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**Title:** Collaborative inquiry project-based learning: Effects on reading ability and interests

**Corresponding Author:** Dr. Samuel Kai Wah Chu, PhD. [samchu@hku.hk](mailto:samchu@hku.hk)

**Corresponding Author's Institution:** Faculty of Education, The University of Hong Kong

**Order of Authors:** Samuel Kai Wah Chu, PhD; Shek Kam Tse; Elizabeth Ka Yee Loh; Ken Chow

### **Abstract**

The academic performance of students has been shown to be associated with reading ability. Inquiry learning can potentially enhance the reading abilities and interests of students. This study verified this proposition by examining the effects of an inquiry approach to group projects on the reading abilities of primary school students. Using a case study design, an inquiry project-based learning (PBL) approach, with the collaboration between three kinds of teachers and the school librarian was implemented to support the development of reading abilities and interests of students in a primary school in Hong Kong. The participants included primary 4 students, teachers, and parents. PIRLS tests were used to evaluate the students' reading abilities; survey questionnaire and interviews examined the participants' perceptions of the inquiry PBL; and the PIRLS survey was used to measure the students' attitudes and self-perceptions. Quantitative and qualitative data analyses showed positive effects on the reading abilities and attitudes of the participating students. Students' attitudes and self-perceived abilities appeared to influence the improvements in reading abilities. Finally, the participants perceived improvements in the students' reading comprehension, reading speed, and vocabulary. These findings provide evidence and insights to support further implementation of inquiry PBL in primary schools.

### **Keywords**

inquiry learning, project-based learning, collaborative teaching, reading abilities

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### **1. Introduction**

Inquiry learning as an educational strategy has been shown to have relevant advantages over the traditional rote learning method (Harada & Yoshina, 2004; Hu et al., 2008). Constructivist approaches to teaching emphasize that inquiry is essential for students to learn effectively (Krajcik et al., 1998; Marx et al., 2004). Students are encouraged to bring to school informal ideas which they gradually develop towards a structured set of concepts and procedures (Kuhlthau, 2004; Singer & Moscovici, 2008). Project-based learning (PBL) has been used to introduce inquiry in primary schools (Marx et al., 1997), and is made up of instructional strategies that provide students with opportunities to engage in tasks to enhance learning (Mettas & Constantinou, 2007) and develop reasoning skills (David, 2008; Wilhelm et al., 2008). It typically involves students carrying out tasks that lead to a final product, which in many cases, consists of a written or oral report (Prince & Felder, 2006). In this study, inquiry learning was applied in a primary school through project implementation, and is referred to in this report as inquiry PBL (Chu, 2009). A collaborative teaching approach was utilized in implementing the inquiry PBL, engaging the participation of three subject teachers, and one librarian.

It has been shown that the quality of project output can be better when it comes out of an inquiry process on topics that are of personal interest to students (Alberta Learning, 2004). Students are more engaged in their work and perform better when they are actively working on topics of their own interest (Alloway et al., 1996; Gross, 1999). It was hypothesized in this research that the implementation of inquiry PBL might also result in greater motivation to read materials that were relevant to the project. As such, it was suggested that this approach might bring positive changes to students' reading abilities and attitudes towards reading. This study was designed to

verify these propositions through an examination of students' performance in standard evaluation procedures, responses to a survey, and in-depth interviews. Specifically, this study examined the changes in the reading abilities and attitudes towards reading of students after implementing the inquiry PBL approach in their General Studies (GS) subject.

### *1.1 Problem Statement*

Reading ability has a significant impact on students' learning and performance in school (Leppanen et al., 2005), and supportive strategies for its development are important. The development of relevant skills in reading comprehension may be positively affected by the inquiry learning approach as students go through the processes of exploring, selecting, collecting, analyzing, and comprehending information sources (Kuhlthau, 1997). In addition, the use of computers and technology in learning activities has been shown to have a positive correlation with higher reading performance (Topping, 2006), and can lead to improved reading comprehension and motivation (Leu & Kinzer, 1999; Matthew, 1997; Doty et al., 2001).

It appears that inquiry learning, with support of information technology and information literacy, has the potential to enhance the reading abilities and interests of students. While current literature have explored the collaborative teaching approach for implementing inquiry PBL, its effects on reading abilities and interests in particular, have yet to be explored. This research attempts to fill the gap by examining both actual and perceived changes in reading abilities and interest among students who carried out their school projects through inquiry PBL. Furthermore, the involvement of three subject teachers with the librarian in the collaborative teaching team is an expansion of what has been reported so far by previous studies (i.e., one subject teacher and one librarian). The findings of this study provide empirical evidence to support the proposition that a collaborative inquiry PBL approach may be beneficial for the development of reading abilities and interests. Furthermore, this reports on a teaching approach that may provide educators with insights on the application of similar strategies, thereby creating an impact in education practice.

