Title: The development of students' information literacy and IT skills via inquiry PBL and collaborative teaching

Dr. Sam Chu, The University of Hong Kong Dr. Ken Chow, Canossa Primary School
Prof. S. K. Tse, The University of Hong Kong

Abstract
Recent research has shown that inquiry-based learning and project-based learning are better than the traditional didactic approach in promoting various learning outcomes. There is also a large literature on how collaboration among different teachers can enhance student learning. In Hong Kong, inquiry-based learning has been integrated in to the General Studies curriculum. This study investigates the effects of an intervention that used a collaborative teaching approach and inquiry project-based learning on the development of primary students' information literacy and information technology skills. Students in a Hong Kong primary school completed two inquiry-based group projects as part of their General Studies curriculum. A collaborative teaching approach involving three different teachers (Chinese, IT, and General Studies teachers) and the school librarian was taken in guiding students through the two projects. Results indicated the positive impact of collaborative teaching and inquiry PBL on the development of students' information literacy and IT skills.

Introduction

Recent studies have indicated that inquiry-based learning is more effective in promoting different learning outcomes such as deep thinking, the ability to apply knowledge and reasoning skills, etc. when compared to the traditional didactic approach (Hmelo-Silver, Duncan, & Chinn, 2007). Inquiry-based learning can be implemented in schools through student group projects. Project-based learning has been shown to provide students the opportunity to engage in realistic and thought-provoking problem learning (Blumenfeld et al., 1991; Marx, Blumenfeld, Krajcik & Soloway, 1997). As a result, the Education Bureau (EDB) of Hong Kong has incorporated inquiry project-based learning (inquiry PBL) into its General Studies curriculum for primary schools (Education Bureau, 2002).

The authors of this article did an intervention that involved a collaborative teaching approach bringing in a team of 3 teachers and the school librarian to equip students with knowledge/skills they need to do well in their group projects. Before adopting this new approach, students' inquiry PBL group projects were guided mainly by the General Studies (GS) teachers only. Under this new collaborative teaching approach, two other kinds of teachers (IT and Chinese language) together with the school librarian provided instructional support in guiding students through their GS group projects.

Justification for this study is threefold. First, few studies have investigated how combining both collaborative teaching and inquiry PBL can foster student learning, especially the acquisition of information literacy and IT skills. Second, studies of how collaborative teaching and inquiry PBL can promote information literacy and IT skills are lacking in the Asian setting as most of the Asian classrooms are still dominated by the traditional didactic approach to teaching (Watkins & Biggs, 1996). Third, there has been much research showing the benefits of information literacy and information technology skills for students. However, little research has been conducted on the pedagogical approaches that can be used to promote IT and information literacy (Mokhtar, Majid, & Foo, 2008; Moore, 2001). Most of the studies that investigated information literacy and IT skills in the context of project-based learning focused on how students used their information literacy and IT skills as tools for doing their projects and not as learning outcome that resulted

from project-based learning approach (Bowler, Large, & Rejskind, 2001; Chan Lin, 2008), thus there is a need to investigate how an approach different from the traditional classroom-based instruction can promote information literacy and IT skills among students. This study investigates the effects of collaborative-teaching and inquiry PBL on student's information literacy and IT skills in the Hong Kong setting.

Figure 1 presents the framework for the present study. It shows how a collaborative teaching approach that involves three teachers and the school librarian and inquiry project-based learning can improve student learning across different domains. For the present study, the focus will be on the development of information literacy and IT skills among students. Previous studies have shown how the collaborative teaching approach combined with inquiry PBL can foster improvement in the other domains like research skills (see Chu, Chow, Tse, & Kuhlthau, 2008).

