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

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**Abstract**

Recent research has shown that inquiry-based learning and project-based learning (PBL) 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 into the General Studies curriculum. This study investigated 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 teachers with different specialties (Language [Chinese], IT, and General Studies) and a 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 (IBL) is more effective in promoting different learning outcomes such as deep thinking and the ability to apply knowledge and reasoning skills when compared to the traditional didactic approach (Hmelo-Silver, Duncan, & Chinn, 2007). IBL can be implemented in schools through student group projects. Project-based learning (PBL) 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). Integrating PBL and IBL can be a promising learning approach (Chu, in press; Krajcik et al., 1998), thus in this article this integrated approach will be referred to as inquiry PBL. 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 three teachers with different specialties and a school librarian to equip students with knowledge/skills they need to do well in their group projects. Justification for this study is twofold. 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. This is especially true in the Asian setting as most of the classrooms are still dominated by the traditional didactic approach to teaching (Watkins & Biggs, 1996). Second, 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 these skills as tools for doing their projects and not as learning outcomes 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 didactic instruction may promote the learning of these skills among students. This study investigates the effectiveness of collaborative-teaching and inquiry PBL on improving student's information literacy and IT skills among primary students in Hong Kong.

Figure 1 presents the framework for the present study that tries to assess the improvements in various domains due to inquiry PBL and collaborative teaching (Chu, in press). This framework was adapted from Kuhlthau et al.'s (2007) conceptualization of the different kinds of learning that can be promoted in the inquiry process. Previous articles by the same research team have used a similar framework to show how the collaborative teaching approach combined with inquiry PBL can foster improvement in other domains like research skills, writing skills, and reading skills (Chu, in press; Chu et al., 2007; Chu, Chow, Tse, & Kuhlthau, 2008). For this study, the focus is on the development of information literacy and IT skills among students.

