Final Report on Development of Evaluation Tools for Assessing Students' Information Literacy and Promoting Information Literacy among Students

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Executive Summary

1 Purpose of the Study

Education Bureau (EDB) has commissioned the Centre for Information Technology in Education (CITE), University of Hong Kong to conduct a one year project on "Development of Evaluation Tools for Assessing Students' Information Literacy and Promoting Information Literacy among Students".

This project aims to develop self-evaluation tools for assessing students' Information Literacy skills in Science at Key Stage 1- 3 and to work with front line teachers including those who are members of the Information Literacy Focus Working Group (ILFWG)[1]. The specific objectives of this study are to:

1. Develop strategies/pedagogies that can enhance IL among students in local primary and secondary schools;
2. Make use of the self-evaluation tools as developed in the project for assessing students' IL; and
3. Investigate the impact on students' IL when they are taught with the strategies/pedagogies developed for enhancing IL among students.

2 Methodology

As the aims of this project are to develop self-evaluation tools in assessing students' IL, develop learning and teaching activities that promote IL among students, and find out the impact on learning and teaching in naturalistic classroom environments, the project team therefore considered design research as the most appropriate methodological approach for the present study. The project research questions are answered through a multiple case study method, treating each of the 15 curriculums and assessment units developed in this project as a single case, in which a case refers to the enactment of a small intact curriculum unit at the school level.

To get an overall picture of how the classroom activities along with assessment tools were used and how teachers' strategies/ pedagogical intervention impact students' performance on IL at different Key Stages, data were collected from five main sources: collaborative lesson planning

[1] ILFWG is a working group comprised of front-line teachers, professional officers from the Education Bureau and the Hong Kong Education City as well as seconded teachers working in the Education Bureau who meet regularly with a view to develop innovative IT supported pedagogies and organize professional development programmes for school teachers on how to nurture IL among students.

materials, classroom lesson observations and videos, students' artifacts and the pre and post performance assessment (PA) test as well as teacher interviews and student focus group interviews.

There were a total of five primary schools and five secondary schools participating in this project. There were two schools involved in the curriculum development in the key stage one and four schools involved in key stage two. One primary school was involved in both key stage one and two. Five schools were involved in the curriculum development in key stage three. A total of 24 lesson observations were conducted (11 for secondary schools and 13 for primary schools).

3 Summary of Findings

3.1 Project deliverables

3.1.1 Curriculum and professional development resources

All together four training workshops were organized for participating teachers. Two workshops on introducing the concept of IL and the design of learning and teaching activities that involved the IL elements were conducted. Two for the assessment design. The project team also made a total of 79 visits to the ten schools to provide professional support on the implementation of IL. Finally four sharing seminars were also organized for local primary and secondary school teachers to share the key outcomes of the project.

3.1.2 The project website

A project website has been developed (URL http://iltools.cite.hku.hk/revamp). It includes an overview on the key concepts and outcome from this project as well as a collection of 15 curriculum exemplars. All the curriculum materials and respective assessment tools as well as sample of students' work, if applicable were uploaded onto this website.

3.1.3 Generic IL rubric and Key stage rubric

Two sets of rubrics including generic IL rubric which depicts the general progression of students' development in each dimension of IL and Key stage rubric provides a description of the expected level of students' performance at the end of KS1, KS2 and KS3.

3.1.4 Self-evaluation checklists and assessment rubrics

A total of 77 sets of self-evaluation checklists and assessment rubrics were designed for evaluating students' performance in eight IL dimensions.

3.2 Difficulties encountered

Teachers reported that five main difficulties were encountered during the project implementation. They were unfamiliarity with the concept of IL and the curriculum and assignment design that foster the development of IL, short implementation period, and problem concerning the infrastructure such as low bandwidth for internet access and the availability of the computer room were mentioned.

3.3 Changes in pedagogical practices

The data collected in this study reflected 3 major changes in pedagogical practices. First, the mode of teaching have shifted from teacher-centered to student-centered throughout this project as students have taken a more active role in their learning . Second, through collaborative planning from the project team and the teachers, the teachers have expressed their readiness to design their own lesson activities, rubrics as well as evaluation tool in the future. Third, changes in assessment practices were shown as this project has allowed students themselves to act as evaluators as well through self and peer evaluations, and it was reflected that this new practice of assessment has provided more space and autonomy for students to learn.

3.4 Students and teachers learning gains

The student focus group interviews conducted in each case study have revealed learning gains and enhancement in 8 IL dimension skills from this project regardless of which key stages they were in (KS1, KS2 and KS3) after the curriculum intervention.

Apart from learning gains in eight IL dimensions, teachers mentioned that students' learning motivation and learning attitude have enhanced through the integration of IL activities. Besides, both students and teachers pointed out that the integration of IL activities has broadened students' perspectives in subject learning.

Some benefits of teachers from participating in this project have been reflected from the data, including enrichment of the curriculum design, a clearer conceptual understanding of IL, and professional development on pedagogical strategies in designing and assessing IL.

3.5 Views on the assessment tools

Most teachers and students found assessment tools beneficial. In sum, teachers reflected that both self-evaluation checklists and assessment rubrics can help to promote IL among students.

3.6 Performance Assessment tests

Analyses of the pre-test and post-test results have revealed that generally students' overall competence in IL has been significantly improved after the curriculum intervention.

4 Conclusions

To conclude, it was found that in general, students from the three key stages were able to benefit from the implementation of different information literacy implementation strategies from this project. Positive changes in information literacy skills have been observed after the use of the developed assessment tools. Science and General Studies teachers who participated in this study have also shown to have a more comprehensive understanding of IL and hence able to and grasp a better knowledge and skills in assessing students' IL after the project implementation.

5 Major Recommendations

A number of recommendations for consideration in the next stage have been proposed based on the findings from the present study. It includes the recommendations for students, science teachers, IT teachers, teacher librarians, school Principals and EDB.

For students, guidelines and suggestions regarding the integrity of information, self-protection and privacy as well as how to use information ethically were given when they were engaged in online activities

For teachers, it is suggested that widen implementation to broader curriculum coverage for IL dimensions is needed.

For IT teachers, they should look for collaboration opportunities with teachers in other KLAs so that students will have an authentic situation to apply their knowledge learnt in the computer lessons.

For teacher librarians who would have a role to play in developing IL in school can provide KLA specific profession support and IL resources to subject teachers.

For school principals, it is suggested that more support from senior management level would be desired to accomplish fundamental changes in approach to teaching and learning, such as providing means for whole school approach in teaching ethical issues in information literacy, cultivating cross- and within- subject collaboration in promoting IL.

For EDB, as results in this study indicated that teachers were not familiar with the IL concepts and how to design learning activities as well as assessment tools that foster students' learning in IL, it is suggested that providing professional development opportunities that includes the IL introductory course as well action learning and professional community building on curriculum and assessment design that foster students' IL competence in different KLAs is deem necessary. Besides for the research and development project it is suggested that longer period of the implementation time for curriculum and assessment innovation is necessary. Finally, providing clear guidelines for the use of technology and the role of IL in science curriculum documents is also recommended.

