Since 2000, the contest in Taiwan has been held once a year to promote information education, reduce the digital divide, encourage new teaching practices, facilitate cultural exchange, and broaden students' international awareness through the use of ICT in their learning and living settings. The official website provides students with system support helpful to their projects. Students wishing to join the contest are required to register online and, after registration, they would be validated to become formal participants of the contest. The interactive modes of PBL supported by ICT are shown below in Figure 1.

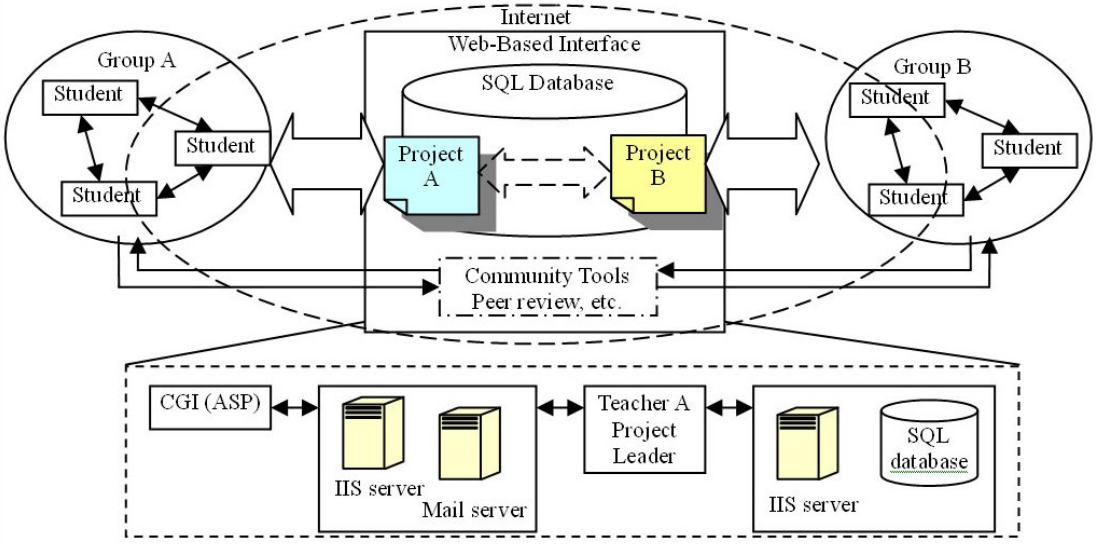

Figure 1. PBL supported with ICT

The extensive application of the PBL approach in Taiwan can be identified among the activities of the Taiwan Schools Cyberfair. The Cyberfair contest, based on PBL, has both global and local significance. Students participating in the Schools Cyberfair work in small groups. They collaborate with each other, facilitated by teachers. Each group is assigned a task, and the members cooperate to fulfil it. Along the way, through the process of repetitive discussions, students achieve more effective learning results than they would have through individual learning. This type of project provides students with the opportunity to obtain a more in-depth understanding of their community through project-based action studies and to present outcomes via multimedia on the Internet. The activities incorporate valuable cooperative learning within and between countries and communities. Ultimately, the localized content pertaining to different countries displayed on the Internet helps facilitate the development of global concerns and visions.

Purpose of the study

The purpose of this study was to investigate the alternative ways of applying ICT in primary schools in informal educational settings in Taiwan. The results are anticipated to shed light on the potential applications of ICT in the Schools Cyberfair, which offers the students a stage to present their technological competence and collective web projects to their peers as well as to seek a flexible combined learning approach and model through the uses of ICT.

Research questions

In order to explore the potential uses of ICT in primary education for alternative learning opportunities, the study asked the following specific questions:

1. Since participating in the Schools Cyberfair contest requires group commitment and long-term (at least six months) engagement, what are the possible student motivations in being actively involved in the web-based project contest?
2. What might be the teachers' cooperative model of adopting PBL? What might be the collaborative models applied by the winning teams in producing web projects with the support of information technology? What might be the overall cooperative model identified from the contest?
3. What are the students' learning gains in this kind of extra-curricular learning setting?