## **2. Research Question**

The main research question of this study was: *How effective is the combined inquiry PBL and collaborative teaching approach, as implemented in this study, in facilitating the improvement of reading ability, attitudes, and self-concept among the student participants?*

As an outcome of this collaborative inquiry PBL approach, improvements were expected along eight dimensions of learning, and this report focuses on the dimension of reading comprehension. These dimensions are components of the five kinds of learning that students engage themselves with in the inquiry approach (Kuhlthau et al., 2007) as shown in Table 1. The effects on other dimensions of learning have been reported elsewhere (see Chu, 2009). In this report, the proposition is that an inquiry PBL, implemented through a collaborative teaching approach will facilitate improvements in reading abilities, attitudes, and self-concept.

[Take in Table 1 about here]

## **3. Literature Review**

### *3.1 Inquiry project-based learning (PBL)*

The importance of inquiry learning, as noted by the Education Bureau of Hong Kong SAR (EDB, 2002), is that it enables students to gain the skills and attitudes that will enable them to become active learners throughout life. In this approach, the teacher assumes the role of a facilitator of learning, while students actively build their knowledge base as they raise questions and find answers through information search. Inquiry learning also uses systematic methods of collecting and analyzing data.

Inquiry-based learning may occur in the best manner through the implementation of projects (Wilhelm et al., 2008). Project-based learning (PBL) is an approach that engages teams of students in open-ended assignments, where they are encouraged to continually search for information and evaluate their findings (Prince & Felder, 2006). It has been described as an approach that involves finding answers to a real-world problem, through investigations that are done collaboratively and supported by technology (Krajcik et al., 1998). Project work is

also a useful strategy in teaching children who have different learning styles, cultural and ethnic backgrounds, and ability levels, by building on students' individual strengths, and allowing them to explore their interests in the framework of a defined curriculum (Railsback, 2002). Furthermore, it promotes a sense of responsibility, such that students take charge of their own learning (Alloway et al., 1996).

Self-generated or semi-imposed tasks, through which students negotiate problems, are emphasized in inquiry learning (Harada & Yoshina, 2004). After all, students have a stronger sense of ownership of self-generated tasks than of those that are imposed on them (Gross, 1999). It has been noted that inquiry projects are completed well when the topics are of personal interest to the students (Alberta Learning, 2004). Students perform better in terms of research skills, subject knowledge, and writing, when they are working on subjects that are interesting and relevant to them (Chu et al., 2007; Chu et al., 2008; Frank et al., 2003). As such, it seems logical that assignments should allow students to choose and personalize their work in order to promote more effective learning.

The role of parents is also important in inquiry learning, especially in the Hong Kong Chinese society. Parents of primary school children in Hong Kong have been found to be eager to participate in the education of their children (Ng, 2000), and Chinese tradition has the belief that academic achievement is the most important measure of upward mobility (Bond, 1993). Inquiry PBL is mainly a kind of self-directed learning (Silen & Uhlin, 2008) which involves self-exploration as a core concept (Luke, 2006). These concepts are assumed to relate to students' responsibility and independence in learning. Thus, the input of parents in an implementation of inquiry PBL in the Hong Kong Chinese milieu may be of interest.

### *3.2 Collaborative teaching*

Collaborative teaching practices have been found to be useful in enhancing instruction and student learning (John-Steiner, 1992; Murata, 2002; Thousand, Villa, & Nevin, 2006). Teachers have been shown to respond to the needs of their students better when planning and teaching are done between teachers of different subject areas (Thousand et al., 2006). The inclusion of librarians in collaborative teaching has been discussed as beneficial for student learning (Donham, Bishop, Kuhlthau, & Oberg, 2001; Kuhlthau et al., 2007). Recent studies have reported the increasing involvement of librarians in collaborative teaching, (Warmkessel & McCade, 1997; Konzal, 2001; Mokhtar & Majid, 2006; Chu, Chow, Tse & Kuhlthau, 2008; Montiel-Overall, 2008), which is generally a partnership between a librarian and one subject teacher (Donham et al., 2001). However, to increase the effectiveness of harnessing the domain knowledge of subject teachers and the information literacy skills of librarians, Kuhlthau et al. (2007) suggested a flexible three-member team (2 subject teachers, 1 librarian) to work together in guiding students' inquiry learning projects.

### *3.3 Reading ability and interest*

Learning to read may be considered as one of the most important academic skills that form the basis of performance and learning of a child in school (Leppanen et al., 2005). According to Lau and Chan (2003), students with good reading abilities possess well-developed cognitive skills in comprehension. Moreover, proficient readers are better able to apply sophisticated reading strategies and analyze textual organization, and possess more metacognitive skills than less proficient readers (Yau, 2005).

Reading ability has been shown to be affected by interest and positive attitudes about reading (Twist et al., 2004). Students who have more positive attitudes towards reading tend to gain higher reading achievements (Gnaldi et al., 2005). With greater interest, students may be exposed to more reading experiences, and this has been shown to facilitate further development of reading abilities (Leppanen et al., 2005). It may then be inferred that students who are disinterested in reading may find it more difficult to develop their reading abilities. In building up reading abilities, learning curricula may include exercises on comprehension, reading fluency, written composition, and emphasizes on stimulating the students' interest in reading (Hammill, 2004).