Chapter 1 Introduction

1.1 Background

With the technological advances and increasing sophistication of different forms of media, a major challenge in the 21st century is how to handle and make use of diverse and emerging forms of information coming from all over the world. What are the associated opportunities and challenges to school education? Schools are preparing children for jobs that may not yet exist today and to use tools that have not yet been invented. In order to help students to prepare for life and work in the society, many government agencies and non-government agencies around the world have identified information literacy (IL) as one of the essential 21st century skills (Bundy, 2004; Partnership 21st century skills 2003; SCONUL, 1999; USECO, 2008). Kozma (2005, 2008) also points out that information literacy is one of the knowledge creation skills that may directly contribute to economic growth and social development. With the increasing importance of information literacy, standards and frameworks have been established on the kinds of competencies that an information literate people should have (ETS, 2002; ISTE, 2007; UNESCO, 2008). In Hong Kong, the Education Reform document (EC, 2000) launched by the Hong Kong SAR government also identified information literacy (IL) as one of the important skills for the 21st century. Subsequently, an information literacy standard for students was released (EMB, 2005). Based on empirical findings, the report of the "Study on Evaluating the Effectiveness of the 'Empowering Learning and Teaching with Information Technology' Strategy" (EDB 2007) recommends that efforts should be made to develop pedagogical designs for implementing the IL in learning and teaching in different Key Learning Areas (KLAs) as well as to incorporate IL in curriculum design and assessment practices.

In this connection, Education Bureau (EDB) commissioned the Centre for Information Technology in Education (CITE) of the University of Hong Kong to conduct a one year project on "Development of Evaluation Tools for Assessing Students' Information Literacy and Promoting Information Literacy among Students".

1.2 Objectives of the study

This project aims to develop self-evaluation tools for assessing students' Information Literacy skills in Science at levels from Primary 1 to Secondary 3 and to work with front line teachers

including those who are members of the Information Literacy Focus Working Group (ILFWG)[2]. The specific objectives of this study are:

1. Develop strategies/pedagogies that can enhance IL among students in local primary and secondary schools;
2. Make use of the self-evaluation tools as developed in the project for assessing students' IL; and
3. Investigate the impact on students' IL when they are taught with the strategies/pedagogies developed for enhancing IL among students.

The following services were provided in the context of this project:

1. Develop the self-evaluation tools for assessing students' IL in General Studies at Primary school level and Science Education at Secondary school level
2. Suggest feasible learning and teaching pedagogies that can enhance IL among students;
3. Provide proven examples on successful applications of the suggested strategies/pedagogies that can enhance IL among students for teachers in the aforesaid collaborative learning community to test run and to offer onsite support to these teachers when necessary; and
4. Conduct a study in five primary and five secondary schools within the aforesaid collaborative learning community on the impact on students' IL when they are taught with the suggested strategies/pedagogies for enhancing IL.

1.3 Research questions

The following research questions are addressed in this study:

1. What are the strategies that can enhance students' information literacy skills?
2. What changes, if any, can be observed in student's IL skills through the project process?
3. What recommendations can be made with regard to the development of a coherent strategy to integrate the development of IL skills in different KLAs based on the experience in this project on involving teachers in pedagogical and assessment design and implementation in this project?
4. What changes can be observed in teachers' knowledge of IL before and after the implementation of this project?

[2] ILFWG is a working group comprised of front-line teachers, professional officers from the Education Bureau and the Hong Kong Education City as well as seconded teachers working in the Education Bureau who meet regularly with a view to develop innovative IT supported pedagogies and organise professional development programmes for school teachers on how to nurture IL among students.

Chapter 2 Conceptual Framework

This chapter presents the conceptual framework for this study. Assessment for learning, the overarching principle will be introduced first and then the definition of information literacy will be delineated. Following this, the reasons for choosing Science Education as the subject area will be presented and finally the conceptual framework including elements of assessment for learning, elements in IL and scientific inquiry as well as role of researcher and teacher in this study will be described.

2.1 The overarching principle – Assessment for learning

One of the aims of this project is to develop self-evaluation tools for assessing students' information literacy and promoting information literacy among students. First, we need to define the concept of assessment in this project. This project is underpinned by the concept of assessment for learning: that learning, teaching and assessment are integral. Assessment is the practice of collecting evidence on how students learn and should provide information on how best they might do it as well as to inform students about the appropriate next steps (Black & Wiliam, 1998; Clarke, 2001). Hence, assessment in this project focuses on formative assessment and the purpose is to inform learning and teaching. It is also clearly indicated in the report of "Information Literacy Framework for Hong Kong Students" (EDB, 2005) that one of the possible ways to implement IL is to infuse it in the basic education curriculum and it also mentioned that *"IL assessment should be formative and developmental as the assessment would be designed for developing the capability of learners in learning different subject disciplines, which would reflect the ultimate learning outcomes of the IL initiatives*" (p.18). Therefore, the project team believes that the development of students' IL should be implemented and assessed in a meaningful learning context that is the design cum with the subject content and cannot to be developed in a vacuum. In this regard, while developing the self-evaluation tools for evaluating students' information literacy must be integrated into the learning and teaching processes it has to be developed in conjunction with the design of the learning and teaching activities as these are critical in providing students with the opportunities to develop and demonstrate IL skills.

Rubrics are the most common type of assessment tool adopted for the purpose of self-evaluation, and is also identified as the most appropriate for the purpose of the present project. Rubrics are descriptive scoring tools for rating authentic student work qualitatively. Rubrics are used when a judgment on the quality of a piece of work is required (Moskal, 2000). Rubrics use specific criteria as a basis for evaluating or assessing student performance, and provide narrative

descriptions that are separated into levels of possible performance related to a given task. According to the literature, rubrics can be designed as either general or task-specific (Hays, & Lantz, 2004; Moskal, 2000). According to Moskal (2000) rubrics provide general scoring guidelines that can be used for multiple tasks. Task-specific rubrics, in contrast to generic rubrics; only provide scoring guidelines that are appropriate for a single task. In this project, general rubrics describing the development of IL at the end of each key stage as well as analytic rubrics and checklists for specific criteria of information literacy attributes will be developed.

2.2 Defining information literacy

Information literacy is one of the essential skills for the 21st century (NCREL. 2003; OECD, 2003, Partnership for 21st century skills, 2003). The concept of information literacy was first defined by Zurkowski (1974). Since then considerable effort has been invested by both scholars and practitioners in many parts of the world in defining information literacy (ALA, 1989; Bundy, 2004; Kuhlthau, 1993; SCONUL, 1999; Shapiro & Hughes, 1996). The most generally accepted definition of information literacy that one finds in the literature is the one put forward by the American Library Association in 1989: *"To be information literate, a person must be able to recognize when information is needed and have the ability to locate, evaluate and use effectively the needed information*" (p.1). More recently UNESCO (2008) defines information literacy as *"the capacity of people to recognize their information needs; locate and evaluate the quality of information, store and retrieve information, make effective and ethical use of information and apply information to create and communicate knowledge"* (p.7). In this project, the UNESCO's definition of IL is adopted as it gives a more comprehensive view on how an information literate person works with information. It includes not only the technical skills of IL but also the cognitive and ethical aspects of IL.