Methodology

The methodology employed in this study is primarily a qualitative approach. This study is interpretive and descriptive in nature and uses the case-study method. Case studies are used to examine a specific unit such as an event, a programme, an organization, and a time period in depth and detail, in context, and holistically (Merriam, 1988; Patton, 1980; Stake, 1995). In addition, quantitative data, such as student demographic information, is also included. The researchers conducted individual and group interviews with the students and the teachers at school sites. Online questionnaires requesting personal and background details of the teachers and students (demographical data such as sex, age, computer skills, and Internet use) were administered to the participants at the beginning of the study. In addition, observations were conducted intensively on the Internet, focusing on subjects' online PBL learning activities, including the collection of their electronic data from journals, chats, discussions, and email exchanges on the Internet. The research was also concerned with how the students collectively designed and presented their web materials and how they interacted with the distributed students. Triangulation was used to improve the probability that findings and interpretations would be reliable.

Data collection

The data-collection methods and tools for this study included a questionnaire, telephone interviews, online data collection, activity observations, and quantitative data analysis of the web projects produced by each group.

Duration of the study

The study lasted about a year and a half, from September 2003 to February 2005 and comprised three major phases:

1. Preparation and orientation: September 2003 to January 2004: participants' school learning activities in preparation for the Cyberfair contest;
2. Participation and collaboration: February 2004 to July 2004: Participants' collective effort in the web project, online journal keeping; and
3. Follow-up data collection: August 2004 to February 2005: follow up interviews with the students and teachers at school sites.

Data analysis

The data analysis procedure included two main phases: the descriptive statistical data analysis and the qualitative data analysis. Regarding the descriptive data, SPSS software was used for data storage, and for the calculation of frequencies and percentages. The qualitative data analysis was guided by the research questions stated previously. The analysis evolved around the data reduction, organization, and matching as well as the generation of categories that resulted from the study of all data sources. Questionnaires and interviews were the primary data source for this study. Observation notes, online journals, related documents, and web logs were used to provide an extensive understanding of the study and PBL contexts. Demographic data related to each case school's background information and information technology status and students' profiles were reviewed. The categorized data eventually assisted the researchers in data interpretation, drawing conclusions, and verification.

Limitations of the study

The present study has certain limitations that need to be taken into account. The four winning cases were carefully selected for study. The number is too small to be representative of the elementary-school population in Taiwan so the findings cannot be directly generalized to the larger population. The validity and the reliability of the study are limited by the level of honesty in the participants' responses to the instruments.

Results and discussion

For a better understanding of the four school cases and participants, we first focus on the participants' profiles and then address the research questions, including looking at students' motivations in participating in the PBL web-project contest, the SPECS collaborative model derived from the PBL supported with ICT, three PBL-collaborative models enabled by ICT, learning effects of PBL activities, and analysis of applications of ICT in project-based learning.

Participants and four school cases

Four winning schools from the Taiwan Schools Cyberfair contest were identified as four cases for in-depth study. They were selected according to their ethnic origins, regions, contest themes, and willingness to participate and came from different parts of Taiwan, representing eastern, southern, rural, and urban areas. The four winning schools together comprised 48 subjects (36 students and 12 teachers). They participated in the theme of "local features for sightseeing." Their schools and locations are listed in Table 1. To preserve subjects' privacy and confidentiality, the information has been coded.

Each of the groups consisted of eight to ten students, with three teachers as advisors (Table 1). The teachers in this study consisted of nine males and three females. Their age range was 25 to 46 years, with a mean age of 29.58. They created a PBL learning environment, helping students to create their own web project.

Table 1. Basic information for the four schools and participants

	School Code	Location	Total number of students in each school	Students participating in PBL projects	Teachers participating in PBL projects
1	School B	Northern mountain area	65	10	3
2	School H	Northern city area	1985	8	3
3	School U	Central rural area	1800	10	3
4	School K	Off-shore remote island	134	8	3
Total = 48				36	12

Of the four schools, B, H, K, and U, two (school B and school K) were mini schools with 65 to 134 students. School B is in a remote mountainous area in northern Taiwan. Most of its students are aboriginal. School H is located in the town of Dan-shui, in Taipei County. School U is in the village of Yong-jing, in Chaung-hua County, which is in the central part of Taiwan. School K is in Jin-men County, on an off-shore remote island.

Information technology status of each school and the students

The information technology status of each school and the subjects will help us understand more about the computer access of those students in this study. Table 2 below indicates the school locations, computer facilities, and percentage of participants' with personal home computers.