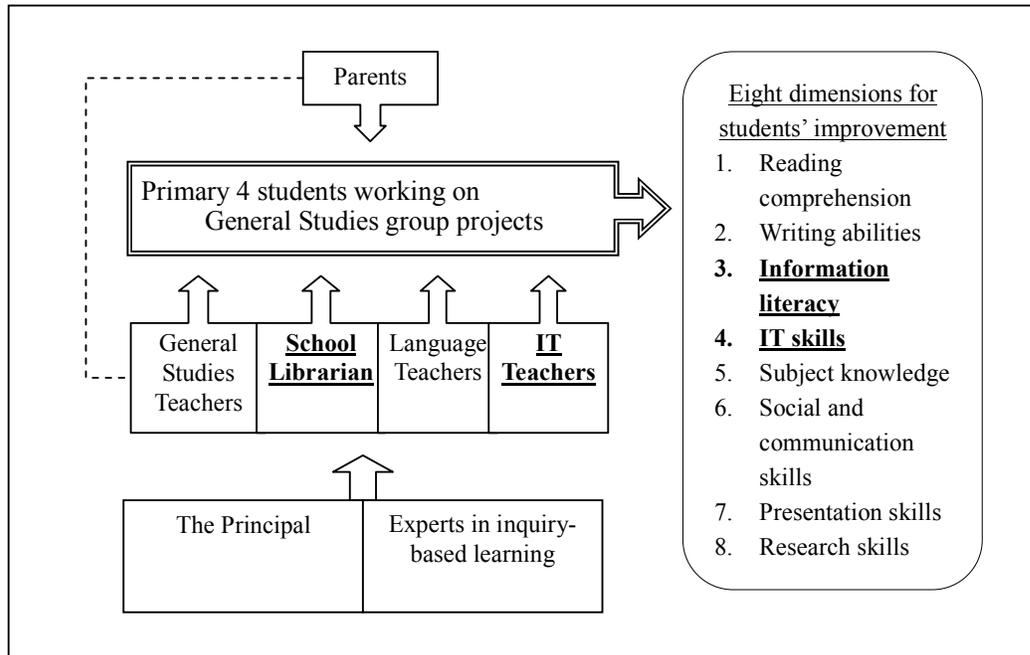


Figure 1. Framework for collaborative teaching and inquiry PBL

## Literature review

### *Inquiry project-based learning*

Traditionally, teachers used a transmission approach to teaching where students learn by “copying word for word from a text or lecture and then reporting back, usually in the form of a test” (Kuhlthau, 1997, p.710). With the rise of constructivism, however, educators have moved towards a conception of teaching that acknowledges the informal ideas students bring to school and the importance of developing these into a structured set of concepts and procedures through the dynamics of experience (Kuhlthau, 2004; Singer & Moscovici, 2008). A new pedagogical approach within the constructivist paradigm is inquiry PBL which combines both IBL and PBL. IBL 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, look for necessary information, and find their own answers. They are engaged in identifying problems, collecting information and solving the problems they encounter” (Para. 1). A specific example of how IBL can be applied in the classroom setting is through the use of group projects. Projects can capture 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 PBL 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). A considerable amount of research conducted in different domains and with different outcome measures generally provide support for the effectiveness of inquiry PBL over the traditional didactic approach (Guthrie, Wigfield, Barbosa, Perencevich, Taboada, & Davis, 2004; Hickey, Wolfe, & Kindfield, 2000; Hmelo-Silver, Duncan, & Chinn, 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, in press; Chu et al., 2008; 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 PBL*

"Information literacy encompasses knowledge of one's information concerns and needs, and the ability to identify, locate, evaluate, organize and effectively create, use and communicate information to address issues or problems at hand." (US National Commission on Library and Information Science, 2003). Previous studies have shown that information literacy and IT skills are important components of inquiry PBL (ChanLin, 2008; Owens, Hester, & Teale, 2002). Since inquiry PBL requires students to do an in-depth exploration of particular issues, themes, or problems (Harada, Kirio, & Yamamoto, 2008), thus 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; Owens, 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. What gains in information literacy and IT skills did the participants perceive as a result of combining a collaborative teaching approach with inquiry PBL?
3. How important did the students perceive the information literacy and IT skills they learned in completing their inquiry PBL?

##### *Participants*

Four classes of Primary 4 students in a local school participated in the study. There were around 35 students in each class, constituting a total of 141 participating students. All the students completed the two projects and filled out the survey. Aside from the students, the teaching staff involved in the project (a school librarian, five GS teachers, four Chinese teachers, and an IT teacher) and 27 parents were also interviewed by telephone.

##### *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 first three sessions were given during the beginning stages of Phase 1, while the last three sessions were given during the beginning stages of Phase 2. 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. The IT teacher conducted 10 sessions to teach these different skills and spread these across the two phases. Students also received support from Chinese Language and General Studies teachers in the course of their projects. Before adopting this new approach, only the General Studies (GS) teachers were involved in the group projects. The medium of instruction during the whole study was Chinese.

### *Method of analysis*

For 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. For the second and third research questions, P4 students who completed the two projects were given self-administered questionnaires, which assessed their perceived competence in information literacy and IT skills both before and after the inquiry PBL. Students were also asked to evaluate their perceived importance and familiarity with: sources/databases, search skills and knowledge, and IT skills and knowledge before and after the projects. Interviews with selected teachers, parents, and students were conducted. Observations of how four groups of students in each of the four classes searched for information were done. In addition, group project grades of the students were compared with grades from the previous year. Students from the previous year did not undergo the collaborative teaching and inquiry PBL, thus serving as a control group. Data from the questionnaires were analyzed using dependent sample t-test to assess whether there were significant differences in terms of perceived competence in information literacy and IT skills before and after the inquiry PBL. Independent sample t-test was conducted to determine whether there was a grade difference between the students who underwent the inquiry PBL and students from the previous year who did not.