### *3.4 PIRLS*

The Progress in International Reading Literacy Study (PIRLS) is an international assessment that compares data about students' reading achievements in primary school (Martin et al., 2003). It assesses four processes of reading comprehension: (1) focus and retrieval of explicitly stated information, (2) making straightforward

inferences, (3) interpretation and integration of ideas, and (4) examining and evaluating language content and textual elements (Mullis et al., 2007). It measures trends in reading literacy achievements, and explores the impact of psychosocial and environmental factors. For this study, data were obtained using the PIRLS standard assessment procedures among Hong Kong students to objectively examine the reading abilities of the participants.

#### **4. Procedures**

A case study design is used when research aims to provide an in-depth examination of variables as they occur in the field (Ary et al., 2006). This study design was used to investigate the effects of the combined collaborative teaching approach and inquiry PBL on the reading abilities and interests of primary school students.

The collaborative inquiry PBL model used in this study involved the school librarian and several subject teachers. Previous studies on the implementation of inquiry PBL have mainly focused on the school librarian and one subject teacher (Donham et al., 2001). However, based on more recent findings, a flexible three-member core team, consisting of two subject teachers and a librarian, has been recommended (Kuhlthau et al., 2007). This present study used the extended team approach, but included three kinds of teachers (GS, Chinese Language, and Information Technology [IT]) and the school librarian.

##### *4.1 Participants*

The study was conducted in a local Hong Kong primary school where the collaborative inquiry PBL approach was being implemented. Research participants included students ( $n=132$ ), teachers ( $n=11$ ), and parents ( $n=25$ ). The students were at primary 4 (P4) level, and were asked to complete their group projects in their GS course. P4 level corresponds to grade 4 level in the US educational system. The teachers were those who were participating in the collaborative teaching approach, and were teaching GS ( $n=5$ ), Chinese language ( $n=4$ ), and IT ( $n=1$ ). The librarian ( $n=1$ ) was also considered as a teacher, since librarians in Hong Kong all have teacher qualifications. The parents were invited to participate, and those who consented to do so answered questionnaires through phone interviews.

##### *4.2 Instructional design*

The instructional design was based on models and guidelines developed by Harada and Yoshina (2004a; 2004b), and Kuhlthau (1997; 2003; 1994). The learning activity involved two phases, with students completing a group research project on a topic approved by their GS teachers in each phase. Students decided on their research topics according to a theme that guided each phase. The first phase lasted for 10 weeks, and the theme for their topics was “The Earth”. The second phase was done over a period of 9 weeks with the theme of “History of Hong Kong and Mainland China”. The students were asked to search for information on their specific topic and work together to produce a project presentation.

Since the group projects were a part of the GS course, the GS teachers served as keystone participants in the collaborative teaching approach, and provided the directions for the students, feedback for the work in progress, and evaluation marks upon completion of the projects. In previous years, the group projects had been implemented with the guidance of only the GS teachers. In this current approach, support for students was provided by the Chinese Language teachers, IT teacher, and school librarian as well.

To gain familiarity with the collaborative teaching approach, four formal meetings were conducted among the participating staff and the first author of this paper who served as a project consultant. From these formal meetings, it was determined that written assignments in Chinese language courses would be integrated with the GS inquiry PBL topics of the students. The curricular changes in the IT curriculum were also identified in the formal meetings. Several informal discussions between the teaching staff subsequently occurred at different stages of the project implementation. From these discussions, the content of the librarian’s lessons for the students was determined, to focus on information literacy skills through hands-on library sessions.

An important element of the inquiry PBL approach was that students had to collect materials relating to their own topics, and in so doing, were encouraged to explore different sources. The school librarian, serving as the

information provider, provided access to various kinds of resources for students. These included books (e.g., a block loan of 200 books were borrowed from the public libraries), newspaper clippings and webpage links related to the main theme. Besides these, the school librarian held training sessions to equip students with basic information search skills for finding relevant resources online. In the process of searching for information, students were free to use any database or search engine that they had learnt about from the school librarian (e.g., WiseNews, public library catalogues), or any other sources that they had known about previously (Chu et al., 2007).

Chinese Language teachers conducted exercises aimed at equipping students with proficient reading skills, and used reading materials that were related to the students' group projects. During phase 1, a maximum of seven in-class exercises and seven take-home assignments were given to each student participant. In phase 2, a maximum of six in-class exercises and seven take-home assignments were done. For each in-class exercise, students were required to read an article with informational text, related to the main theme of the phase (i.e., newspaper articles, textbook sections, or printed materials from the web). Students were asked to underline the key sentences in the article, and to follow this by writing a summary and their opinions in 100-150 words. For each take-home assignment, students were asked to search at least three pieces of writing (e.g., articles, books) related to the project theme, read them, and write a research journal entry of 150-200 words.