Table 2. School location, computer classrooms and the rate of ownership of personal computers

	School code	Number of computer classrooms/computers	Number of participants' personal home computer ownership/rate	
1	School B	1/18	3/10	(30%)
2	School H	2/80	6/8	(75%)
3	School U	1/38	8/10	(80%)
4	School K	1/32	8/8	(100%)

Among the three schools in Taiwan (schools B, H, & U), the percentage of the participants' personal home computer ownership in School B (30%) is far less than that of school H (75%) and school U (80%). It seems that the IT resources vary according to school locations. However, the technological equipment in school K, on the off-shore island, is almost the same as that in the other schools in Taiwan. Surprisingly, the participants' personal home computer ownership in school K is 100%, even higher than the percentage of ownership among students from the schools in Taiwan. This indicates that the parents in school K show great awareness of the importance of information technology in their children's lives. This point was further verified by interviews with teachers who reported that the parents in school K offered great support and assistance to the students during the project-making process. Conversely, parents at the other schools tended to be less involved in students' project-making because they were too busy with work.

Student motivations for participating in the PBL web project contest

According to the data collected from the student questionnaires, interviews, and observations, student motivation to be engaged long-term in the PBL web project contest held by the Cyberfair can be categorised into five types:

1. ***Personal interest.*** According to our analysis of the questionnaires, almost all of the students found the PBL scenario combining teaching and outdoor activities in the real world to be very "interesting" and "fun" (B04, B05, B06, B07, H01, H04, H06, H08, U04, U05, U09, U10, K02, & K05). Students U01 and H03 were also curious about a method of doing project research that was not common in regular lecture-based teaching settings. Their

learning interests were piqued and they were excited to take part in related learning activities outside of school, during their leisure time. Data from the questionnaires revealed that the students gave overwhelmingly positive feedback to PBL, combining the networked system offered by the contest organizer and noticing that they had gained a lot through the PBL activities. The following comment reflects this sentiment: "I found that this activity is great, even if I didn't win the prize… Learning how to make use of the Internet correctly and knowing more about computer technology made our life rich and interesting!" (H05).

2. ***Gaining situated knowledge and skills.*** Students got involved in authentic affairs in the real world and outdoors through PBL activities. In conducting a PBL web project, they had to collectively make a plan in advance, allocate individual work, find supporting resources, go out to collect documents, take pictures, and interview people using digital cameras and recorders, etc. They applied their newly acquired IT skills and knowledge in real-life situations. The students felt that they learned new knowledge and skills from the extracurricular activities (B09, B10, H01, H04, H05, H06, U02, U03, U04, U05, U07, K01, & K06) (Brown, Collins, & Duguid, 1989).

3. ***Winning awards.*** The main motivation for most of the students to participate in this project-making activity was to win a prize. Some students said that if they were to win, they would feel very proud because they would "receive the awards and medals in public" (U05 & H05). The goal of achieving recognition appeals to the students' inner sense of honour, impelling students to participate actively in the contest (U04, U05, H05, K05, & K07).

4. ***Encouragement from teachers or schools.*** There are two kinds of encouragement: teachers' encouragement to students; and the encouragement from school administrative officials.
   1) Teachers' encouragement. Teachers in the four schools actively asked their students to take part in the contest and pushed them to make the projects with additional support during out-of-class time.
   2) Encouragement from the school. For example, the principal of School B has encouraged students to participate in the contest since 2000. At Schools H, U, and K, the school officials offered a lot of assistance in obtaining software and hardware as well as providing other resources for the students.

5. ***Helping boost local tourism via the Internet communication.*** The four groups in this study all signed up in the "local tourist resources" category of the Taiwan Schools Cyberfair. The purpose of producing their web projects was to present the natural beauty and sight-seeing spots in their hometown. In order to give an overview and provide in-depth information about their chosen sites from different aspects, students in each group had to study historical events, culture, the origins and significance of local spots, and agricultural projects in order to help boost local tourism through the Internet, free of charge. In our follow-up interviews with the students and the teachers, they mentioned that the project raised people's awareness of the community and their identity within their neighbourhood (B05, B09, H03, H05, U03, U05, U07, U09, K01, K02, K07, & K08). They hope to advance economic development and increase local prosperity through this IT-boosted event led by the younger generation.