In considering appropriate indicators for evaluating students' IL, a number of educational frameworks for assessing information literacy from different geographic regions were examined. Among the frameworks, the project team identified two frameworks, namely "Digital transformation: a framework for ICT literacy" developed by Education Testing Service (ETS, 2003) and "Big 6" developed by Eisenberg and Berkowitz (1990) as providing indicators most amenable to adaptation for operational adoption in the assessments to be designed in this project. These sets of indicators formed the basis for the final set of general rubrics constructed for adoption in the Project. A new set of indicators for "ethical use" that deals with values and beliefs such as using information wisely and ethically, social responsibility and community participation, which is missing from the above two frameworks was added into the set of IL indicators adopted. Figure 2.1 shows the eight dimensions of IL including define, access, manage, integrate, create,

communicate, evaluate, and ethical use of information. Descriptive explanations for the eight dimensions are presented in Table 2.1.

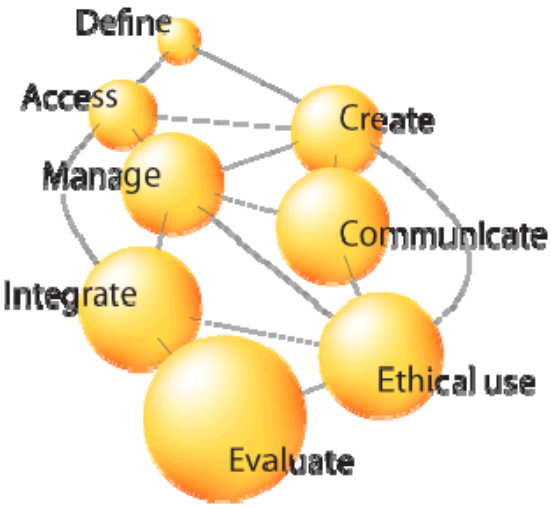

Figure 2.1 Diagram of eight dimension of information literacy

Table 2.1 Descriptions for the eight dimensions of IL in this study

Define	The ability to use ICT tools to identify and appropriately define the information needed to tackle the problem/task.
Access	The ability to collect and/or retrieve information. This includes the ability to identify likely digital information sources and to get the information from those sources.
Manage	The ability to master basic computer operation and apply an existing organizational or classification scheme for data management. It includes the ability to identify preexisting organizational schemes, select appropriate schemes for the current usage and apply the schemes.
Integrate	The ability to interpret and represent digital information. This includes the ability to use ICT tools to synthesize, summarize, compare and contrast information from digital sources.
Create	The ability to generate an artifact by adapting, applying, designing or inventing information in ICT environments.
Communicate	The ability to communicate information in its context of use for ICT environments. This includes the ability to gear electronic information for a particular audience and communicate knowledge in the appropriate venue.
Evaluate	The ability to determine the degree to which digital information satisfies the needs of the task in ICT environments. This includes the ability to judge the quality, relevance, authority, point of view/bias, currency, coverage and accuracy of digital information.

Ethical use	The ability to understand and model the positive, ethical technology use.

2.3 Science Education as the target Key Learning Area for this project

Science education was selected as the target subject for the present study. There were two reasons for choosing Science as the subject content for this project. First of all, the development of information technology skills is one of the nine generic skills mentioned in the curriculum reform document (CDC, 2001). Although there are some illustrations of the use of ICT for interactive learning in the Science Education Key Learning Area Curriculum Guide (Primary1-Secondary 3) (EMB, 2002), the expected learning outcomes for information technology skills described in each key stage are not explicit.

Second, IL skills can contribute greatly to achieving the aim of preparing students to be a 21st century learner in science and technology. As described in the Science Education Key Learning Area Curriculum Guide (CDC, 2002), the aim of science education is to prepare students so that they can learn independently, think critically and creatively and make decisions as well as solve problems. Through engaging in the scientific inquiry process throughout their study at primary and secondary levels, students are expected to develop progressively the 12 inquiry skills depicted in Figure 2.2, which includes understanding science investigation, predict, plan, define variable, application, information gathering, classify, record data, interpret, conclude, valuate and communicate. From the above, it is clear that the knowledge and skills emphasized in information literacy will contribute greatly to success in scientific inquiry, and that there is a lot of overlap between the two sets of competences. Thus, on the one hand, the Science curriculum provides a context for meaningful integration of IL-related learning activities to substantive learning tasks for the development of IL skills. On the other hand, higher levels of IL competence will lead to more productive scientific inquiry and better learning outcomes in science.

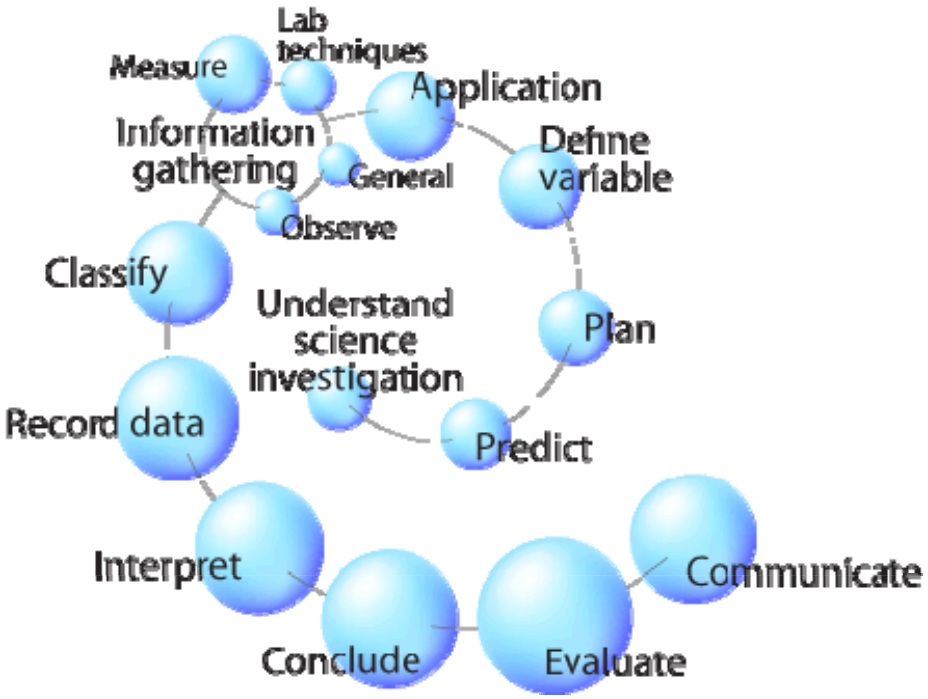

Figure 2.2 Diagrammatic representation of the12 inquiry skills in the Science curriculum guide (CDC, 2002)

2.4 Overall conceptual framework for this study

Figure 2.3 presents the overall conceptual framework for the study. It identifies the two important parties involved in this study—the teachers and the researchers. According to the research literature on curriculum innovation at the classroom level, the teacher is an important person in the curriculum implementation process (Fullan, 2007). In this study, the researchers also take up an important role—working collaboratively with teachers to develop curriculum materials, implementation plans and assessment tools that promote students' learning of IL. Therefore both the researchers and teachers take up the role of co-designers who design the curriculum and the role of producers who produce learning and teaching materials. During the process of interaction, both researchers and teachers work collaboratively on the curriculum design, with the researchers contributing innovative ideas, concepts and implementation suggestions to teachers and the latter making adaptations and finals decisions on implementation.