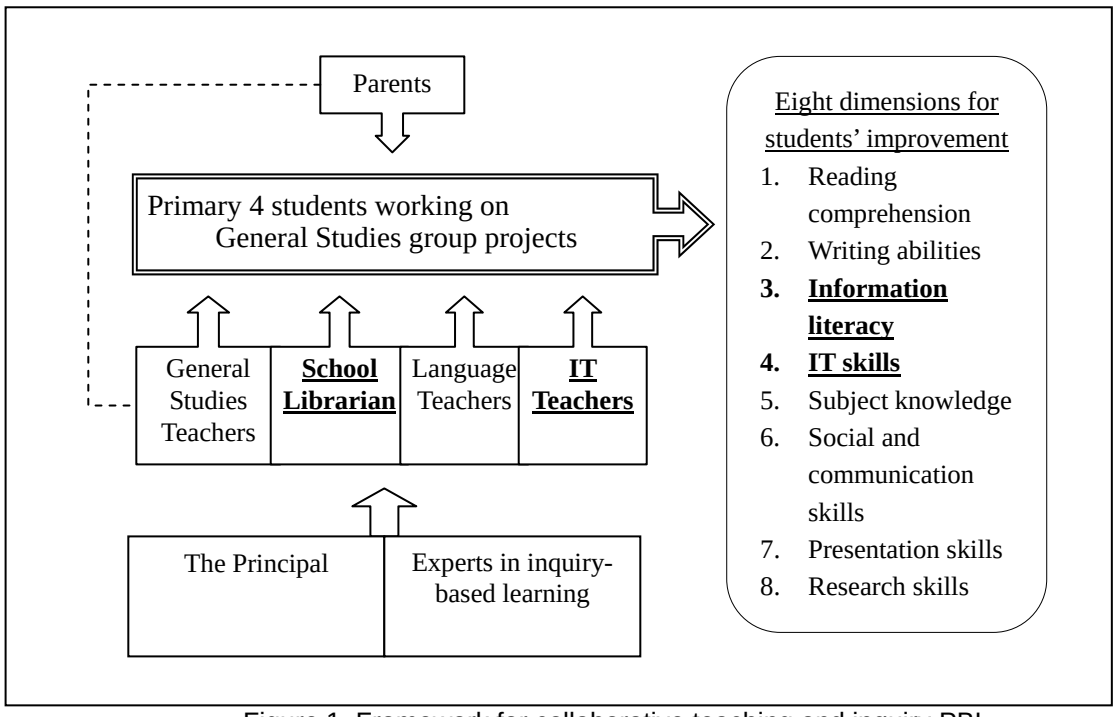


Figure 1. Framework for collaborative teaching and inquiry PBL

Literature review

Inquiry project-based learning

Inquiry-based learning uses questioning to actively involve students in their own learning (Harada & Yoshina, 2004). Hong Kong's Education Bureau (2002) defined it as "a student-centered approach which helps students integrate generic skills, knowledge and values in the learning of General Studies. In the inquiry process, students are active constructors of knowledge and the teacher is a facilitator in their learning. Instead of having the teacher give the right answers to students, they have to raise questions, find their own answers and look for necessary information. They are engaged in identifying problems, collecting information and solving the problems they encounter." (Para. 1) A specific example of how inquiry-based learning can be applied in the classroom setting is through the use of group projects. Projects can capture the students' interests, provoke serious thinking, and enable the students to apply their knowledge in a problem solving context (David, 2008). Harada, Kirio, and Yamamoto (2008) claimed that project-based learning involves in-depth exploration of issues, themes, or

problems, which have no predefined answers. It facilitates the development of ownership by giving students the chance to select topics that are personally relevant and by giving them a sense of responsibility to take charge of their own learning (Alloway et al., 1996).

Recent studies supported the advantage of using inquiry PBL over the traditional didactic approach. For example, Boaler (2002) compared the student mathematics achievement of two secondary schools where one school used project based learning while the other used traditional instruction. After three years, students in the project-based learning school outperformed the students from the traditional instruction school in terms of mathematics skills, conceptual, and applied knowledge. A considerable amount of research conducted in different domains and with different outcome measures generally show support for the effectiveness of inquiry learning over the traditional didactic approach (Guthrie, Wigfield, Barbosa, Perencevich, Taboada, & Davis, 2004; Hickey, Wolfe, & Kindfield, 2000; Hmelo-Silver, Duncan, & Chinnn, 2007).