### **Results**

#### *Research question 1: Roles of the school librarian and the IT teacher*

Table 1 summarizes how the librarian and the IT teacher saw their roles in this project

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

<b>Librarian</b>	<b>IT Teacher</b>
<ul style="list-style-type: none"><li>• '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</li><li>• 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</li><li>• Assessed students' effectiveness in using various information sources and development of information searching skills.</li></ul>	<ul style="list-style-type: none"><li>• Set up and managed the WiseNews database, which contains news sources from Hong Kong, mainland China, Taiwan, and other parts of the world.</li><li>• Taught various IT related skills, including Microsoft PowerPoint and Excel, and Chinese input methods (e.g., Simplified Cangjie)</li></ul>

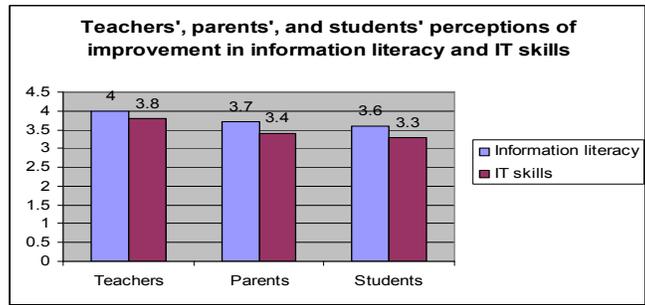
During the information literacy and library sessions, students were equipped with the basic skills for using various electronic sources. According to the school librarian, the provision of relevant materials to students, as well as training on using the materials effectively increased student motivation 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, on the other hand, trained students in the use of search engines (Yahoo and Google) and the WiseNews database. The IT teacher helped students improve their IT 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 also 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."

#### *Research question 2: Perceived gains in information literacy and IT skills*

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 inquiry PBL, (c) the students' perceived information search knowledge and skills before and after the inquiry PBL, and (d) the students' perceived IT skills and knowledge before and after the inquiry PBL. In addition to the self-report data, group project grades of the students were also compared with a control group to provide a more objective assessment of learning gain.

#### *Teacher, parent, and student perceptions of improvement in information literacy and IT skills*

Teachers, parents, and students assessed the improvement of the students' information literacy and IT skills. The survey showed that the three groups perceived 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 inquiry PBL help students improve in their Information literacy and IT skills?” according to a scale of 1-5, with 1 as ‘low improvement’ and 5 as ‘high’ improvement.

Fig. 2. Teachers’, parents’, and students’ perceptions of improvement in information literacy and IT skills via collaborative teaching and inquiry PBL.

Interviews with teachers and parents support these findings. For example, the IT teacher said, “Most students managed to accomplish the standards of PowerPoint skills that I set for them. They were able to insert pictures, add hyperlinks and edit words in PowerPoint.” One parent also viewed the improvement in information literacy and IT skills as helping her child become “exposed to more reading materials when searching for information—no longer limited to textbooks.”

*Students’ perceived familiarity with various information sources/services before and after the project*

Of the different information sources and services (use of the school library, use of school library’s online catalog, etc.), 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. Students’ familiarity with Yahoo was greater than that of Google (4.5 compared to 3.2), which might be explained by Yahoo’s more child-friendly services such as “Yahoo! Kids” (<http://kids.yahoo.com/>) that Google does 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 all of the other information sources and services prior to the inquiry PBL, however, the biggest improvement was also seen in this domain. This big improvement in familiarity with Wisenews was supported by our interview data. The students became so comfortable with using it that one of them “used it for leisure reading and for doing the homework in the Scouting Movement.” Another student used it for reading topics of interest to him but not really required in school. Figure 3 summarizes the students’ responses about their perceived familiarity with the various information sources and services before and after the inquiry PBL.

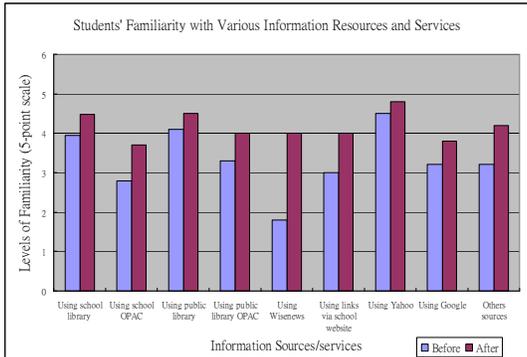


Fig. 3. Students’ perceived familiarity with information sources/services before and after the projects

*Students perceived information search knowledge and skills before and after the inquiry PBL*

Figure 4 shows how the students perceived their information search knowledge and skills before and after the inquiry PBL. Students perceived an overall improvement on the different information search knowledge and skills. Before the inquiry PBL, students were particularly weak in using the Dewey classification system in looking 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.