Different ICT tools offer different affordances for student's learning (Webb, 2005). Teachers' pedagogical approach and skills, and the subject matter content also affect what and how ICT is used (Mishra & Koehler, 2006). Strategies and pedagogies that facilitate the use of ICT in learning and teaching also promote the development of both general and subject-specific IL skills (Cox et al., 2004). Therefore, in order to achieve the goal of fostering students' IL skills and

facilitate students' learning in science, it is necessary for the project team to provide support for and to study classroom practices targeting the fostering of IL skills within the science curriculum. In designing the curriculum units, the 12 Science inquiry skills and the eight dimensions of IL are both taken into consideration. Figure 2.3 provides a diagrammatic representation of these two elements placed at the centre, bounded by the principle of assessment for learning, with teachers and researchers interacting and collaborating as co-designers. Such collaboration will also play an important role in the innovation diffusion process.

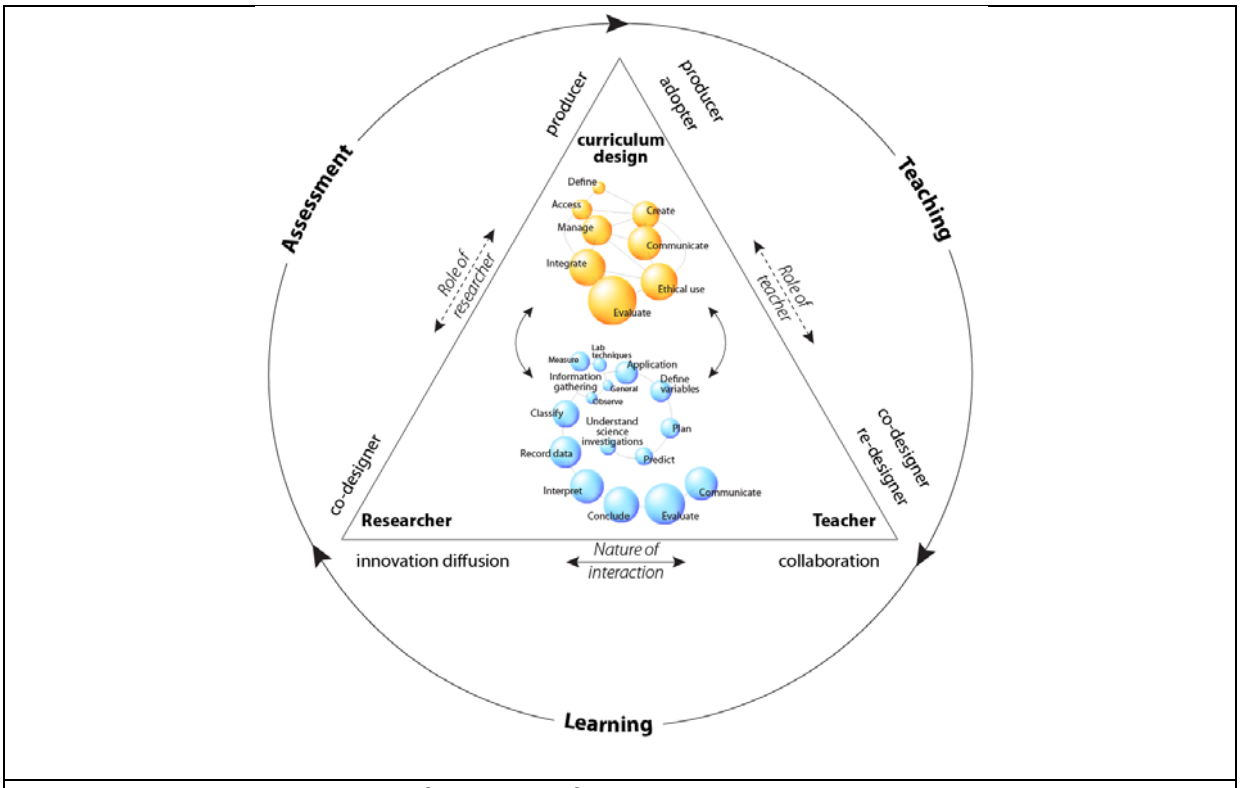

Figure 2.3 Overall conceptual framework for this study

Chapter 3 Methodology

3.1 Methodological approach

Design research is taken as the overarching methodological approach in this study. Barab and Squire (2004) define this approach as "*a series of approaches, with the intent of producing new theories, artifacts, and practices that account for and potentially impact learning and teaching in naturalistic settings.*" (p. 2). Building on previous work (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003; Design-based Research Collective, 2003; Kelly, 2003; Reeves, Herrington, & Oliver, 2005; van den Akker, 1999), van den Akker et al., (2006; p. 4) summarize the characteristics of design research as follows:

- *Interventionist: the research aims at designing an intervention in the real world.*
- *Iterative: the research incorporates a cyclic approach of design, evaluation and revision.*
- *Process-oriented: a black box model of input-output measurement is avoided; the focus is on understanding and improving interventions.*
- *Utility-oriented: the merit of a design is measured, in part, by its practicality for users in real contexts.*
- *Theory-oriented: the design is (at least partly) based upon theoretical propositions; and field testing of the design contributes to theory building.*

As the aims of this project are to develop self-evaluation tools in assessing students' IL, develop learning and teaching activities that promote IL among students, and find out the impact on learning and teaching in naturalistic classroom environments, the project team therefore considered design research as the most appropriate methodological approach for the present study.

However, it is important to note that the design research approach is different from the curriculum implementation and evaluation approach implicit in the project contract, which specifies the role of teachers as implementers of new curriculum resources and that of the research team as resource developers and evaluators. During a first consultation meeting with teachers from the participating schools, they indicated clearly that their schools have decided on their own curriculum implementation schedule and that they would only be able to participate if the curriculum implementation matches with their set curriculum schedule. Hence the implementation of the specific modules as proposed in the project plan and schedule was not acceptable to the teachers. As a result, the project team and the teachers agreed to work on teachers' preferred curriculum topics and to plan together to develop the sets of curriculum related activities and assessment tools accordingly. Thus the project team adopted the design

research approach, and the role of teachers was not just as an implementer but also as a co-designer of curriculum, pedagogy and assessment tools.

The adoption of the design research approach allows teachers to act as co-designers to engage in the process of curriculum, pedagogy and assessment design. According to Bereiter (2002) successful design research has the characteristics of innovativeness, responsiveness to evidence, connectivity to basic science and dedication to continual improvement. He further points out that in design research, practitioners need to be receptive to change and willing to try unproven methods. As co-designers of the curriculum materials, teachers would have a better understanding of the problems that they need to tackle and to contribute their ideas to the design as well as continual improvement of the curriculum materials used. Because of the contribution they have made, they would also have ownership of the project, leading to higher probabilities of the innovation being sustained after the completion of the project.

There were four main stages in this design research project:

Stage I: Researchers and teachers held collaborative curriculum planning sessions to design learning and teaching activities to incorporate the eight IL dimensions.

Stage II Researchers developed the self-evaluation checklists and assessment rubrics as appropriate for each school's curriculum. Teachers reviewed the rubrics and checklists, making further amendment, if needed.

Stage III Classroom implementation of the learning and teaching activities and the assessment tasks.