The main role of the IT teacher was to revise the IT curriculum such that Microsoft PowerPoint, Microsoft Excel, and Chinese keyboarding skills were included in the P4 lessons. In previous years, these skills had only been taught at the P5 level, but in this study, they were introduced earlier so that students could gain the essential IT skills needed in searching and organizing information for their group projects. Chinese keyboarding skills were crucial in the students' process of information search, while Microsoft PowerPoint was utilized for the students' presentations.

#### *4.3 Evaluation methods*

Students took the standard reading test of PIRLS twice: one week prior to the start of the first phase of the inquiry PBL, and one week after the completion of the second phase. Each phase lasted for 10 weeks, with about a one month gap in between, thereby giving a period of about 6 months between the two evaluation points. Comparisons were made for the students' scores before and after the two phases. The PIRLS reading ability test focused on two aspects: (1) the process of reading comprehension, and (2) reading and understanding different reading materials. Students were required to employ various reading processes: focusing on specific aspects of text, making simple and complex inferences, interpreting and integrating information, and examining and evaluating text features. Two types of reading materials were included in the test battery: literary materials such as stories or fables for enjoyment purposes, and scientific descriptions or manuals for information value (Mullis et al., 2006). Because both types of reading experiences (literary and informational) are important for the reading development of pupils, the reading test battery consisted of one literary passage and one informational passage. Pupils had 40 minutes to answer questions on the first passage, rested for 10 minutes then spent another 40 minutes on the second passage of text. Total test scores for each pupil were estimated using the Item Response Theory (IRT) Model (Lord, 1980) based on the responses of each pupil to the test items. The computer program PARSCALE 4 (Muraki & Bock, 2003) was used in the estimation of the IRT scores of pupils. The IRT scores were scaled to a mean of 500 (Martin, et al., 2003).

Students also completed the PIRLS survey on their reading habits, attitudes, and interests. Two of the components of this survey used a 4-point Likert scale to examine the students' attitude toward reading (SATR), and their reading self-concept (SRSC).

Students, teachers and parents were surveyed with a questionnaire after students had completed the first phase of the GS projects. The questionnaire was implemented 10 weeks after the start of the PBL approach, thereby evaluating the effects of the inquiry PBL approach in phase 1. The participants' perceptions of the effects of the inquiry PBL approach were examined using close-ended questions with a 5-point Likert-type scale. Open-ended questions were included, and probed on the participants' perceptions of the students' change in learning dimensions. They were also asked to give a detailed account of improvements that they observed among

students. Teachers were also asked to give an account of their collaborative activities during the implementation of the study (see Appendix A for sample interview questions). Since the questionnaire was implemented before phase 2, it was expected that should there be any relevant insights from the participants, modifications in the teaching approach would have been made in time for the second phase. However, no pressing concerns that required modifications were found.

SPSS 14.0 was used to conduct quantitative analysis. T-tests were used to compare the PIRLS scores before and after the inquiry PBL. Data obtained through the questionnaires were presented with descriptive statistics and illustrated in box plots. Statistical significance was set at  $p < 0.05$ . Findings from the open-ended questions in the interviews were analyzed qualitatively with NVivo 8 to identify themes.

## 5. Findings

### 5.1 *Students' reading performance before and after the inquiry PBL projects*

The students' reading performance indicated an improvement after the inquiry PBL projects. Paired samples t-tests showed statistically significant differences ( $p < 0.05$ ) in the pre-test and post-test scores on PIRLS tests (see Table 2). Improvements were found in overall reading performance, as well as in informational and literary reading performance.

[Take in Table 2 about here]

### 5.2 *Students' attitudes toward reading (SATR)*

The students' attitudes toward reading (SATR) were evaluated based on 5 survey questions, with a 4-point Likert-type scale for response options. Aggregate scores between 3 and 4 were classified as high SATR, scores between 2 to 3 were medium SATR, and scores lower than 2 were low SATR. As shown in Table 3, the number of students at each level of SATR did not change much between the pre-test and post-test. Improved reading performances were indicated by statistically significant differences (using paired samples t-tests) in the pre-test and post-test overall scores of students in the medium and high SATR groups. The most substantial improvements were noted in the medium SATR group. Students with low SATR scores did not manifest significant changes in their pre-test and post-test overall scores. It may be noted that the pre-test overall scores of those in the low SATR group were actually higher than the pre-test overall scores of the other two groups. Increases were found in the scores of the low SATR group, but the higher baseline may have resulted in improvements that were not significant.

Particularly for the component of informational reading performance, improvements were noted for all three groups, but were statistically significant only for the medium SATR group ( $p = .001$ ). On the other hand, for literary reading performance, the improvement was not statistically significant for students with low SATR. However, improvements for the medium and high SATR were significant ( $p = .015$ ,  $p = .005$  respectively).

