Title	Virtual project-based learning: A case study of Hong Kong and Singapore students' collaboration
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Source	*MERA-ERA Joint Conference, Malacca, Malaysia, 1-3 December 1999*

VIRTUAL PROJECT-BASED LEARNING: A CASE STUDY OF HONG KONG AND SINGAPORE STUDENTS' COLLABORATION

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Abstract: As we move into a global knowledge-based economy, there is an increasing awareness of the importance of information and telecommunication technologies in learning and instruction. With learning no longer limited to the classroom, students have the impetus enabled by such technologies to collaborate with students of other institutions both local and overseas. One approach that is relevant to virtual collaboration is project-based learning (PBL). The components of PBL are authentic task, collaborative learning strategies, project management, knowledge representation, reflection, and teacher as facilitator (Ang, 1999). In this paper we report on the findings of a collaboration project among students of three schools in Hong Kong and Singapore using a virtual collaborative learning environment. We discuss some key issues on virtual project-based collaboration based on information collected through observation, field visits, interviews, and online conversational logs. These issues are related to information technology development and infrastructure of the schools, coordination, collaboration, facilitation, and tool usage.

Introduction

Conventional school learning too often fails to prepare students for life-long learning. Students are often not prepared for the kind of learning and performance that is required outside the school (Resnick, 1987). Wiggins (1993) points out that "…we cannot be said to understand something unless we can employ our knowledge wisely, fluently, flexibly, and aptly in particular and diverse contexts". Many current theorists argue that thinking is situated, that is, activity, concept, and culture (context) are interdependent. Learning must involve all the three domains. According to Brown, Collins, and Duguid (1989), the components of situated learning include: authentic activity, apprenticeship, coaching (scaffolding), repeated practice, articulation, reflection, collaboration, technology, and stories. Project-based learning provides an approach for addressing these components.

In this paper we report the findings of a virtual collaboration among students of three schools in Asia using a virtual collaborative learning environment. The objectives of the project are:

- To engage students in the collaborative construction of science concepts and skills using a web-based collaborative learning environment.
- To expose and engage students in project work within a web-based collaborative learning environment.
- To provide teachers with facilitation and scaffolding experience in engaging students in collaborative project work.

We discuss some key issues in virtual project-based collaboration based on information collected through observation, field visits, interviews, and online conversational logs. These issues relate to information technology development and infrastructure of the schools, coordination, collaboration, facilitation, and tool usage. In the next section we discuss the project-based learning approach and some of the components that are important in project-based learning. We describe a virtual

collaborative learning environment called *SpaceALIVE!* that was used in our case study. Then we discuss the findings of the case study.

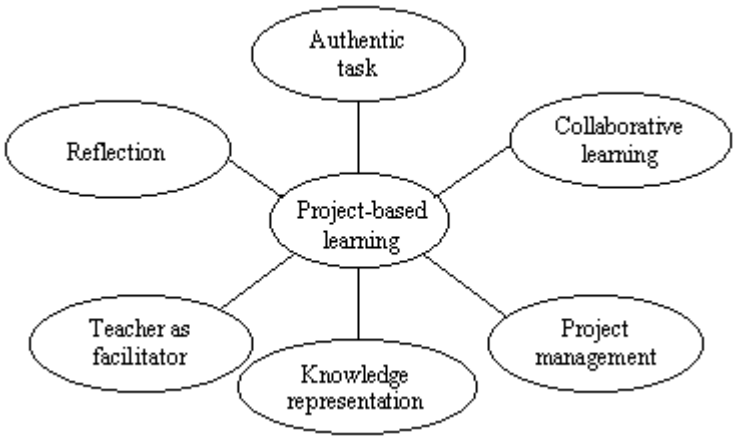
Project-based learning

Project-based learning involves students identifying problems and the generation of activities and artifacts that will solve the problem (Blumenfeld, et al., 1991). The idea of PBL was first heralded by William Heard Kilpatrick, a professor at Teachers College, Columbia University, New York, in the first quarter of this century (Kilpatrick, 1918). He concurred with John Dewy that a school should not prepare student for life but be life itself (Wolk, 1994):

> As the purposeful act is thus the typical unit of the worthy life in a democratic society, so also should it be made the typical unit of school procedure. (Kilpatrick, 1918)

Figure 1 below illustrates some of the components in project-based learning (Ang, 1999). We next briefly describe its components.