Collaborative teaching

Previous studies have shown the importance of collaborative teaching practices in improving instruction and student learning (John-Steiner, 1992; Schwab Learning, 2003; Thousand, Villa, & Nevin, 2006). For example, Thousand et al. (2006) argued that when teachers collaborated on their planning and teaching, they have greater abilities to meet the needs of students with diverse backgrounds. A new trend in the collaborative teaching literature is the acknowledgment of the librarian's role in the modern school setting. Teacher-librarian collaboration has been the focus of a lot of studies as school librarianship has moved towards more active involvement in student learning (Chu et al., 2008; Chu, Tang, Chow, & Tse, 2007; Montiel-Overall, 2008). Despite the research supporting teacher-librarian collaboration, the role of school librarians as an education partner seems to gain little acceptance from teachers (Mokhtar & Majid, 2006).

Information literacy, IT skills, and inquiry project-based learning

The 2003 Prague Declaration stated that information literacy "encompasses knowledge of one's information needs and the ability to identify, locate, evaluate, organize and effectively use information to address issues or problems at hand" (quoted in Webber and Johnston, n.d. Par 11). Previous studies have shown that information literacy and IT skills are important components of inquiry-project based learning (ChanLin, 2008; Owens, Hester, & Teale, 2002). Inquiry PBL requires students to do an in-depth exploration of particular issues, themes, or problems (Harada, Kirio, & Yamamto, 2008). In this regard, information literacy is crucial since it helps learners become "critical users of information and creative producers of knowledge" (Bowler, Large, & Rejskind, 2001, p. 205). Owens et al. (2002) likewise emphasized the importance of information technology (IT) skills in inquiry PBL. Mastery of IT skills can allow students to organize and edit their projects more easily. At a higher level, IT skills can help students communicate with experts in different places, access information from a vast array of resources, and create high quality presentations combining text, sound, and visual images.

Numerous studies have recognized the importance of technology to student learning (Cognition and Technology Group at Vanderbilt, 1992; Ownes, Hester, & Teale, 2002). There is evidence, however, indicating that students may not have the necessary information literacy and IT skills needed to utilize technology effectively (Bowler et al., 2001; Borgman, Hirsh, & Walter, 1995; Bilal, 2001). Even teachers found it difficult to incorporate technology use in the classroom (Wallace, Kupperman, Krajcik, & Solloway, 2000).

Research method

Research questions

This study has the following research questions:

1. What are the roles of the school librarian and IT teacher in the collaborative teaching approach and inquiry PBL?
2. Did students' information literacy and IT skills develop as a result of the intervention involving collaborative teaching and inquiry PBL?
3. Can information literacy and IT skills help students with the completion of their IBL projects?

Participants

Four classes of Primary 4 students in a local school participated in the study. There were around 30-40 students in each class, constituting a total of 141 participating students.

Instructional design

The study consisted of two phases. Each phase lasted for about 10 weeks. The main theme for Phase 1 was, "The Earth." Students were free to choose any topic based on the theme and to work on it in groups. The theme for Phase 2 was "The History of Hong Kong or China." Students were asked to work with the same group members whom they worked with in Phase 1. Again, they were free to choose any topic within the given theme. At the culmination of each phase, the students prepared a written report and presented it before class. In order to enhance the students' skills in searching for different kinds of information, the school librarian arranged six library lessons for the students, with each session lasting for 50 minutes. The goal was to make the students familiar with the Internet and with online searching. The IT teacher, on the other hand, was responsible for equipping students with IT skills which would help them in doing their projects such as using PowerPoint. During the IT classes, students also learned the use of the Chinese handwriting device, Chinese inputting methods, and other relevant IT skills for information searching. In addition, they received support from Chinese Language and General Studies teachers in completing the projects.