Teachers' collaborative model of structuring PBL with the students

According to our interviews and observations, we have identified three major roles that the teachers played during the projects:

1. Project leader. The project leader is in charge of project integration, planning and, knowing students' abilities, working with students to decide the project direction and goals and set the timeline of the project. This role was dominant and important to the success of the project.
2. Website technician. The website technician's role was to mainly give professional opinions on making the website, instruct students on how to use all kinds of editing software and hardware, maintain computer facilities, and solve problems related to website creation.
3. Coordinator. The coordinator was in charge of external and internal communication, combining ideas of students and other teachers and communicating with related organizations.

The three kinds of teachers had their own contributions to the projects. They worked together to assist students make the project run smoothly (see Figure 2).

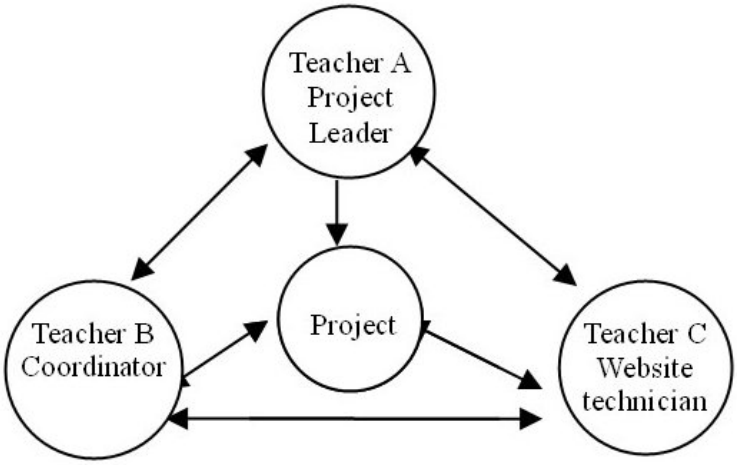

Figure 2. Teachers' collaborative model

Three PBL collaborative models enabled by ICT: SCGP, DCGSP, & DCGP

By analyzing the make-up of each group, the observed data, and student ways of collaboration, we identified three collaborative models: (1) SCGP Model (same class, grade, and project), (2) DCGSP Model (different class and grade, same project), and (3) DCGP Model (different class, grade, and project). (See Table 3.)

Table 3. Three PBL Collaborative Models Enabled by ICT

	Models	Ways of collaboration	Representing schools
1	**SCGP**	Collaboration with classmates (same class, grade, and project)	Schools U & K
2	**DCGSP**	Collaboration with different grades (different class and grade, same project)	School B
3	**DCGP**	Collaboration with different grades and projects (different class, grade, and project)	School H

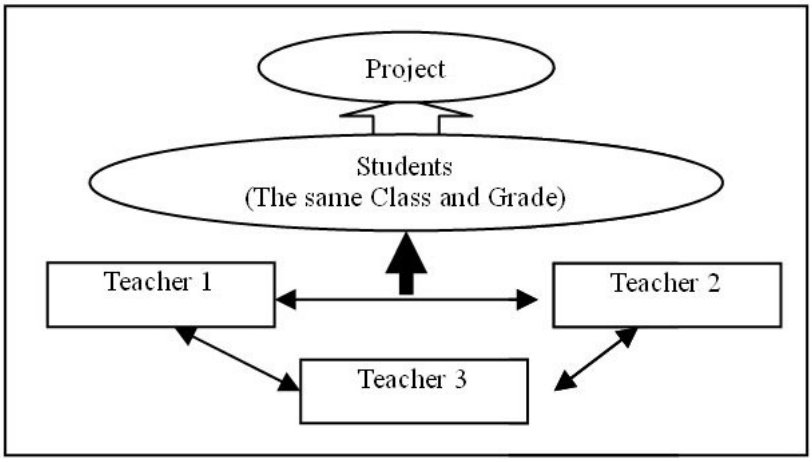

Figure 3. SCGP model

During the PBL process, it came to our attention that the students in the four schools had the flexibility to break the class or grade constraints by expanding their cooperation beyond their own classes. Use of the networking technology meant that students could form a project group transcending the limitations of classes, grades, space, and

time — something that was otherwise not possible before the advent of ICT. Excitedly, they communicated, shared information, and exchanged digital files on the Internet. These kinds of cross-class or cross-grade cooperative groups gave students more stimulus and experiences, allowing students to create different learning environments in the given situations.