Figure 1: Components of project-based learning



Authentic task

In project-based learning, "Students pursue solutions to authentic problems by asking and refining questions, debating ideas, making predictions, designing plans and/or experiments, gathering information, collecting and analyzing data, drawing conclusions, and communicating their ideas and findings to others." (Krajcik, Blumenfeld, Marx, and Soloway, 1994, p. 483). Authentic tasks can help improve the transfer of knowledge.

Collaborative learning

Authentic tasks lend themselves to collaborative work. In collaborative learning, students are engaged in knowledge construction through generation of ideas and the negotiation of meanings within a *shared space* (Jonassen, Pack, and Wilson, 1999; Kane, 1997). Often students have to critique the work of others. In doing so, they become more reflective about their own thinking and are able to evaluate the quality of their work. When students are engaged in collaborative work, they generate ideas, clarify ideas, and evaluate and reflect upon the ideas. Swartz and Park (1994) refer to these activities as the three core thinking skills.

Teacher as Facilitator

In collaborative learning, the teacher plays the role of a facilitator rather than as a mere transferor of knowledge (Jonassen, Park, and Wilson, 1999; Kane, 1997). Teachers set up inquiry projects, arrange access to resources, but once the project begins, they allow students to take diverse learning paths. They give feedback, structure the way to do things, provide hints, encouragement, and reminders, and diagnose problems (Collins, Brown, and Newman, 1989).

Project Management

In project-based learning, students are given the autonomy to plan their project while the teacher plays the role of facilitator. Since a project is not a scripted task, students will be engaged in the complex task of managing projects, which involves authentic tasks. They are required to coordinate activities, such as meetings, review of portfolios, and so on.

Knowledge representation

Constructing and representing knowledge is fundamental to learning. Knowledge once represented becomes a cognitive artifact and can function as a tool for thought. Students engaged in project-based learning develop goals, objectives, and portfolio, which will have to be represented. These representations act as a cognitive tool for other learners in the community (Scardamalia and Bereiter, 1996).

Performance-based assessment

In project-based learning, assessment strategies tend to be more qualitative rather than quantitative. Some popular assessment methods center on student portfolios with examples of the artifacts they produce (Bateson, 1994), and performance-based assessments in combination with checklists of criteria for judging students' performance (Linn, 1994).

Traditionally, project-based learning are carried through students working together on a project. They meet together to discuss and work on their project face-to-face. However, in recent years, students are involved in project-based learning that requires them to work with students from another school or from another country. The advent in information and telecommunication technologies has provided the necessary infrastructure to make virtual project-based learning possible. There have been an increasing number of virtual collaborative learning environments that are available. In the next section we describe the potential of virtual collaborative learning environments in project-based learning. We illustrate one such environment called *SpaceALIVE!* developed by the Kent Ridge Digital Labs (KRDL) in Singapore.

Virtual collaborative learning environments

A virtual learning environment plays three roles in project-based learning (Guzdial, 1997):

- A design environment or activity where the project is going to be created.
- Scaffolding the learning and design activity. Scaffolding is the modeling of good process and coaching students through their effort (Gudzial, 1995).
- Building community. The interaction and collaboration among fellow students can facilitate good learning and effective design (Scardamalia, et al. 1989).

A virtual collaborative learning environment facilitates project-based learning by providing a suite of tools. These tools facilitate the process of project-based learning.

SpaceALIVE! is a virtual collaborative learning environment which consists of a suite of collaborative and communication tools and is integrated with the World-Wide Web. It communicates through HTTP and HTML protocols, thereby supporting multimedia on the web page. *SpaceALIVE!* can be accessed from a Java-enabled browser. The *SpaceALIVE!* client is a normal web browser with a special Java applet running at the bottom as a telnet session. *SpaceALIVE!* exploits the combined power and ubiquity of the WWW, Netscape, and Java.

We next discuss the suite of collaboration objects and tools available in the *SpaceALIVE!* environment for supporting collaboration.

Discussion forum

A discussion forum is a form of asynchronous communication that enables participants to share resources and ideas. Participants can generate, clarify, and evaluate ideas. The ideas discussed are normally threaded with responses to specific comments listed in order by idea. Participants can reflect on what has been discussed at a later stage. The discussion forum can be used as a message board for participants to coordinate activities, such as meeting dates and times.