Method of analysis

To answer the first research question, the school librarian and the IT teacher were interviewed about the roles they played and the support they offered to students. The second and third research questions were answered through a survey given to P4 students who completed the two IBL projects. The questionnaire assessed students' development of information skills and IT literacy in terms of: (1) the information/IT skills and knowledge they have become familiar with and (2) the information/IT skills and knowledge they found important/useful for their IBL projects. The questionnaire also asked students to evaluate their familiarity with sources/databases, search skills and knowledge, and IT skills and knowledge before and after the IBL projects. The perceived importance of these was also recorded. Interviews with selected teachers, parents, and students and an informal observation of how certain students searched for information for their projects were also conducted.

Results

Research question 1: What are the roles of the school librarian and IT teacher in guiding the students as they did their inquiry projects?

Table 1 summarizes how the school librarian and the IT teacher saw their roles in the collaborative inquiry PBL

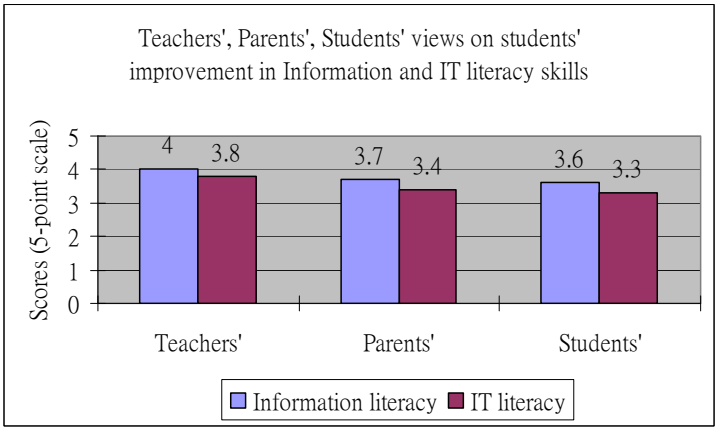
Table 1. Roles of librarian and the IT teacher in the collaborative inquiry PBL

Librarian	IT Teacher
• 'As an information provider'; provided relevant books (a block loan of 200 books from public libraries), information folders (containing newspaper clips) and related webpage links • Held information literacy classes to provide training for students on the use of various printed sources (e.g., reference books), information searching skills (e.g., Boolean operations), the school and public library catalogs, and the WiseNews database • Assessed students' effectiveness in using various information sources and development of information searching skills.	• Set up and managed the WiseNews database, which contains news sources from Hong Kong, mainland China, Taiwan, and other parts of the world. • Taught various IT related skills, including Microsoft PowerPoint and Excel, and Chinese input methods (e.g., Simplified Cangjie)

During the information literacy and library sessions, students were equipped with the basic skills for using various electronic sources. According to the school librarian, the provision of relevant materials to students, as well as training on using the materials effectively increased student motivation and interest in conducting their own inquiry PBL. The librarian also tried to cultivate a positive attitude towards the use of the Internet among the students, and cautioned against indecent Web materials and Internet addiction or overuse. The IT teacher also trained students in the use of search engines (Yahoo and Google) and the WiseNews database. The IT teacher helped students improve their IT and information searching skills and contributed to the development of their self-directed learning. He commented that students became better at creating PowerPoint slides for effective presentation by the end of their projects. The librarian and IT teacher showed a high degree of collaboration as they coordinated with the other teachers. For example, the librarian said, "I would find out from the Chinese Studies teachers what topics they needed me to cover and I would organize a class that involved students…so that they could master the relevant skills… this also complemented the GS teachers' teaching. Basically the classes that I conducted were based on the needs of GS, IT and Chinese Studies teachers. For instance, for Chinese Studies, I taught the students SQ3R reading techniques to help them catch the main points of an article. This would enable them to do their Chinese comprehension better during their Chinese studies classes. For IT, I taught them how to use WiseNews (a news database), such as how to use keywords to search for relevant information."