Stage IV Review and reflect on the whole design research process

Professional development workshops on information literacy were conducted for all ten schools at the beginning of stage I and another professional development workshop on using rubrics as assessment tools was also organized at stage III for all the ten schools.

3.2 Research design and instrumentation

3.2.1 Multiple case study design

The conceptual framework presented in section 2.4 describes the interactions between the teacher and the researchers in the context of a specific design and implementation of a curriculum unit and its associated performance assessments. Each such unit in this project is a case study. That is a case refers to the enactment of a small intact curriculum unit at the school level.

The curriculum unit, in each case, may involve one or more lessons. Each of the lessons will have clearly defined objectives and may involve several learning activities. The activities within the lessons need not be confined to a single classroom, but could be carried out in several locations inside or outside the classroom. The four research questions listed at the end of chapter 1 are answered through a multiple case study method, treating each of the 15 curriculum and assessment units developed in this project as a single case. Multiple case study design offers more compelling evidence and lends itself to generalization far more readily than a single case (Miles and Huberman, 1984). It facilitates cross-case analyses, helping researchers to get a deeper understanding of their investigation by comparing and contrasting cases in order to determine what the general patterns are and what specific differences exist among the cases. Yin (2004) agrees that a multiple case design helps the researcher to pursue a logical framework of inquiry.

Research question one asks, "What are the strategies that can enhance students' information literacy skills?" This question is explored at both classroom and school implementation levels. The data sources for the former were primarily the meeting notes taken during collaborative lesson planning with teachers and during classroom observations. Data related to school level implementation were collected through teacher interviews.

Research question two focuses on "What changes, if any, can be observed in student's IL skills through the project process. The key data sources used to address this question are students' self-proclaimed learning gains and teachers' perception of students' learning gains, collected through students' focus-group interviews, teacher interviews. Results of the pre- and post- tests are also taken into consideration as one source of data on possible changes in students' IL skills. A main constraint in the use of the pre- and post- test data is that the tests administered have not been validated to be equivalent in difficulty. More details on this is provided in chapter 4.

Research question three asks "What recommendations can be made with regard to the development of a coherent strategy to integrate the development of IL skills in different KLAs based on the experience in this project on involving teachers in pedagogical and assessment design and implementation in this project". To answer this question, we collected data through interviews on teachers' experiences and learning gains in this project. Their reflections on the entire project process, including the innovations they have contributed to and/or adopted changes in their practice as well as how the innovation was implemented and supported at the school level. Sometimes, data collected through lesson observations also revealed significant features in the implementation process.

Research question four asks “What changes can be observed in teachers’ knowledge of IL before and after the implementation of this project?” In order to answer this question, teacher’s views on the meaning of IL and its relationship with scientific investigation skills were solicited through interviews conducted at different stages of the project.

3.2.2 Instrumentation

3.2.2.1 Lesson observations

In order to get an overall picture of how the learning and teaching activities as well as the assessment tools were organized and used, lesson observation was employed as one of the key methods of data collection. For each lesson observation, at least two researchers were involved. One was responsible for video shooting and one for taking field notes to describe the settings, the transactions and the interactions between the teacher and students as well as students to students, and comments on the observations made. Such rich qualitative data would be very useful in building up the “stories” of how the self-evaluation tools could be used and to examine the effectiveness of different pedagogical strategies in the facilitation of the development of IL in students’ learning, which forms an important part of the deliverables in the present study.

As the length of the implementation period in schools was different, the project team asked the teachers to identify at least one lesson that engages students in activities that require the demonstration of information literacy skills for the project team to observe and video-record.

3.2.2.2 Lesson Materials Collected

The lesson plan of the whole topic, worksheets, handouts and other printed curriculum materials as well as resources used in the classrooms were collected so as to provide more comprehensive information on how elements of information literacy were integrated into the normal pedagogical practices. Students’ work arising from the lesson, such as assignments, project reports, web-pages, etc. and their self-evaluation checklists were also collected as data on students’ IL performance, providing information on the diversity in the levels of achievement attained by students.

3.2.2.3 Teacher interviews

Teachers play a crucial role in the teaching, learning, and assessment processes. Semi-structured interviews were constructed. The first teacher interview (Appendix 3.1a) was conducted at the beginning of the project. The second teacher interview (Appendix 3.1b) was conducted after each lesson observation, if possible, to solicit teachers’ views on and considerations given to the pedagogical and assessment aspects of the resources and tools. The third interview (Appendix 3.1c) was conducted at the end of the project to solicit the participant’s reflections on their experience as well as more in-depth information about teacher’s background, learning gains,

knowledge of IL, and suggestions on the project. Besides, information on teachers' view on IL and the pedagogy will also collected via first school visit and collaborative lesson planning with teachers.

3.2.2.4 Student interviews

Student focus group interviews (Appendix 3.2) were conducted after each observed lesson, if possible, so as to collect information on students' responses on their perceived learning gains as well as the rubrics and checklists used in learning and teaching activities. The purpose was to get a more comprehensive understanding of students' perspectives, feedback, and opinions on the use of the assessment tools and their overall learning experiences.

3.2.2.5 Self-evaluation checklist and Assessment rubrics

Within the framework of assessment for learning, assessment should provide students with information about how they are going to be assessed and feedback on performance that can promote learning and inform students about the appropriate next steps (Black & William, 1998; Clarke, 2001). Checklists and rubrics are identified as the appropriate form of evaluation tools in this project. Checklists are used for student self-evaluation and assessment rubrics are for use by teachers to evaluate students' work. According to Stergar (2005), checklists are effective tools for students and teachers to evaluate students' task performance. A checklist provides a list of measurable categories and indicators for project, product and performance. Therefore, checklists allow students to judge their performance and determine whether they have met established criteria on a task. Research pointed out that the use of self-evaluation checklists can help learners develop metacognitve skill; enhance their learning strategies and learning how to learn (Bransford, Brown and Cocking, 1999*;* Stenmark, 1993).

Rubrics are descriptive scoring tools for rating authentic student work qualitatively. Rubrics are used when a judgment on the quality of a piece of work is required (Moskal, 2000). Rubrics use specific criteria as a basis for evaluating or assessing student performance, and provide narrative descriptions that are separated into levels of possible performance related to a given task. According to the literature, rubrics can be designed as either general or task-specific (Hays, & Lantz, 2004; Moskal, 2000). General rubrics provide scoring guidelines that can be used for multiple tasks. Task-specific rubrics, in contrast, provide scoring guidelines that are only appropriate for a single task.

In considering appropriate indicators for the 8 IL dimensions, a number of educational frameworks for assessing information literacy from different geographic regions were examined. These include Hong Kong's "Information Literacy Framework for Hong Kong: Building the

Capacity of Learning in the Information Age." (EMB, 2005), United States' "*Digital transformation: a framework for ICT literacy. A report of international information and communication literacy panel*" (ETS, 2002) and Australia's "National Assessment Program- ICT Literacy years 6 & 10 Report" (MCEETYA, 2005). Based on these, a generic IL rubric which depicted the general progression of students' development in each dimension of IL (Appendix 3.3) at 4 different performance levels has been developed. This rubric can be used to develop information literacy learning indicators and the corresponding guidelines for performance assessment tasks for different Learning Areas

In addition, this study also based on this framework, and further referencing from Chinese, English and Mathematics' Curriculum Guide of their deployment of IL skills, the British science subject national curriculum (DfEE, 1999) in how to promote learning and teaching tasks with IT, Scotland's Information Literacy Framework (Irving & Crawford, 2007), Information Literacy Learning Targets (CDC, 2000), Science Education Curriculum Guide (CDC, 2002) to develop a Key Stage rubric which provides an overarching description of students' IL performance in the respective IL attributes at the end of each Key Stage—KS1, KS2 and KS3—and referred to as Key Stage rubrics (Appendix 3.4). These two rubrics provide the basis and guidelines for the development of task specific checklists and rubrics.