Electronic mails

Electronic mail (Email) is another form of asynchronous communication that facilitates the sharing of ideas and resources. Unlike discussion forum, email is not threaded or organized by topics. Messages can be sent to a specific person or to a group of people in a distribution list. Hence, group members can send private messages to other group members or to the teacher.

Chat window

The chat window is a communication tool that enables group members to communicate in real time synchronously. Participants can get immediate response to queries and provide feedback. Through the chat window, a history of the conversation can be recorded from the text discussion for reflection.

Construction Tools

Form-based tools can be used to create simple content without programming. Users can express themselves visually using computer tools for creating graphics and animation adding new perspectives. Construction tools are critical in project-based learning for the design and creation artifacts, such as web pages and models.

Presentation Tools

Some web-based collaborative learning environments have tools that can be used for instructional purposes, such as the white board and the web projector. The web projector is analogous to an overhead projector. It allows a student to create slides as web pages and display them to students who are logged on to the session (Looi 1998).

Case study of ScienceALIVE! II

The *ScienceALIVE! II* project was carried out in two Singapore secondary schools and one Hong Kong school from November 1998 to June 1999. Students from the different schools collaborate with one another using *SpaceALIVE!* without meeting face-to-face. Four investigative science topics were selected: future home, acid rain, aroma therapy, and natural paint. Students from each school were formed into four groups, except for Hong Kong, where only one group of seven students was formed. This paper will focus our description and discussion mainly on one collaborative project – *Future Home*.

Teachers from the various participating schools provided facilitation for the teams to work together. This community of students, teachers, technical experts, and researchers interact in face-to-face meetings as well as online using *SpaceALIVE!*. During the project, the researcher logged on regularly to provide online assistance to the students when they encountered technical problems or difficulties. Some teachers also logged on occasionally to facilitate student's online discussions via *SpaceALIVE!*. They also provide offline assistance to the students within their own school. The project teams are encouraged to negotiate on some common times to meet virtually to work on the project.

We have collected data in the form of ethnographic notes of project group activities, interviews conducted with students, online conversation logs, constructed web pages, minutes of meetings, student journals, and other data logged in the system. We have conducted observations of the students collaboration face-to-face when we trained them and subsequently through online observations.

In the next section, we describe some of observation data collected from the *ScienceALIVE! II* project, and discuss how the students and teachers used collaborative tools to support project-based learning processes.

Analysis of ScienceALIVE! II

The analysis reported in this paper is based on data collected from the online conversational logs. We report our findings on the following: IT development and infrastructure, facilitation, collaboration, virtual learning environment.

IT development and infrastructure

The schools differ in their stage of IT development and infrastructure. The two Singapore schools have two computer laboratories each available for students' use. Both schools allocated time for students to make use of the computer laboratory. One of these schools has ten fast speed Internet lines in their computer laboratories. The school in Hong Kong had some problems with providing computer facilities for the students as they were renovating the computer laboratories during the December holidays. As a result, students from this school had to log on from home. This created much difficulty in the collaboration because of the Internet connection speed from home is much slower, that is, students were using 28.8K modems.

Dilemma of synchronizing collaboration in a non-synchronous educational system

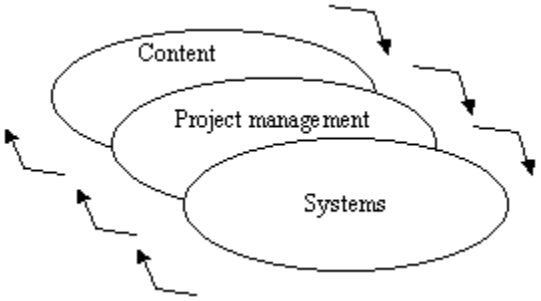
Singapore and Hong Kong differ in their educational systems, that is, syllabus, semester and exam time. It was difficult to synchronize the meeting dates and time as during certain periods, the Hong Kong students have their holidays while the Singapore students do not. Although Singapore and

Hong Kong resides on similar time zone (difference of one hour, GMT time during certain parts of the year), coordination of meetings is still a problem.

Facilitation

As we move from a teacher-centered to a student-centered learning style, facilitation becomes more important. The teacher is no longer the sage, he/she scaffolds the students' learning. However, it is not clear in the literature how the scaffolding process works, especially in a web-based learning environment. From our experience in this project, we suggest that facilitation can be divided into three layers: systems, project management, and content (Figure 2). However, the process in not a static step-by-step process. Rather, it is dynamic in nature, that is, the facilitation can move from one layer to the next and backwards.