1. SCGP model (same class, grade, and project)

The groups in schools U and K belonged to the same class. Three teachers helped organize group members to work on the project together after school. The members communicated and shared individual results through e-mail and networked file-transferring software. For those teachers, the Internet became an important tool to monitor student progress and give students advice on time management. This model is common nowadays in school settings, which makes it easier for teachers to teach and easier for students to interact with each other (Figure 3).

2. DCGSP model (different class and grade, same project)

The working model of school B showed that the leading advisor was a fifth-grade teacher. After discussing with students, the advisor led the group to initiate their project and conduct interviews. A sixth-grade teacher was involved in this project, too. Three sixth-grade students were invited to work with them. Therefore, the project was made by a group of fifth-grade and six-grade students who made concessions in their leisure time to work on the project. In this case, the students were tied closely to the project, having incredibly great interaction (Figure 4).

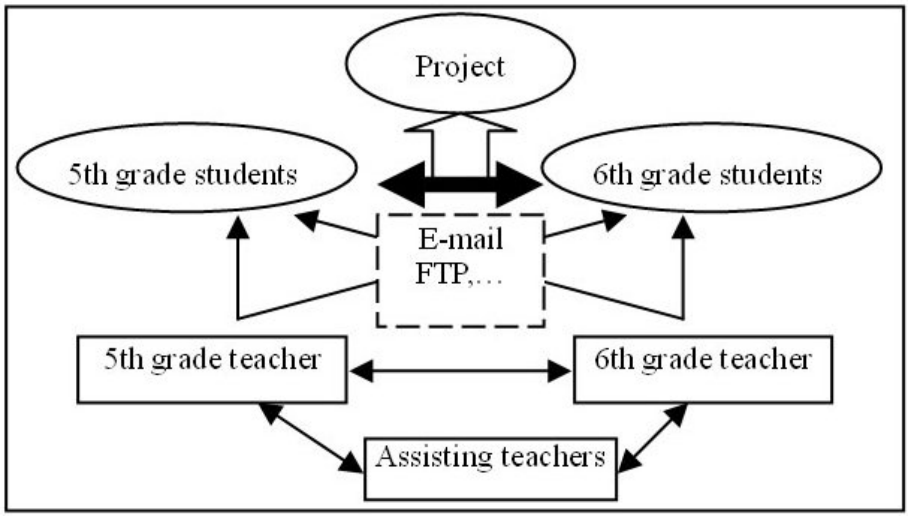

Figure 4. DCGSP model

3. DCGP model (different class, grade, and project)

The collaborative DCGP model (Figure 5) of school H was a cross-grade integration. Because of the great promotion of the competition by the school, there were up to four groups participating in the web project contest. The group in our study was composed of fifth-grade students, while the other three groups were made up of sixth graders. Though the project title of each group was different, the content was centred on the natural and cultural neighbourhood of the school, which resulted in repeating the same interview subjects. Thus the data collected by different groups could be integrated and shared. Juniors and senior students could exchange resources, share information, and learn techniques by e-mail and FTPs. The model made the process more competitive, and enabled the students to be actively involved in their project (HT1).

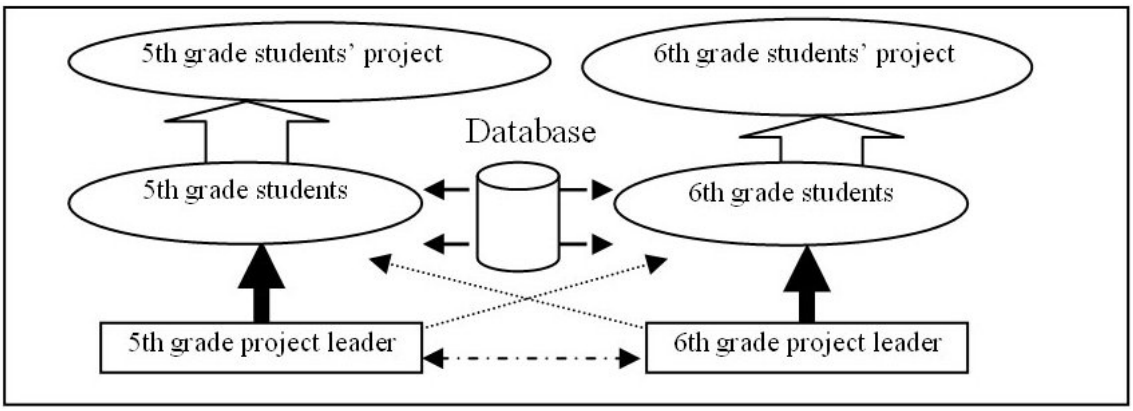

Figure 5. DCGP model

The researchers noticed that the project participants of schools B and H went through all kinds of cross-grade learning activities. Both teachers and students had to deal with the difficulties of time, space, student proficiency, and age difference. However, the PBL learning environment that combined the applications of networked technology made this possible. Furthermore, in addition to the teachers, the senior students also helped the younger ones with their learning. The students could enhance their ability by stimulating or challenging each other. The new cooperative models shed light on different approaches of learning and teaching with the integration of ICT in traditional educational settings.