Research question 2: Did students' information literacy and IT skills develop as a result of the intervention involving collaborative teaching and inquiry PBL?
To answer this question, the researchers looked at (a) the teachers', parents', and students' overall perceptions of improvement in information literacy and IT skills, (b) the students' perceived familiarity with the various information sources before and after the intervention, (c) the students perceived information search knowledge and skills before and after the intervention, and (d) the students' perceived IT skills and knowledge before and after the intervention.

Teacher, parent, and student perceptions of improvement in information literacy and IT skills
Teachers, parents, and students evaluated the improvement of the students' information literacy and IT skills. The survey showed that the three groups believed that the collaborative teaching and inquiry PBL helped students improve their information literacy and IT skills.



Note: The three parties were answering the question "Does the IBL project help students improve in their Information and IT skills?" according to a scale of 1-5, with 1 as 'low improvement' and 5 as 'high' improvement.

Figure 2. Teachers', parents' & students' perception of student improvement in IT and information literacy skills via collaborative teaching and inquiry PBL

Students' perceived familiarity with the various information sources before and after the intervention

Of the different information sources (use of the school library, use of school library's online catalog, the use of the public libraries, public libraries' online catalog, WiseNews, Google, Yahoo, School/library suggested websites, others), students were most unfamiliar with using Wisenews and the school's OPAC. Students were more familiar with using the school library facilities, public library facilities, and Yahoo. Among all the sources, the WiseNews database was the most unfamiliar to students before the intervention. Students' familiarity with Yahoo was greater than that of Google (4.5 compared to 3.2). This could be explained by Yahoo's children services such as "Yahoo! Kids" (http://kids.yahoo.com/), which Google did not offer. Since students did not have access to the WiseNews database in school in the past, and since it is not a freely accessible database available on the Web, students' familiarity with WiseNews was substantially lower than with all other information sources and services prior to the intervention. The biggest improvement brought about by the intervention was in the use of Wisenews. Figure 3 summarizes the students' responses about their perceived familiarity with the various information sources and services before and after the intervention.

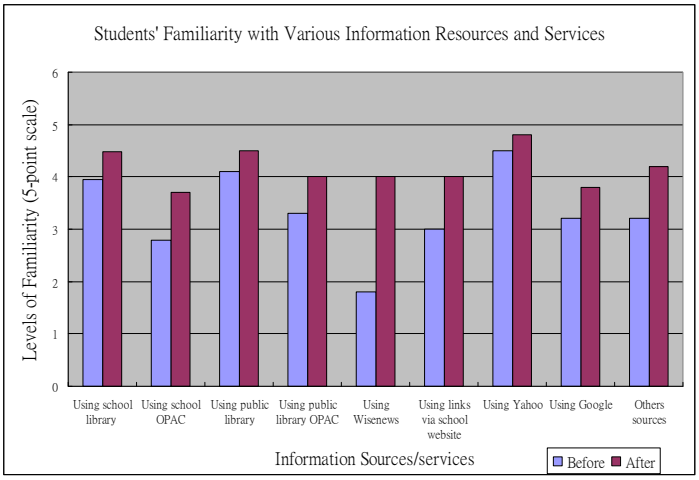


Figure 3. Students' perceived familiarity with informoration sources & services before and after the projects

Students perceived information search knowledge and skills before and after the intervention,