Figure 2: Levels of Facilitation



We observed that students needed more help initially on the technical aspects of using the virtual collaborative learning environment and having someone to assist them is crucial to the project. For example, students had difficulty using the *Web Manager*. The *Web Manager* is a tool that allows students to upload their web pages on to the *SpaceALIVE!* environment. Technical experts and the researcher were present online to assist the students should they come across any major communication problems.

The next level is facilitating the progress of the project. The facilitators are the teachers as well as the researchers. The teachers helped the students with resources needed for the project, such as materials for the experiments and computer resources. The researcher may help to facilitate the online meeting occasionally to ensure that the students stay focused. The teachers are the main facilitator as far as content knowledge is concerned. They help point the students to the necessary resources, such as encyclopedia, books, and Internet web sites.

During our field visits to the two Singapore schools, most students commented that the teachers helped them with resources such as ensuring that the computer laboratories are available, providing them with information on the science topic they are investigating, and bringing them to shops to buy materials for their projects.

All the four teams were given the same guidelines for announcements, online meetings and documentation of logs, journals, discussions, experiments done, and the creation of a Web page for each project. Each project developed at a different pace, and the degree of collaboration varies from team to team and project to project. The uneven development illustrates the importance of social interactions among team members, teacher support and school culture (Chen, Mashhadi, Ang, and Harkrider, 1999). The students appeared to communicate well within their respective schools but not across schools. The difficulties arose less in terms of language but more owing to the uneven

teacher facilitation in promoting the flow of communication, collaboration and construction of knowledge offline and online during the school December vacation and the January term.

Context of collaboration

All the collaborations between the schools were conducted online using the virtual collaborative learning environment. From the analysis of the conversational logs, we observed that there were at least three levels of collaboration: social, task, conceptual.

Students spent a lot of time in social communication, that is, mere chatting. This occurred especially at the beginning of the meeting while they were waiting for other members to turn up. The behavior at this level tends to be more relaxed and students tend to lapse into using colloquial language. The conversation below illustrates a conversation between three students. While waiting for the rest of the members to turn up, they talked about exam results.

> Earth emotes, "[to Sea]: i went to school with a whole group n see"
>
> Sea says, "dunno"
>
> Earth says, "let's wait"
>
> Warmth says, "How long?"
>
> Sea emotes, "[to Earth]: how was your results"
>
> Earth emotes, "[to Sea]: not good"
>
> Sea emotes, "[to Earth]: why?"
>
> Earth emotes, "[to Sea]: it's bad, becoz of some reason lah"
>
> Sea emotes, "[to Earth]: oooh"

At the next level, which students spent a lot of time on is coordinating activities and tasks. Because they did not come to the meeting with a proper agenda, they tended to spend a lot of time deciding what to discuss, allocating tasks to be done, and coordinating the next meeting date and time. Below is a conversation between students coordinating the next meeting date and the tasks to be completed.

> Earth says, "we have another meeting to set"
>
> Dimension says, "then tell me the next meeting so that I can put it on before the date"
>
> Carin emotes, "[to Dimension]: we WERE supposed to have come up with the most suitable place on wednesday..."
>
> Earth says, "can meet during weekends?so we decide the next meeting?"
>
> Earth emotes, "[to Carin]: what's done cannot be undone"
>
> Comfort says, "when"
>
> Carin emotes, "[to Dimension]: we WERE supposed to have come up with the most suitable place on WEDNESDAY 18th of
>
> NoVemBeR"
>
> Earth emotes, "[to Carin]: relax"
>
> Carin says, "and we have postponed it to today..."
>
> Carin says, "yes earth i am very relaxed.... heehee"
>
> Dimension says, "so when do we chat again???????"
>
> Comfort says, "'me too"

Earth emotes, “[to Carin]: set 1 on weekend, so we decide”

The third level is the conceptual level, where the discussion focussed on the science topic. At this level, the discussion tends to be more serious and related to their research topic. Below is a conversation between the students discussing the best alternative living venue besides earth.

Carin says, “and how do you achieve that?”

Earth says, “then needs lots of power source”

Sea emotes, “[to Earth]: what about nuclear energy?”

Earth emotes, “[to Sea]: nuclear is too dangerous”

Earth says, “what if the power plant explode, then the people die”

Sea emotes, “[to Earth]: i think home in space is way too expensive.”