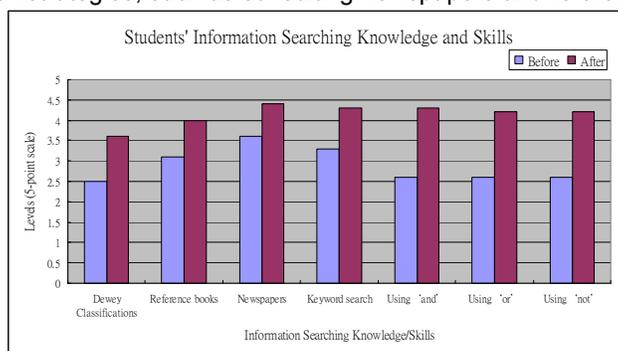


Figure 4. Students' perceived information search knowledge and skills

*Students' perceived IT skills and knowledge before and after the inquiry PBL*

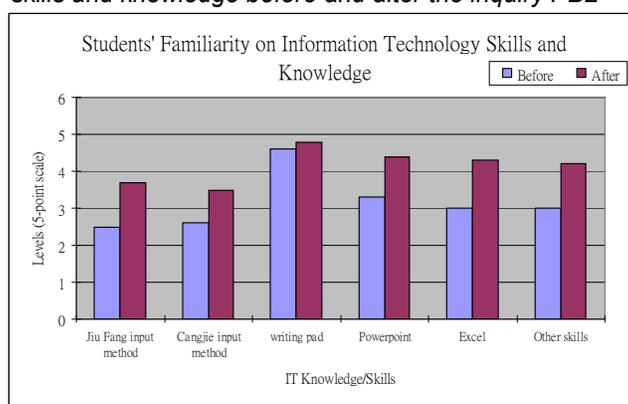


Figure 5: Pre and post inquiry project familiarity with IT knowledge/skills

Figure 5 shows students' IT knowledge/skills before and after the inquiry PBL. Students regarded their IT skills in using Chinese inputting methods like Jiu Fang (九方) and Simplified Cangjie (簡易) as weak before the project. In Jiu Fang, only the numeric keypads are used to input Chinese characters into the computer, while in Simplified Cangjie, Chinese characters are inputted using the qwerty keyboard. After the project, 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.

*Objective measure of improvement*

In addition to the self-report data, the final group project grades of the students who participated in the inquiry PBL were compared to those of the students in the previous year who did not undergo inquiry PBL. The latter served as a control group, and independent sample t-test showed a statistically significant difference ( $p < .001$ ) with the inquiry PBL group ( $M=2.46$ ,  $SD=0.20$ ) obtaining higher grades than the control group ( $M=1.85$ ,  $SD=0.17$ ). The improvement in information literacy and IT skills of the students may have contributed to the higher grades of the inquiry PBL group compared to the control group.

*Research question 3: Perceived importance of information literacy and IT skills to project completion*

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

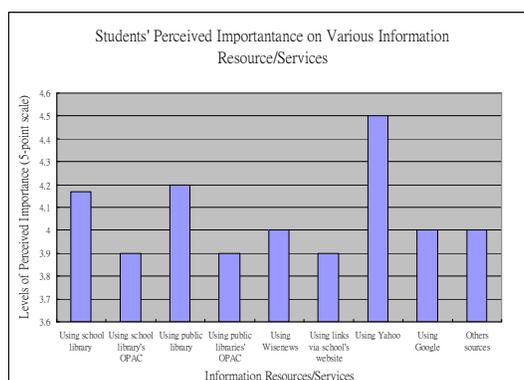


Figure 6. Students' perceived importance of information sources and services

Students perceived Yahoo as the most important source of information. Also important were using the school and public libraries. 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/services. 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 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.