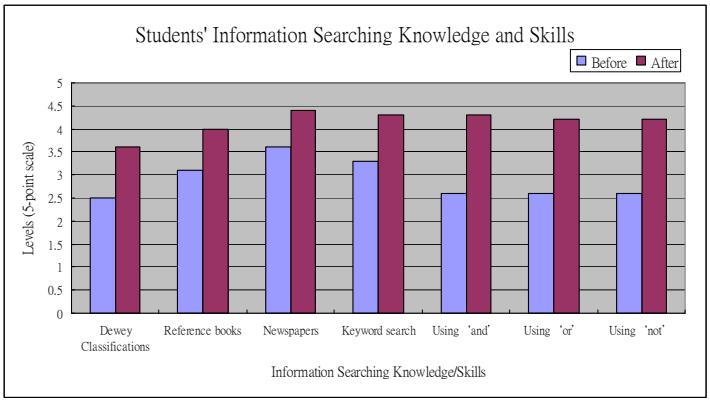


Figure 4. Students' perceived information search knowledge and skills

Figure 4 shows how the students perceived their information search knowledge and skills before and after the intervention. Students perceived an overall improvement on the different information search knowledge and skills as a result of the collaborative teaching and inquiry PBL. Before the intervention, students were particularly weak in using the Dewey classification system to look for books and in using the three Boolean operators in constructing a search query. Collaborative teaching and inquiry PBL were most helpful in training the students in the use of Boolean operators ('and', 'or', 'not'). They seemed to gain little, however, in more commonly used information search strategies, such as consulting newspapers and reference books.

Students' perceived IT skills and knowledge before and after the intervention

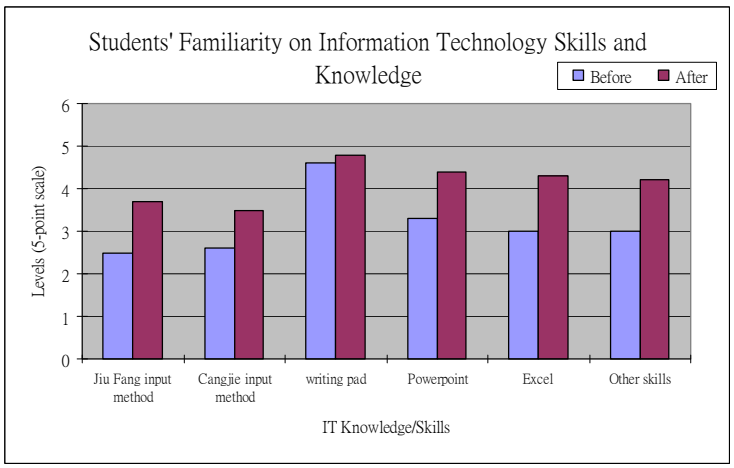


Figure 5: Pre and post inquiry project familiarity with IT knowledge/skills

Figure 5 shows students' IT knowledge/skills before and after the intervention. Students thought that their IT skills in using Chinese inputting methods like Jiu Fang (九方) and Simplified Cangjie (簡易) were weak before the project. After the intervention, students perceived an improvement in all aspects of IT skills and knowledge. Students gained the most in 'making PowerPoint presentations' (improvement of 1.28 points), 'Using Jiu Fang method' (improvement of 1.22) and 'making Excel spreadsheet' (improvement of 1.16). Students learned the least with

'Writing Pad.' This was probably due to their high familiarity with it even before the intervention.

Research question 3: Can information literacy and IT skills help students with the completion of their IBL projects?

To answer this research question, students were surveyed on (a) their perceived importance of the various information sources/services for completing their projects, (b) their perceived importance of information search knowledge/skills for completing their projects, and (c) their perceived importance of IT knowledge and skills for completing the projects

Students' perceived importance of various information sources/services for completing the projects

Students answered a survey on the perceived importance of various information sources or services for the completion of their projects, and their ratings are summarized in Figure 6 below.