[Take in Table 3 about here]

### 5.3 *Students' reading self-concept (SRSC)*

The students' reading self-concepts (SRSC) were evaluated based on 4 survey questions that utilized a 4-point Likert-type scale. Those with scores between 3 and 4 were classified as high SRSC, scores between 2 to 3 were medium SRSC, and scores below 2 were low SRSC. The groups' pre-test and post-test scores were compared (see Table 4) using paired samples t-tests, and showed no statistically significant differences in the pre-test and post-test scores of those in the low SRSC group. In the medium SRSC group, a significant difference was noted only in the overall score ( $p = .011$ ). On the other hand, the high SRSC group manifested significant differences in the overall and literary scores ( $p = 0.000$  and  $p = .002$  respectively).

[Take in Table 4 about here]

### 5.4 *Perceptions of effects of inquiry PBL on reading abilities and interests*

The three groups of participants responded to a survey on their perceived effects of the inquiry PBL approach on the students' reading abilities and interests. The questionnaire utilized a 5-point Likert-type scale, where 5 corresponded to "most helpful" and 1 represented "not helpful at all". All the participant groups indicated positive perceptions of the helpfulness of inquiry PBL in improving the students' reading abilities. Teachers gave the highest ratings ( $3.9 \pm 0.2$ ), followed by students themselves ( $3.5 \pm 0.2$ ). Parents, on the other hand, gave the lowest ratings for the helpfulness of inquiry PBL for improvements in reading abilities ( $3.3 \pm 0.4$ ). Nevertheless, all the ratings were found to be positive.

The participants also evaluated whether the inquiry PBL projects helped increase the students' interests in reading. As with reading ability, positive findings were found, with the mean rating given by teachers ( $3.7 \pm 0.3$ ) the highest, followed by the students' mean rating ( $3.5 \pm 0.25$ ), while the mean rating of parents ( $3.1 \pm 0.5$ ) was the lowest.

### 5.5 *Qualitative findings*

Besides the ratings given by the participant groups, as seen in the previous section, open-ended questions were also given to the participants during the interviews. The responses were coded and several aspects of reading were reported to have positive changes, as seen from the comments and responses of the different participant groups.

One student (SE1) commented, "We now know how to identify the main ideas of a passage or an article, and know how to select relevant information when much information is given." This reflects the students' perceptions on the development of their comprehension skills. Parents also gave responses that indicated a perceived improvement in comprehension skills. One parent (PH9) noted that his/her child was now able to "know the key points" of reading materials. Even more explicitly, another parent (PH11) reported that his child "improved in comprehension". Such perceptions were noted by teachers as well, as shown in a teacher's (TCh1) reporting that "students learnt how to figure out the main points when reading in Chinese lessons."

A number of parents also perceived improvements in their children's ability to read faster. For instance, one parent (PF19) mentioned that "the reading speed is faster than before", while another parent (PG1) noted that his/her child's reading speed had become "much faster." This was also reported by teachers as shown in one teacher's statement that "many students said they could read faster than before" (TCh1).

Gains in vocabulary and language usage were also noted by parents. One parent (PG1) mentioned that, "My child now knows more vocabulary than before...his skill in using appropriate vocabulary in his writing has also improved." Another parent said that his/her child had "learned more vocabulary and better organization in writing" (PE13).

Generally, teachers noted that there had been an improved reading ability, which may have been related to an increased interest in reading. One of the teachers (TGS1) noted that: "There was an obvious improvement in the reading ability in Phase 2. Phase 2's material is more interesting." This was also noted by several parents, as in the case of a parent who said that his/her child "borrowed more books from the school library, searched more information in magazines or newspapers" (PE12). The heightened interest in reading was even reflected during leisure time; as one parent put it, "my child reads books when he is free". In addition to borrowing material from the library, one parent (PF10) also noted that his child would "buy books from bookshops".

## 6. Discussion

The collaborative inquiry PBL approach as implemented in this study for the GS group projects has been reported to be perceived by students, parents, and teachers as beneficial in improving eight learning dimensions, one of which is reading comprehension (Chu, 2009). Owens, Hester, and Teale (2002) described inquiry-based learning as made up of the following components: students select their own topic of interest to research; they formulate questions; search and synthesize information; and finally, come up with an output. The inquiry PBL approach used in this research may be described as involving a similar process. Additionally, we have illustrated the collaborative nature of the approach and the contributions of the different kinds of teachers. It has been

shown in previous research that high levels of collaboration between different teachers and the librarian promote effective learning among students (Montiel-Overall, 2009; Thousand et al., 2006). This project contributes to the evidence indicating that a collaborative teaching approach may be beneficial for students. It has been previously reported that students who engaged in inquiry PBL gained significantly higher project grades, relative to students in the previous year, who conducted their projects with the support of the GS teacher only (Chu, 2009). The findings that have been presented now, further expand this by demonstrating improvements in objective measures of reading abilities, attitudes, and interests.