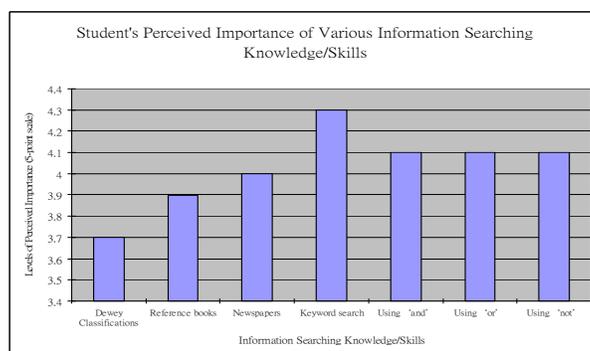


Figure 7. Students' perceived importance of information searching related knowledge/skills

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 through printed material 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 presentations. Chinese inputting methods were also important, as they enabled students to effectively use databases and search engines. IT skills such as PowerPoint and Excel enabled 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).

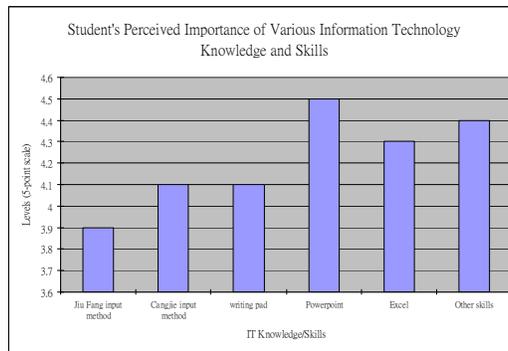


Figure 8. Students' perceived importance of IT knowledge/skills

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 only during their projects. Since Simplified Cangjie is available at home, but not Jiu Fang, it is reasonable for students to find the former more important. This is an interesting finding since it shows that teachers might be teaching skills that might not be so 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 ranged 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 perceived improvement in the information literacy and IT skills of the students as they did their projects 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 previous research by showing how inquiry project based learning can be effectively combined with a collaborative teaching approach, which led to a perceived 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 (e.g. Alloway et al., 1996), there has been a dearth of research investigating the role of inquiry PBL in actually fostering improvement in information literacy and IT skills. This study shows that inquiry PBL is a suitable 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 potential of inquiry PBL and collaborative teaching in promoting information literacy and IT skills is especially relevant since students need to be equipped with these competencies "for participation in society and the work force" (21<sup>st</sup> Century Workforce Commission, 2000). Despite the increasing need for these competencies in today's information society, students have been found to lack these essential competencies (Educational Testing Service, 2006), thus suggesting the need for an effective teaching approach.

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 (e.g. Bowler, Large, and Rejskind, 2001). Interviews showed that the IT teacher and the librarian played different roles in helping the students complete their 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 search. 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 different roles (e.g. giving access to information through providing sources like books and newspaper clippings, holding information literacy classes) played by the librarian in helping students improve their learning.

### Limitations

The study relied mostly on subjective perceptions of improvement since self-evaluations were used to assess the effects of inquiry PBL and collaborative teaching. Future research could be conducted with more objective measures of improvement. Although the research included an objective measure of improvement in terms of comparing the grades of students in the inquiry PBL group with a baseline group, the higher grades of the inquiry PBL group cannot be directly attributed to the improvement in information literacy and IT skills that they learned. Other external factors or factors associated with the whole intervention may have been responsible for the increase in grades, thus the results have to be interpreted with caution.

### Conclusion

This study aimed at investigating the effectiveness of combining a collaborative teaching approach with inquiry PBL in improving the information literacy and IT skills of the students. It also examined the perceived importance of these skills learnt in completing the projects and the roles of the librarian and IT teacher in this intervention. It was found that 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 these 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. Confucius' statement about learning holds true for the present study: "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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