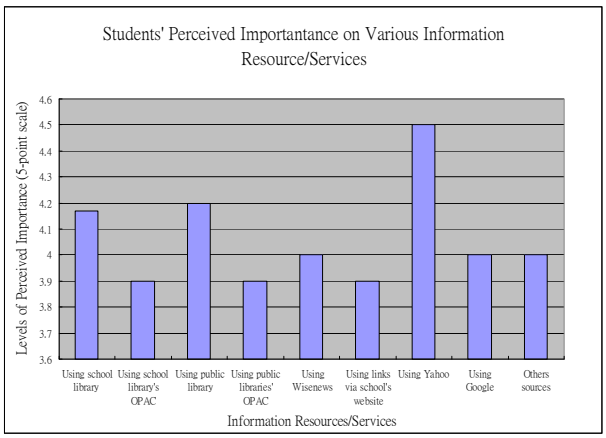


Figure 6. Students' perceived importance of information resources and services

Students perceived Yahoo as the most important source of information. As mentioned earlier, Yahoo seems to be more child-friendly, and hence may be more appealing to primary school children than Google. Moreover, the home page of "Yahoo! Hong Kong" (http://hk.yahoo.com/) is more eye-catching than "Google Hong Kong" (http://www.google.com.hk/). Using school library's OPAC', 'Using public libraries' OPAC', and 'Using links via school's website' were perceived as slightly less important than other information sources. Perhaps primary students prefer to browse through the shelves rather than search within library catalogs, particularly when there is a dedicated bookshelf—containing 200 relevant books from public libraries—for the inquiry PBL. Meanwhile, the relevant web links available via the school website, while useful, may have been perceived as limited, when compared to the vast amount of resources available in the libraries and in search engines and databases.

Students' perceived importance of information searching related knowledge/skills for completing the projects

Students were also asked about how important the different information search knowledge or skills were in completing their projects. Their answers are summarized in Figure 7.

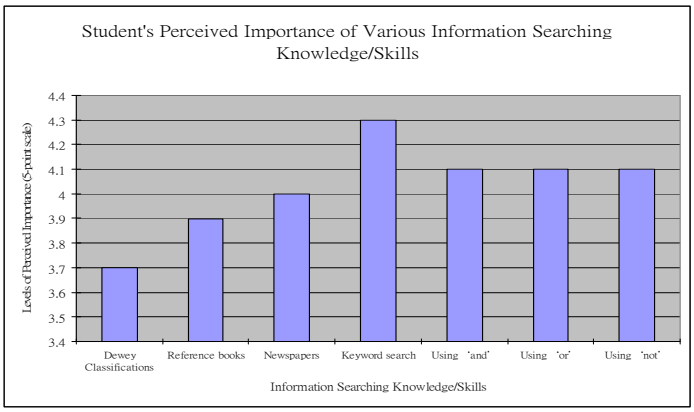


Figure 7. Students' perceived importance of information searching related knowledge/skills

Students perceived 'keyword search' to be the most important, followed by the use of the three Boolean operators. This suggests that students considered information searching through electronic resources such as search engines and databases more important than searching printed resources such as newspapers and reference books.

Perceived importance of IT knowledge and skills for completing the projects

IT skills are important for students to search for information related to their projects, as well as prepare for their final project reports/presentations. Chinese inputting methods were also important, as they enable students to effectively use databases and search engines. IT skills such as PowerPoint and Excel enable students to create effective presentations for their projects. Students generally thought IT skills were quite important to them. Students thought that the most important area was the use of Microsoft Office (PowerPoint and Excel).