Finally, sets of self-evaluation checklists and assessment rubrics for use in each of the fifteen curriculum units in the ten participating schools were also developed for the purpose of evaluating students' performance in specific IL task. These checklists and rubrics were specific to the learning and teaching activities co-designed by the research team and the teachers. The purpose of these checklists and assessment rubrics was.

3.3 Performance assessment of students' IL skills in science

To investigate the impact of teachers' strategies/ pedagogical interventions on students' development of IL skills in science at different Key Stages, two performance assessments (PAs) (one for the pre-test and one for the post-test) at each Key Stage have been developed. A total of 6 sets, two for each key stage, of performance assessment (PA) tasks, together with answer keys and scoring rubrics were developed. Each PA test consisted of seven questions. The durations for test administration were 30 minutes, 35 minutes and 45 minutes at KS1, KS2, and KS3 respectively.

Each set of PAs is designed in accordance with the following criteria:

- The scenarios designed for all PAs were related to "Space Travel", one of the curriculum topics in science.
- The difficulty levels of the PAs were designed to be in line with the expected IL skills required at the respective grade levels according to the Key Stage Rubrics of IL Framework.
- The full score for each PA question is approximately proportional to the expected time for its completion.
- General guidelines on how to answer the questions were provided to students at the beginning of the assessment period. The approximate completion time for each main question was also indicated at the end of each question statement in the PA.

3.4 Project administration

There were a total of five primary schools and five secondary schools participating in this project. Two of the primary schools participated in Key Stage one implementation and four schools participated in Key Stage two implementation. All the five secondary schools engaged in the project at Key Stage three. A detailed description of the level and scale of involvement of the ten schools is presented in Table 3.1. The curriculum implementation period was from December 2009 to June, 2010.

Table 3.1 Details of the curriculum units implemented in the 10 participating schools.

School	Level	No. of classes involved	Total no. of students	No. of teachers involved	No. of curriculum topic	Subjects involved
A	P6	4	125	3	1	Chinese, Library , Computer, Moral and Civic Education
B	P5 P6	1	23	2	1	General Studies
C	P3	3	65	5	1	General Studies
	P6	5	150	7	1	General Studies
D	P5	1	40	3	1	General Studies
E	P3	4	129	4	1	General Studies
F	S3	1	41	1	1	Chemistry
		1	41	1	1	Physics
I	S3	1	41	1	1	Chemistry
		1	40	1	1	Biology
J	S3	1	40	2	1	Biology
					1	Physics
K	S3	1	35	2	2	Chemistry
L	S3	1	30	1	1	Chemistry
		1	29	1	1	Physics

Chapter 4 Results and analyses

The project team made a total of 79 school visits to the ten project schools. The aims of these school visits were to conduct pre- and post- tests, collaborative lesson planning with teachers, lesson observations as well as conducting interviews. A total of 24 lesson observations were conducted (11 visits to secondary schools and 13 visits to primary schools). In this chapter the reasons for and the details of the variations to the project plan are reported first, followed by a report on the strategies in promoting IL at classroom level as well as at school level adopted by the project schools. It further reports on the roles of the teachers and the project team members, students' learning gain and teachers' learning gain, teachers' conceptual understanding of IL and its relationship with the learning of Science, and the impact of using self-evaluation tools and assessment rubrics on students' learning. Finally, students' performance in the pre- and post-tests and the difficulties encountered in conducting the performance assessment are reported.

4.1 Variation of project implementation from initial plan

The project team would like to report on several variations in the project implementation necessitated by the need to respect teachers' wishes to follow their own school teaching plan instead of implementing the curriculum units originally proposed in the project proposal.

4.1.1 Project design

As reported in Chapter 3, the project design in the original proposal had to be changed as the science teachers in the participating schools did not see the proposed curriculum units to fit the science curriculum plan for the targeted grades and would not want to implement units that did not match their plans. As was made clear by the participating teachers in the first meeting, different schools have their own curriculum schedule and it is hard for them to implement the same curriculum in a fixed period of time. In the original project design, teachers were to play the role of implementing new curriculum units developed by the project team. During the process of discussion, teachers indicated a preference for choosing their own implementation topic and to work with the project team as a co-designer of curriculum resources and assessment tools that can fit the needs of their own schools.

4.1.2 Changes in the no. of participating schools

In the original project plan, there were only four schools each at the primary and secondary levels respectively. However, from the listed given by EDB, four primary schools and two secondary

schools were selected as partnership school and among the four primary schools only one primary school indicated that they will include primary three student and only one secondary school indicated that they could implement in Science subject. Therefore, the project team sources out other opportunities and finally five primary schools and five secondary schools participated in this project.

4.1.3 Changes in the no. of curriculum units developed and implemented

The initial plan was to arrange for each participating school to try out two curriculum units so that each of the two curriculum units for Key Stages 1 and 2, and each of the four curriculum units for Key Stage 3 would be tried out by at least two schools. However, as the teachers were to participate in the design of the curriculum units they were to try out, each subject-level team at each of the participating schools did not engage in more than one curriculum unit. There were a total of two curriculum units developed and implemented for KS1 and four for KS2 among the five participating primary schools. At Secondary 3 (for KS3), science is taught in all the participating schools as separate subjects. In four of the five participating secondary schools, teachers from two subject areas took part in the curriculum design and implementation, resulting in a total of nine curriculum units at this level being designed and implemented, instead of the proposed four.

Table 4.1 provides a summary of the 15 curriculum units developed and implemented. Each of the exemplars includes a brief introduction of the case, lesson plan and curriculum resources, implementation strategies as well as lesson videos, student samples of work, students' reflection and teachers' reflection. These are uploaded to the following website: http://iltools.cite.hku.hk/revamp/exemplars.php

Table 4.1 Content of the 15 curriculum exemplars

Subject	Key Stage	Level	Topic
General Studies	1	P.3	Cold and hot
General Studies	1	P.3	I love Nature
General Studies	2	P.5	Media and wise consumer
Project	2	P.5, P.6	Human and environment—daily life science and technology
Project	2	P.6	"Be Net Wise" project-based learning"
General Studies	2	P.6	World issue- environmental problem
Biology	3	S.3	Digestive system
Physics	3	S.3	Ohm's Law
Chemistry	3	S.3	Bonding and structure
Physics	3	S.3	Mechanics
Chemistry	3	S.3	Reactivity of Metals

Subject	Key Stage	Level	Topic
Physics	3	S.3	Total internal reflection, Snell's Law Experiment and Calculation of refraction
Biology	3	S.3	Food and nutrients
Chemistry	3	S.3	Metals
Chemistry	3	S.3	Rocks and minerals

4.1.4 Delay in the completion of data collection

In the project plan, it was scheduled that all the data collection would be completed by the end of May 2010. However due to various reasons, some schools postponed the implementation schedule such that the data collection could only be completed by late June 2010.