Earth emotes, “[to Sea]: on some thing”

Earth says, “planets, moons”

Earth says, “but not floating in the mid space”

Sea emotes, “[to Earth]: what about Mars”

Carin says, “actually scientists and astronomers are doing research on two moons Titan and Europa..”

Earth emotes, “[to Carin]: mars can right?”

Earth says, “my bookmarks got what.. all the information on titan, europa and mars”

Tools usage

During the training provided to the students in the use of *SpaceALIVE!* tools, we emphasize the use of certain tools as we feel that they are the essential ones that students should know in order to accomplish the task. Students used MOO dialogues, emails, bookmarks, personal folders, WOO rooms to organize their content, and the construction tools to upload their content into the WOO rooms.

Each student was provided with a personal folder in *SpaceALIVE!* where they can store files containing information to be shared with other students. The personal folder provides a convenient way of sharing information as other students can pick up the files from the folder at any time. Most of the students made use of this tool regularly to exchange information. Initially some student had problem knowing how to use the tool but with some coaching they were able to use it for the project.

We had encouraged students to use the discussion forum to post questions and to coordinated online meetings during our field visits. However it was used much less than we had expected. One of the main reasons for this is that when students posted onto the discussion forums, they are not sure if the others will actually read their messages from the discussion forums. In this regard, emails are used more often as email messages are seen as always reaching their recipients and grabbing their attention. Most of the online meetings were arranged using the chat window.

Students used the web uploader quite frequently to upload their web pages. The web uploader provides a convenient means for the students to upload information that they had published as web pages as a result of the collaboration onto the *ScienceALIVE!* rooms. One of the major problems with using this tool is coordinating the web pages to be uploaded. For example, one school may have certain information that they want to publish, and the other school may have other information

to publish as well. The tool does not allow the students to specify links to existing web pages. In other words, the structure of home page must be designed first with the links to other web pages created by one person. Otherwise, the structure will be pretty messy, thus a fair bit of coordination is required.

Implications

Virtual collaborative learning environments provide the necessary infrastructure for project-based learning. The collaborative and communications tools within a virtual collaborative learning environment can help facilitate the processes that are crucial to the success of the student's learning. Table 1 below illustrates how collaborative and communication tools can be used to facilitate project-based learning.

Table 1: Collaborative and communicative tools for facilitating project-based learning

Processes	Tools	Project-based learning use
Scaffolding	Internet chat, email, presentation tool, bulletin board	Teacher can provide immediate feedback targeted at explaining and supporting performance at various tasks through "chat" software, or email. Experts may use the presentation tools to deliver online lecture on topics related to student's project.
Collaborative learning	Discussion forum, Internet chat, email	Discussion forum software is a good tool for stimulating discussion, generating, clarifying and evaluating ideas. Messages posted on the discussion forum are normally threaded, hence, students can follow the discussion. Internet chat can be used for on-line real-time discussion, but students will need to organize ideas generated as responses within Internet chat is synchronous and students can switch to different topics at will.
Project management	Internet chat, email, bulletin board	Students can use Internet chat or email to coordinate activities, such as online meetings. Bulletin board may be used to make announcement to students. Other project management tasks, such as establishing specific objectives, start and stop dates would require more specialized tools.
Knowledge representation	Construction tools	Knowledge constructed as a result of collaboration can be represented using construction tools. Form-based tools can be used to create simple content without much programming.

Conclusion

Information and communications technologies have provided students with the impetus to collaborate with students of other institutions both local and overseas. One approach relevant to virtual collaboration is project-based learning. In this paper we have reported our findings on projects carried out among students from three schools using a virtual collaborative learning environment. We discuss our findings based on the following topics: IT development and infrastructure, facilitation, collaboration, virtual learning environment. In virtual project-based learning, the collaborative learning environment is just a medium for collaboration. Other factors such as the IT infrastructure within the school, the facilitation process, and the context of collaboration are just as important.

We illustrated how collaborative and communicative tools can facilitate project-based learning. However, virtual collaborative learning environments are just mediums that facilitate collaboration and communications. Teachers' facilitation is crucial to the students' learning and performance. As such, there should be close coordination of the process of learning by the teachers even in a virtual learning environment.

Acknowledgement

The authors wish to thank the students and teachers who were involved in *ScienceALIVE! II*

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