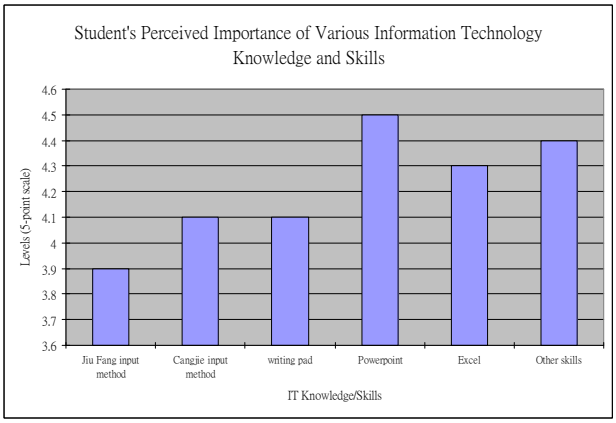


Figure 8. Students' perceived importance of IT knowledge/skills

Although students improved more in Jiu Fang inputting method than in Simplified Cangjie (See Figure 5), they tended to see 'Simplified Cangjie' as more important than Jiu Fang (4.1 vs. 3.9 /5). This may be due to Simplified Cangjie being offered as a free bundle in Microsoft Windows. Jiu Fang, on the other hand, is only available at school. Before the projects, some students might have already had some experience with Simplified Cangjie at home, while they started to learn Jiu Fang during their projects. Since Simplified Cangjie is available at home, but not Jiu Fang, it is reasonable for students to find Simplified Cangjie more useful. This is an interesting finding since it shows that teachers might be teaching skills that are not really personally

relevant from the point of view of the students.

In general, the students considered most of the things taught to them to be important for the completion of their inquiry PBL. For example, the scores range from 3.9-4.5 in a 5-point scale. The Chinese input method of Jiu Fang was considered least important, while the use of Powerpoint was considered the most important.

General Discussion

There was a general improvement in the information literacy and IT skills of the students as they did their inquiry PBL in the General Studies class. This finding is in line with previous studies that showed the effectiveness of inquiry-based learning compared to rote learning (Harada & Yoshina, 2004). The results of the present study, however, extend the previous studies by looking at how inquiry project based learning can be combined with a collaborative teaching approach. This combination led to an improvement in children's information literacy and IT skills.

Although research has been done before on how technology can serve as a tool to create learning environments that are inquiry-based (Alloway et al., 1996), there has been a dearth of research investigating the role of inquiry PBL in actually fostering improvement in IT skills and information literacy. This study showed that inquiry PBL is a suitable pedagogical approach to promote information literacy and IT skills. This is in line with previous research which showed that these skills cannot be learned through one-time training such as tutorials or workshops (Mokhtar et al., 2008). These skills need to be reinforced through a longer period of time with proper scaffolding and guidance from the teacher.

The results showing that students considered the information literacy and IT skills they learned as important for completing their inquiry-based projects build on the previous studies that show the importance of technology in completing school work (Bowler, Large, & Rejskind, 2001).

Interviews showed that the IT teacher and the librarian played different roles in helping the students complete their IBL projects. The collaborative teaching approach between the school librarian and the IT teacher helped the students tap into the expertise of the two. For example, they learned about the different IT skills from the IT teacher. The librarian, on the other hand, taught them how to do online searches. This finding supports the conclusions of previous research on the benefits of collaborative teaching (Thousand, Villa, & Nevin, 2006). Collaborative teaching has been seen as an important part of inquiry-based learning since it involves taking advantage of expertise in school and it allows each teacher to offer his or her unique expertise to meet the specific needs of the students (Kuhlthau et al., 2007). The present study also highlighted the role of the librarian. In the traditional school setting, the librarian was not really visible in the school context and the role of the librarian in schools was often overlooked and undervalued (Hartzell, 2002). The present study showed the important role played by the librarian in helping students improve their learning.

Conclusion

Combining a collaborative teaching approach with inquiry PBL was shown to be effective in improving the information literacy and IT skills of the students. The students likewise perceived the information literacy and IT skills they learned as important in helping them complete their group projects. The school librarian and the IT teacher played essential roles in equipping students with information literacy and IT skills through their collaboration with the other

teachers and through the way they designed their instructional content. The collaborative teaching method enabled the students to tap into the expertise of the different teachers.

We end this article with a quote from Confucius on learning: “Tell me and I will forget; show me and I may remember; involve me and I will understand.” We argue that the collaborative teaching approach and inquiry PBL used in this study involved the students more as compared to the traditional didactic approach thus promoting student outcomes in terms of information literacy and IT skills.

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