4.2 Strategies for promoting the eight IL skills through the science curriculum

4.2.1 General strategies

Within the framework of assessment for learning, the design of learning activities is one important element in the cyclic process of teaching, learning, and assessment. It is the predominant means through which students have the opportunities to learn and exhibit the required skills in IL. The Project Team worked collaboratively with teachers in each school to design lesson plans that would fit their respective curriculum plans, priorities and schedules. Taking the identified curriculum unit and associated learning objectives, suggestions were made on the related IL goals and learning activities that could be introduced to help raise students' IL skills in the 8 dimensions. The final plans differ greatly even across the curriculum units at the same educational level (Key Stage, KS) as the aspirations of and constraints faced by the teachers in the different schools are very different. In general, we find that for KS1, the foci of the curriculum units were on the less demanding IL dimensions such as define, access and manage. For the curriculum units developed for use in KS2 and KS3, more technological tools were used and a wider range of IL skills spread throughout the eight IL dimensions were targeted. The learning tasks adopted by the teachers can be broadly categorized into two types: short assignments that can be finished within a lesson or within one to two days, and project work that has many sub-tasks and extends over a longer period of time.

The common kinds of learning and teaching activities that are appropriate for facilitating the development of IL skills in each of the eight dimensions and adopted in the 15 curriculum units in this project are summarized in Table 4.2 below. The design and implementation of each of these curriculum units are documented and analyzed as a case study.

Table 4.2 Learning activities adopted in the 15 curriculum units in this project to foster students' IL development in each of the 8 dimensions.

IL dimension	Learning Activities
Define	Mind-mapping, Use of keywords, Asking six "W" questions, outlining, brainstorming.
Access	Finding relevant News, Identifying and finding information from relevant Websites, Data collection from field trips, experiments.
Manage	Classifying/organizing data/information, making chart presentations, using general office applications, searching databases.
Integrate	Making data based conclusions, summarizing, exercise, short essay.
Create	Creating PPT presentations, proposals, spreadsheets, videos, posters.
Communicate	Making public presentations, sharing ideas through online forums, blogs.
Evaluate	Comparing different information sources, judging the reliability of websites.
Ethical Use	Referencing, paraphrasing (and not direct copy and paste), discussions around case-based scenarios on internet etiquette and internet addiction.

Mind mapping is a common activity used to foster the development of skills in the "define" dimension, particularly at the primary level. It is observed that students were able to use mind mapping to define their information needs after they have learnt in the first lesson. Search skill is one of the important skills within the "define" dimension. Hence, teaching students how to use keywords to make more effective searches is another common activity for fostering skills in the "define" dimension across the three key stages. It is observed that teachers have different expectations on students' level of performance for the different key stages. For example, at KS1, students were just required to use keyword search, but for KS2 and KS3, students were generally introduced to higher-level skills such as using Boolean operators and other logical operators during search.

For the "access" dimension, activities conducted by the teachers were not restricted only to information retrieval on the Internet, but includes information gathering from printed materials such as books, journals and newspapers as well as through experiments and field trips. For example, one primary school organized a field trip to the Hong Kong Park for students to gather information through observation. At KS3, it was often the case that students had to gather information through experiments.

For the “manage” dimension, common activities include basic computer operations such as saving and uploading files, as well as opportunities to exercise data management strategies such as grouping things, constructing flow charts and organizing information.

As reported by teachers, the “integrate” dimension was the most difficult one for students. To develop such skills, teachers usually arrange activities that require students to synthesize, summarize, compare and contrast information from multiple digital sources. Very often, this kind of task would be submitted at the end of the learning and teaching modules so that students have time to revise their answers before task submission. Examples of such activities include writing a summary on a learning experience, or a short essay on a curriculum topic.

For the “create” dimension, teachers often require students to create some artifacts to present their learning outcomes. PPT creation is one of the popular activities in this category. Students need to integrate information from different sources and summarize them in the PPT presentation. They also need to pay attention to the design of their slides. A wider variety of artifacts such as posters, videos, proposals and drama were created by higher level students.

For the “communicate” dimensions, the most common activity at KS1 was students making verbal presentations and participating in verbal discussions. For KS 2 and KS3, students were often encouraged to use blogs or forums to communicate. Their communication partners include not only their schoolteachers and classmates, but also students from other schools.

Evaluation of information is a relatively unfamiliar dimension for students. Teachers often discussed in class about the reliability of different kinds of websites such as official sites and educational sites to help students develop a better understanding. Related learning tasks include activities to compare different information sources and getting students to discuss the reliability of the websites they accessed.

Using information ethically is also a dimension relatively unfamiliar to students. One strategy often used by teachers was to talk about the importance of proper referencing during lessons. A commonly adopted student activity was to provide case scenarios and ask students to decide and explain how they would react in those circumstances. Teachers also require proper referencing of cited materials in students’ work.

4.2.2 Specific scaffolding strategies for KS1

In addition to the above general strategies, it was observed that teachers used specific scaffolding strategies to help young students at KS1 to develop elementary IL skills. These strategies include:

– Providing the full URL for information access tasks

As KS1 students were rather young, it was common for teachers to provide the full URL to students when information access tasks were given. Teachers often put all the related links on the school intranet or sent the links to students by e-mail.

– Providing hints and breaking down complex tasks

One commonly used method to scaffold students in information access tasks was to provide itemized lists on needed information. For example, in an activity requiring KS1 students to find information about a country park, the teacher provided a list of items such as the name of the country park, the route and common plants and animals found in that park. After this, students were able to locate the information without much difficulty.

4.3 School level strategies in integrating IL in the science curriculum

While this project focuses on IL integration in the science curriculum at the classroom level, such implementation is strongly influenced by the school level strategy (or approach) taken. In this project, a variety of strategies have been observed in the participating schools. These are summarized as follows:

A. Subjects involved

As a generic skill, students' IL development can be fostered through a variety of subject areas. In fostering students' IL in Science, there were several ways project schools have adopted in the assignment of teachers and school subjects to engage in the implementation:

1. Single subject trial

   Here, only teachers from one subject area are involved in the actual implementation process of a curriculum unit. This is the most common strategy adopted by the participating secondary schools. Also, perhaps due to the more rigid teaching schedules in secondary schools, most secondary school teachers chose more traditional pedagogical strategies to enhance students' IL skills, such as through integrating IL learning tasks into a single teaching unit or into a short assignment so that fewer alterations to the original curriculum unit was necessary. For the primary schools, it may also include several teachers teaching the same subject at the same level.

2. Coordinating with Computer Studies

It was found that in two primary schools and one secondary school both subject teachers and computer teachers work together for the implementation of this project. In the secondary school the computer teacher taught those concepts and skills which are needed to perform in the subject discipline beforehand where the subject teachers design curriculum activities which provide opportunities for students to exhibit those IL skills. It was also observed that in the two primary school both computer teacher and subject teachers work at the same time to plan the learning activities, where those activities need to involve computer access will be performed in the computer lessons.