This study also builds on recent recommendations that have suggested collaborations between the school librarian and two subject teachers. We showed that an extended team of three kinds of teachers and the school librarian can actually work to support inquiry PBL. In this study, we included the IT teacher in the team, highlighting the role of technology in inquiry learning, particularly its potential to allow students access to a vast array of resources and create high-quality presentations (Leu, 2001). In this study, the role of the librarian was also crucial in facilitating the students' ability to find and evaluate information. The collaborative teaching approach in this study thus expanded the recommendations from previous studies.

The positive effects of the inquiry PBL approach on reading abilities and interests are illustrated by the results from the PIRLS tests, the surveys, and the qualitative interview data. It has been previously suggested that focusing on inquiry learning heightens students' motivation to read and increases the chance of improving reading abilities (Owens et al., 2002). Our findings provide evidence for this proposition, as shown by the students' improvements in the PIRLS test: their overall reading performance was observed to have improved after the inquiry PBL implementation. However, while our approach was focused on informational reading, the improvements noted appear to have been more in terms of literary reading performance. Informational reading and literary reading may differ in terms of the processes and strategies that readers engage in (Coiro & Dobler, 2007), and it has been found that both children and adults experience greater difficulties with informational reading (Biancarosa & Snow, 2004). In this study, informational reading did not improve as much as literary reading, which may partially be explained by the greater difficulty associated with it. Furthermore, confounders such as external factors outside the scope of this study may have contributed to this finding as well. For instance, students across countries that participated in PIRLS 2006 reported that they generally read stories and novels outside of school more frequently than informational materials (Mullis et al., 2007).

The improvements in the students' reading abilities did not appear to be consistent across the levels of the students' attitudes toward reading (SATR). Students with low SATR scores did not gain significant improvements in their PIRLS reading performance tests. Previous studies have also shown that readers with higher positive attitudes towards reading perform much better in tests (Artelt et al., 2003). It has been argued that continuous reading progress generally demands a fair amount of positive student motivation (Aunola et al., 2002). The results of this study are consistent with previous findings, in that students who had more positive attitudes towards reading gained significant improvements through the inquiry PBL projects, whereas those who had less positive attitudes towards reading did not gain significant improvements. However, despite these findings, we may note that no cause-effect relationship has been shown as far as attitudes towards reading and reading abilities are concerned.

Inquiry PBL has also been shown to be successful in facilitating benefits for students by increasing interest in learning through the inquiry process (Owens et al., 2002). However, in this study, the inquiry approach did not seem to influence the students' attitudes towards reading as can be seen in the minimal change in the number of students at each SATR level.

Previous research has shown that children's positive perceptions of their abilities have significant constructive effects on their scores in reading tests (Lynch, 2002). Such observations are grounded in firmly established theories that illustrate the effects of self-efficacy in the learning process (Bandura, 1993). With the inquiry PBL approach used in this study, a similar pattern was seen as it appears that students who had better perceptions of their reading skills gained significant improvements in their reading tests. However, these findings must be

considered in relation to the limitations in sample size, which could have affected the statistical analysis. There were considerably fewer participants in the low SATR and low SRSC groups than in the high SATR and high SRSC groups. Generally, the results indicate that the students' reading abilities improved after the implementation of inquiry PBL as shown by the overall findings. Although the students' attitudes and self-concepts appear to have contributed to their improvements, the limitations of the statistical analysis must be recognized.

The improvement in the students' reading abilities is complemented by the survey findings and the interview responses, which indicated a positive effect of inquiry PBL on the reading interests of students. The findings from the qualitative component of the data analysis indicated an increased interest in reading as observed by both parents and teachers. The general feedback seems to be that students became more interested in reading, as manifested by their changed attitudes towards reading materials. This reported improvement in reading interest is important since children who enjoy reading generally read more often, and consequently, the amount of time allocated for reading has been thought to contribute to the improvement of a child's reading comprehension (Lynch, 2002). We may further infer that through an indirect effect, an inquiry PBL approach may promote the reading abilities of children.

The qualitative component of our findings identified three areas of improvement that relate to the reading abilities of the children: reading comprehension, reading speed, and vocabulary. An important element of reading comprehension is the identification of meaningful relationships between different parts of a text, which are identified through an inferential process (Kendeou et al., 2008). The nature of inquiry projects requires students to compare and contrast information repeatedly from different sources (Owens et al., 2002), which involves an inferential process that may be seen to promote reading abilities by improving the ability to make connections between different parts of the text (Cain & Oakhill, 1999).

The ability to read with sufficient speed is one of the indicators of a good reader (Compton, 2000; Hammill, 2004), and both parents and teachers in this study reported an increase in the reading speed of students. It has been argued that the principle that repeated practice leads to speed and smoothness of activity applies to reading abilities as well (Samuels, 1979). The inquiry PBL approach we implemented gave students an increased number of opportunities to practice reading. This may have contributed to the perceived improvements in reading speed of students. In total, the Chinese language teacher gave 27 reading assignments to the students that were related to their inquiry project. Besides this, students also had an increased amount of reading as they searched and sifted through information sources.