The SPECS collaborative model of PBL supported by ICT

The data collected from our prolonged engagement and persistent observations in this study supported the SPECS collaborative model of PBL supported by ICT. The SPECS collaborative model, standing for school (intra), parents, enterprises, community and school (inter), connects all of the possible participants involved in the ICT-enabled activities that contributed to the success of the outstanding performances of the four groups at the contest. The SPECS collaborative model is shown in Figure 6.

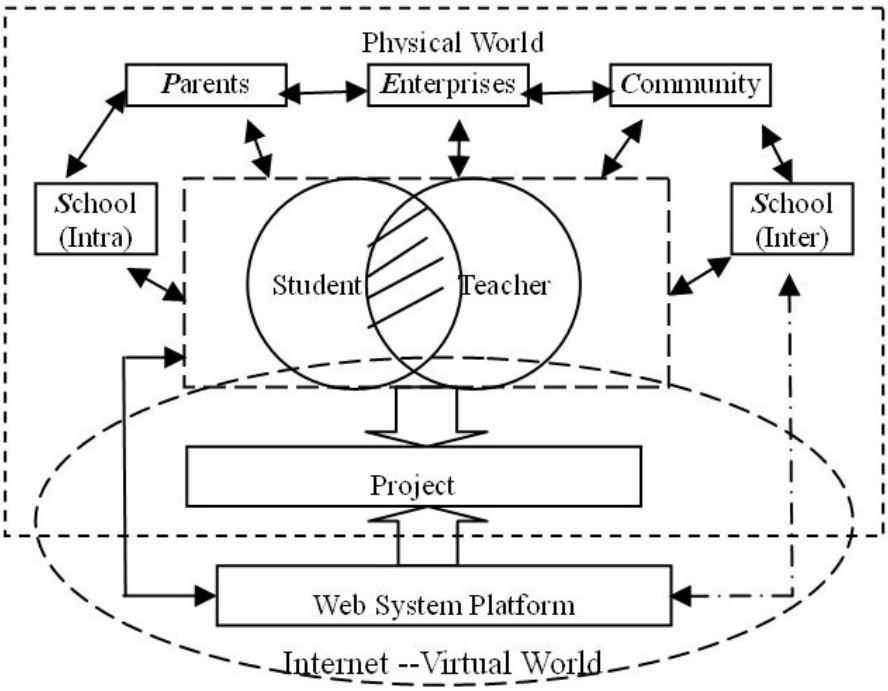

Figure 6. The SPECS collaborative model

We noted that when the students and teachers were carrying out PBL activities on the web projects, there was a lot of assistance from teachers, schools, parents, communities, and other groups. The phenomena indeed are not common in most of the communities or our society in Taiwan. However, the online contest, visible and accessible to most people, has changed the atmosphere and has also piqued people's interests and involvement regarding the activities. The community and parents worked together in securing travel arrangements and safety for the students' field trips. Local literature and history resource centres cooperatively provided students with precious historical data and pictures. For example, when students of school B encountered linguistic difficulties in communicating with tribal elders in their mother tongue, parents volunteered for interpretation and data collection. Schools U and H obtained a lot of important data from local literature and history workshops, local enterprises, and civil, cultural, and educational institutions. Impressively, the members of school K on Jin-men Island received help not only from local people, but also from residents from across the strait in Taiwan.

With PBL, students could expand their learning arena to places off campus and in the community. The assistance from the schools, parents, community, and other groups enabled the students not only to seek resources and help from outside of the school campus but also to gain communication skills through the process of talking to elders or strangers.