Vocabulary plays an important part in reading comprehension (Kirby et al., 2008), and evidence shows a positive correlation between vocabulary and reading achievement (Biemiller, 2007; Biemiller & Boote, 2006). However, there is inadequate evidence that teaching vocabulary may improve reading ability (Biemiller, 2007). After all, vocabulary is best acquired in context that is through reading experiences, and not by being taught in isolation and by memorization (Kirby et al., 2008). This study did not examine vocabulary, but it was reported in the interviews as an area of improvement among the children. The inquiry PBL approach used in this study was based on constructivist approaches, and we suggest that it offers greater possibilities for generalized learning. This could have contributed to the students' reported improvements in their vocabulary and reading abilities.

### *6.1 Limitations and future studies*

As the study was conducted at the same time as the implementation of the General Studies course, the improvements in reading abilities may not be fully attributed to the inquiry PBL approach alone. Other factors that may be considered confounders are activities in the other courses, other assignments in GS, and the students' individual learning styles. However, this may also be considered as a strength of the study, since the variables are examined in a setting that represents the actual implementing scenario. Furthermore, evaluations were done within the space of 6 months: 3 months after the start of the implementation and at the end of the implementation, which limits the possibilities that other factors may have caused the actual and perceived improvements of students. Finally, we are not able to isolate inquiry PBL approach as a single factor in the

change in reading abilities, attitudes, and interests. On the contrary, we may consider the contributions of the IT teacher, language teacher, and librarian as integral components in the learning approach utilized in this study.

## **7. Conclusions**

The findings reported in this paper indicate that the combined collaborative teaching and inquiry PBL approach used in the GS projects of students in this case study helped students improve their reading abilities. Based on group comparisons, the findings also imply that the inquiry PBL approach may be more beneficial for students who have more positive attitudes towards reading, and who have better perceptions of their reading abilities. The perceived improvements in the students' reading abilities were reported by all the participant groups involved, presenting a triangulated set of findings.

The study illustrates the implementation of an inquiry PBL approach in the context of Hong Kong primary education. We showed an extended team of teachers collaborating in providing students with the necessary support to carry out an inquiry project. Though the case reported in this paper is particular to Hong Kong, the findings illustrated the roles of the collaborating teachers, which may serve as a reference for future applications of the inquiry PBL approach in primary school education elsewhere. The evidence presented by this study showed that a collaborative inquiry PBL approach may contribute to the academic performance of students by aiding the development of reading abilities and interests.

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## Appendix A: Sample interview questions

### Telephone Interview for Parents of P4 students

- Does the project help your child improve in the following aspects?

Aspect	None					A lot	N.A.
	1	2	3	4	5		
Ability in finding information (e.g., can find relevant articles/books more easily)							
Interest in reading (e.g., read more books/articles)							
Reading ability (e.g., read faster, can identify the main points of articles more quickly)							
Writing ability (e.g., can write with a wider base of vocabularies)							
Computer related skills (e.g. PowerPoint, Chinese word processing)							
Knowledge about the research topic							
Communication Skills							

Any details on how your child improved on the above mentioned aspects?

Any improvement in other aspect(s) as a result of working on the project?

- Do you think that it is advisable for the school to keep organizing inquiry-based learning project/activity(s) for the students in the future? Why or why not?

### Telephone Interview for P4 students

- How does the inquiry learning project stimulate your interest in reading articles/books?
- How does the inquiry learning project help you improve your reading ability or attitude?

### Telephone Interview for Teachers

- How will you define your role regarding the whole process of students' inquiry learning project?
- Did some students show improvement in certain ways concerning the inquiry learning project? How?

## **Table Legends**

Table 1 Eight dimensions of skills, abilities, and knowledge for students' improvement

Table 2 Comparison of students' pre-test and post-test reading performance measured by PIRLS

Table 3 Students' attitude toward reading and their performance in PIRLS tests before and after the inquiry PBL projects

Table 4 Students' reading self-concept and their performance in PIRLS tests before and after the inquiry PBL projects

## Tables

Table 1 Eight dimensions of skills, abilities, and knowledge for students' improvement

Kind of Learning	Dimension	Indicators of Attainment
Curriculum content	1. Subject knowledge	A good understanding of the subject areas the students are researching, as well as a wider vocabulary in their chosen subject areas.
Information literacy	2. Information literacy	Students' skills in searching for relevant information, in locating, evaluating, and making use of sources should be sharpened by their work on the projects; including familiarity with a greater variety of sources.
	3. IT skills	Familiarity with the writing pad for Chinese-input, and/or a good knowledge of Chinese inputting methods; ability to use MS Excel in creating graphical presentation of data.
Literacy competence	<b>4. Reading comprehension</b>	<b>Gaining/achieving a higher level of reading comprehension ability, which may be illustrated by an improvement in identifying the main points of a passage.</b>
	5. Writing ability	Manifested by the ability to write faster, longer and better (i.e. using a wider range of, and more sophisticated, vocabulary) by the end of the projects.
Social skills	6. Social and communication skills	Improved social skills such as sharing, listening, taking turns and assisting others.
Learning how to learn	7. Presentation skills	Enhanced ability to present information in multimedia formats (e.g., MS PowerPoint), and formal presentation of project findings.
	8. Research skills	Improved investigative skills and problem-solving capabilities; for instance, becoming more skilled in asking questions and organizing their ideas for the projects.

Table 2 Comparison of students' pre-test and post-test reading performance measured by PIRLS

Scores	Pre-test		Post-test		t-test
	Mean	SD	Mean	SD	Sig. (* $p < 0.05$ )
Overall <sup>a</sup>	514.60	120.48	569.64	44.96	.000*
Literary <sup>b</sup>	537.87	47.35	556.73	48.26	.000*
Informational <sup>c</sup>	552.99	93.07	562.28	42.69	.048*

Notes: <sup>a</sup>Overall reading performance, pre-test  $N=151$ , post test  $N=142$ .

<sup>b</sup>Reading for enjoyment, pre-test  $N=138$ , post test  $N=142$ .

<sup>c</sup>Reading to acquire and use information, pre-test  $N=138$ , post test  $N=142$ .

Table 3 Students' attitude toward reading and their performance in PIRLS tests before and after the inquiry PBL projects

		<i>n</i>	Mean	S.D.	t	Sig. (* <i>p</i> <0.05)
Low SATR	Pre-test overall scale score	9	543.92	30.54	0.23	.823
	Post-test overall scale score	9	549.76	56.95		
	Pre-test literary scale score	8	537.80	35.53	0.19	.854
	Post-test literary scale score	8	542.68	47.62		
	Pre-test informational scale score	8	537.17	23.88	1.81	.113
	Post-test informational scale score	8	558.39	39.87		
Medium SATR	Pre-test overall scale score	54	518.77	109.66	-3.36	.002*
	Post-test overall scale score	49	570.14	46.04		
	Pre-test literary scale score	51	530.69	46.16	-2.52	.015*
	Post-test literary scale score	49	552.97	55.82		
	Pre-test informational scale score	41	546.52	51.00	-3.66	.001*
	Post-test informational scale score	49	566.51	36.33		
High SATR	Pre-test overall scale score	87	508.05	132.68	4.27	.000*
	Post-test overall scale score	83	571.22	43.19		
	Pre-test literary scale score	78	541.60	48.66	2.87	.005*
	Post-test literary scale score	83	560.90	43.11		
	Pre-test informational scale score	78	558.55	119.00	0.79	.430
	Post-test informational scale score	83	561.50	44.92		

Table 4 Students' reading self-concept and their performance in PIRLS tests before and after the inquiry PBL projects

		<i>n</i>	Mean	S.D.	t	Sig. (* <i>p</i> <0.05)
Low SRSC	Pre-test overall scale score	5	392.26	221.73	1.57	.192
	Post-test overall scale score	5	571.61	79.69		
	Pre-test literary scale score	4	491.47	54.88	0.91	.430
	Post-test literary scale score	4	541.41	113.45		
	Pre-test informational scale score	4	502.24	26.66	1.73	.182
	Post-test informational scale score	4	556.53	52.61		
Medium SRSC	Pre-test overall scale score	51	531.27	85.23	2.66	.011*
	Post-test overall scale score	51	566.58	48.20		
	Pre-test literary scale score	47	541.77	44.90	1.23	.225
	Post-test literary scale score	47	553.40	53.09		
	Pre-test informational scale score	47	554.48	89.64	0.50	.619
	Post-test informational scale score	47	561.75	42.27		
High SRSC	Pre-test overall scale score	84	507.21	134.07	4.33	.000*
	Post-test overall scale score	84	570.66	41.21		
	Pre-test literary scale score	76	537.06	48.32	3.27	.002*
	Post-test literary scale score	76	559.34	38.81		
	Pre-test informational scale score	76	547.36	75.05	1.98	.052
	Post-test informational scale score	76	565.71	41.03		

## **Authors' Biography**

**Dr. Samuel Chu** is an Assistant Professor (Division of Information & Technology Studies) and the Deputy Director (Centre for Information Technology in Education) in the Faculty of Education, the University of Hong Kong. His research interests include Web 2.0 for teaching and learning, inquiry-based learning, information seeking, and knowledge management.

**Prof. Shek Kam Tse** is a Professor at the Faculty of Education, The University of Hong Kong. His research interests are in reading literacy and Chinese language learning.

**Dr. Elizabeth Ka Yee Loh** is an Assistant Professor at the Faculty of Education, The University of Hong Kong. Her research interest is in Chinese language education.

**Dr. Ken Chow** is the Principal of the Sacred Heart Canossian School, Hong Kong.