Learning effects of PBL activities and network system to support PBL activities

Both the statistical and qualitative results of the learning effects of the PBL web project and the effects of using the information system to support PBL activities are presented below. These results are based on the questionnaires, students' online journals, and interviews with the students,

The questionnaire was composed of nine 5-point Likert-scale questions, in two parts: students' perceptions of the learning effects of PBL activities and students' perceptions of the effects of using the information system to support PBL activities. A total of 30 questionnaires out of 36 were collected and used for analysis. The descriptive statistical results of this questionnaire are reported below (Table 4).

Table 4. Results of the questionnaire
Students' perceptions of the learning effects of PBL activities and students' perceptions of the effects of using the network system to support PBL activities

(5 Totally Agree; 4 Strongly Agree; 3 Agree; 2 Strongly Disagree; and 1 Totally Disagree)

I. Students' perceptions of the learning effects of PBL activities (N = 36)		**(%)**				
	Statements	**5**	**4**	**3**	**2**	**1**
1.	I could learn in-depth information systematically through group work by means of the PBL approach.	33.3	53.3	13.3	0	0
2.	I have experienced new information presentation skills collaboratively in the process of doing the PBL project.	63.3	26.7	10.0	0	0
3.	I could apply computer skills and literacy gained in the class to the PBL web production project in the extra curriculum setting.	33.3	46.7	20.0	0	0
4.	I acquired much more knowledge and applied new of writing skills beyond the regular classes in the process of doing PBL project.	60.0	30.0	10.0	0	0
5.	I have learned and applied a lot of communicative skills in the process of doing the PBL project.	30.0	50.0	20.0	0	0
II. Students' perceptions of effects of using the network system to support PBL activities						
	Statements	**5**	**4**	**3**	**2**	1
6.	I have learned to apply a lot of information communication technology (ICT) skills through engaging in the PBL project in designing and producing the webpage.	46.7	40.0	13.3	0	0
7.	I have used the information system on the Internet frequently in the process of doing PBL project and thus my WWW information and my personal	46.7	40.0	13.3	0	0

	knowledge has been increased and enhanced.					
8.	The use of the information system on the Internet helped me improve my learning effectiveness in doing PBL project.	43.3	40.0	16.7	0	0
9.	Reviewing the other groups' web projects displayed on the "works exchange area" and "exhibition area" on the Internet as a result of the PBL contest has increased my personal knowledge and ICT skills and upgraded my views.	50.0	36.7	13.3	0	0

According to the students' self-reported data collected by the questionnaire, the nine statements listed in the table received overwhelmingly positive responses from the students. The data indicate that students could benefit from the PBL approach in doing the group web-producing project in terms of in-depth information, new ways of knowledge acquisition, applications of computer skills, and acquiring many new skills and knowledge beyond the regular classes as well as communication skills.

The data collected from the students' online journals and interviews further showed that students found the most useful part of the network system provided by the School Cyberfair to be the "works exchange area." By reviewing web projects of the others, students K01, K02, K03, K04, K05, K06, U04, U09, U10, and H01 were able to: 1) understand the history of the displayed places; 2) learn techniques of website-making from other students; 3) acquire related data or information; and 4) collect recent and useful information about website production, research direction, and data collection.

The online information system was used by the students as a cognitive tool (Jonassen, 2006). The process of using the information system provided by the Cyberfair organization supports Jonassen's rationales for using technology as cognitive tools. When students work with computer technology, instead of being controlled by it, they enhance the capabilities of the computer, and the computer enhances their thinking and learning.

Throughout the whole process of constructing the project by means of the PBL approach, the winning groups relied heavily on the information system. They kept a daily journal of their progress and wrote their reflexive notes, updated their website, sought problem solving through Q & A, exchanged ideas with other group members, and more. The websites contained abundant resources, databases, related links, and precious experiences and research methods of others that increased students' interest and motivation and impelled their desire for new knowledge. By assimilating new ideas, they built upon their own intelligence and experiences. In the contest, students also acquired critical-thinking skills through reviewing and critiquing others' work (U01, K02, K03, & K06). They were able to figure out problems by themselves, and collect and arrange data. By trial and error they developed their own abilities in solving problems.

Group project links to the curriculum areas

The significance of the Cyberfair is to encourage school children to connect the knowledge they learn in school to real-world applications. Recognition is given to the outstanding projects in each of eight categories: local leaders, businesses, community organizations, historical landmarks, environment, music, art, and local specialties. Table 5 provides the information about the school code, group project title, category, and links to the school curriculum areas of the four winning teams.

Table 5. Project links to the curriculum areas

	School code	Group project title	Category	Link to the curriculum areas
1	School B	An Aboriginal Tribe in the Clouds of Mt. Bulum LaLa	Environment	Computer/information literacy, mathematics, Chinese
2	School H	History of Old Fu-wei Street	Environment	Computer/information literacy, social sciences
3	School U	A half a century of history of the Hon Bridge	Historical landmarks	Computer/information literacy, Chinese
4	School K	Romance and Scenery of the Islets	Historical landmarks	Computer/information literacy, arts and humanities

The project titles of the four winning groups belong to the two major categories of environment and historical landmarks. Since the Schools Cyberfair encourages students to use technology to share what they have learned and to connect the knowledge they learn in school to the real world, obviously all of the PBL projects commonly link to the subject area of computer/information literacy. Depending on the nature and content of the projects, different projects also have a special link to different curriculum areas, such as mathematics (school B), Chinese (school B & school U), social sciences (school H), and arts and humanities (school K).

School B, for instance, merged mathematics into the web project entitled An Aboriginal Tribe in the Clouds of Mt. Bulum LaLa. In carrying out the PBL project, to introduce the specific living environment of the aboriginal tribe, the teachers had to take the students up to the local divine/giant trees areas in Mt. Bulum LaLa. Interestingly, the students had to apply the measurement skills learned in the class to measure the girth of the giant trees, count the tree rings (Figure 7-1), and estimate the height of the giant trees by applying the similar triangle method (Figure 7-2). They had to collaboratively draw a sketch using ICT. In addition, they used a digital camera or a camcorder to record the PBL process at Mt. Bulum LaLa. Significantly, they actually connected the knowledge they learned in school to the real world and then shared the valuable experience with other students on the Internet through the Schools Cyberfair contest.

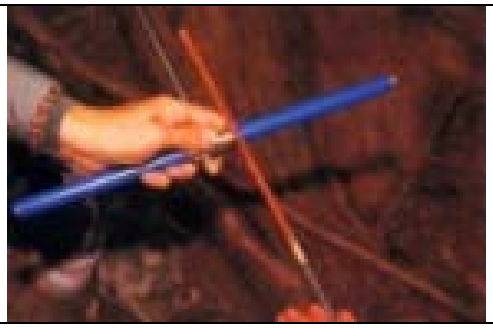

Figure 7-1. Counting a giant tree's growth rings

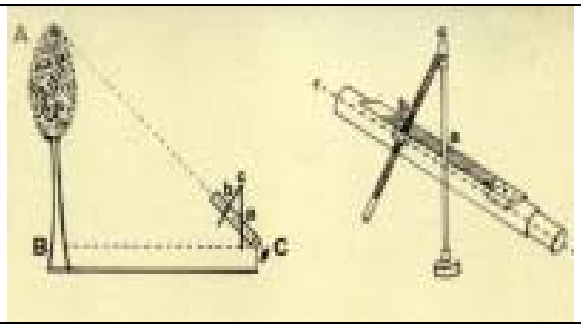

Figure 7-2. Applying the similar triangle method to estimate the height of the giant trees

Conclusion and suggestions

This study set out to understand, describe, and interpret the uses of information communication technology (ICT) in primary education in the Taiwan Schools Cyberfair as a means to expand and enhance student learning in an extracurricular setting. This study reports on collaborative learning models and describes the effects of applying ICT in project-based learning (PBL), based on the four winning school cases in a competition. Eventually the winning teams will be entitled to participate in the International CyberFair by further translating the whole webpage into English with the assistance of English human resources and additional financial aid from the local educational organizations. Through International CyberFair participation, those students will indeed become community ambassadors on the Internet. They could share self-produced local information with the global community that was otherwise impossible without the PBL activities in the extracurricular learning. The students benefited from the integration of ICT in the learning process and have established international connections.

After this longitudinal study, there are a number of research issues that demand further investigation in the near future:

1. Whether or not those teachers adopt these models in formal educational settings to enhance student learning as suggested above, as long as the students continue to benefit from this type of alternative learning mode, what challenges would they encounter in the exam-oriented school culture in formal education settings?
2. If teachers do not wholly accept our methodology and models, will the students who engaged, directly or indirectly, in our study continue to study in an ICT-supported PBL way?
3. What problems might those students face in an exam-orientated school culture?
4. In which ways might assessment processes take into account less prescriptive ways of learning?

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