3. Interdisciplinary *(General Studies/Science subject; Chinese Language; Moral and Civic Education; Computer Studies; Library Studies and Extra-curriculum activities)*

Possibly due to the more flexible teaching schedules and curriculum arrangements in schools, greater diversities in curriculum approaches have been observed in primary schools. Further, many primary schools have provisions for the adoption of more interdisciplinary approaches. Inter-disciplinary approaches have been adopted in three of the five participating schools, but none of the project secondary schools. In one of the primary schools, the interdisciplinary approach adopted was quite sophisticated, involving collaboration among the teachers of General Studies, *Chinese Language*, Moral and Civic Education, Computer Studies, Library Studies. The teachers from this school commented that the implementation would be smoother and more effective if the computer subject teachers and the teacher librarian were involved in the implementation process.

B. Students groups

Schools also differ in terms of the selection and number of students involved in the implementation process.

1. Single class trial

All secondary schools adopted single class trail. That is only one class of students were involved in a single subject. For the primary schools, only one school used this method. Teachers from the secondary schools reflected that this was the easiest way for implementation new things in school as it involves less manpower.

2. Whole-grade

Four out of five primary schools adopted the whole–grade approach for the implementation. It was observed that all four schools already established a collaborative lesson planning in

the same grade level; therefore they preferred to implement it in whole grade level so that teachers could share their work.

3. Selected students grouping and Cross-grade grouping
   It was found in one primary school, the students involved in this project is a group of students who were identified as gifted students and cross-grade grouping was also found in this group. As teachers pointed out that at the beginning the upper form students (P. 6 students) only have the privilege on content knowledge but others are the same as lower form students (P.5 students), therefore it is not a big problem for this cross-grade grouping in a extra-curriculum project.

To conclude, teachers also shared with us that for schools did not have any experiences in IL, it would be better for the school to start the implementation in a more manageable scale first that is start from a single class and single subject trial and let those participating teachers to have a taste of success first.

4.4 Changes in pedagogical practice

Based on the project team's observations and interviews with teachers and students, changes in teaching and learning in the following three areas have been observed in all the 15 cases of curriculum implementation involved in this project, albeit to different extents.

4.4.1 Students take on active roles as learners

In traditional classrooms, the teacher is the subject matter expert who presents appropriate information for students to learn and students usually take on passive roles as a learner, who just sit and listen to the teacher. In this project, students were given opportunities to take on more active roles in their learning. Instead of being given instructions on specific subject knowledge, students were often asked to find information by themselves, and to find answers to questions that they have not been taught or sometimes even questions that they raise for themselves. Teachers scaffold and encourage students to explore questions by themselves. The mode of teaching shifted from teacher-centered to student-centered. The following excerpts from teacher and student interviews provide first-hand descriptions of such changes.

- "I ask students to find the related information on bonding, the purpose of this activity is not to ask students to find the answer, but to find out what kinds of things they do not understand and to get them to formulate their own question. This is the first step for scientific investigations". (Teacher 1, School J)

- "Students taking an active role in their learning is the most significant change that I have observed. They need to search for the needed information beforehand and complete their lesson preparation first. " (Teacher 1, School G)

- "Teachers did not set a topic for our project. We can decide on the topic by ourselves. Our group chose the issue of world poverty because we think that this problem is very serious." (Student 8, School C)

- "Our project let students explore their own learning. We just provide different kinds of learning environments such as field trips, and case scenario mini-conferences, and students decide what kinds of methods they would use and the things they would like to present. They take up the responsibility for their own learning." (Teacher 1, School B)

4.4.2 Teachers develop curriculum innovation and pedagogical design expertise by collaborating as co-designers with project team researchers

Traditionally, teachers plan their lessons individually or collaboratively with colleagues to implement a specified curriculum making use of textbooks and published curriculum resources. In this project, the project team and participating teachers did the planning collaboratively as co-designers in the development of curriculum and assessment activities. The researchers brought in new knowledge on how to design curriculum and assessment activities that integrate IL elements into the science curriculum. The teachers expanded their professional expertise through an experiential process of learning through doing. At the end of this project, many teachers commented that they would be able to design their own lesson activities, rubrics as well as evaluation tools in future after this project experience. Some related teachers' comments are listed below.

- "If starting from nothing, I think it is difficult. It is good that researchers from HKU already gave us some templates and so we can follow them. Time maybe needed. But it will not be too hard for us." (Teacher 2, School D)

- "After this experience, implementation will be easier next time. If there is a new topic, we need to design it again. I think I have confidence to develop it." (Teacher 2, School J)

4.4.3 Changes in assessment practices

In traditional classrooms, teachers act as the assessor of students' learning. In this project, students also take on the role of an assessor to evaluate their own and peers' work. Further, the nature of the assessment tools used have also changed. Assessment instruments are no longer confined to pencil and paper tests. Performance-based assessment is more appropriate for assessing students' information literacy skills, and the new instruments used for this type of assessment include self-evaluation checklists and assessment rubrics. The impact of this type of assessment will be discussed in a later part of this chapter.

Teachers responded very positively to this kind of assessment during the interviews. They reflected that the assessment tasks developed allow teachers to provide more space and autonomy for students to learn. Some of their related sharing is excerpted below:

- "For the first assignment in this project, we allowed students to freely choose their methods of presentation, and we saw that students were able to present their materials using different methods, as some students drew a poster and listed some key points on it, others found images to share with others using PowerPoint and some used video. This could allow students to compare the different presentation methods and know which is the best solution for presenting their work." (Teacher 2, School J)

- "In the classification task, I did not restrict the students on the number of types they need to classify. I was surprised to see how well they could classify information. For example, I have not yet taught them about amphibians and reptiles yet, but they were able to identify and categorize these words and related information. When other students ask them about these words, this could allow them to learn from each other, and to further stimulate their thinking and learning." (Teacher 1, School C)

4.5 Learning gain according to students

The student focus group interviews conducted in each case study revealed that students made some learning gains through participation in this project; particularly in the eight IL dimensions are commonly found. Details of the nature of these gains are described below.

4.5.1 Students' learning gains in the eight IL dimensions

4.5.1.1 Define

"Define" refers to the appropriate identification and search for the information needed to tackle the problem/task. It was found that teachers attempted to enhance students' capabilities in the 'define' dimension by integrating activities involving the use of mind-maps, brainstorming using '6W' questions, etc. into the school's science curriculum. After the lessons, students reported that the activities introduced by their teachers were useful. Some of the P3 students reported:

- "The use of mind-map helps us to remember the concepts easily." (Student 1, School E).

- "There is no need for us to write such a long paragraph in the mind-map just a few keywords will be fine. It is really helpful for us in doing revision." (Student 2, School E).

The teachers also reported that the use of mind maps helped students to remember the concept terms. As described by one of the teachers teaching P3 students in one of the primary schools:

- "Mind map has enhanced students' memory of concept terms, and could stimulate them to connect related concepts/issues." (Teacher 1,School E)

In terms of information search, students reported that they benefitted from the implementations of project activities after the teachers have explicitly help them acquire better web-searching strategies, e.g. specific search engines, use of logical operators, etc... As students have mastered a better search strategy and found better results through their searching activities, they have could devote more time for the in-depth inquiry. The followings are some quotes from the students:

- "The newly taught online information searching techniques […] allow us to increase the accuracy, speed, and narrow down the search results" (Student 2, School C).

- "I will not choose to enter all sites from the search results. There are too many. I will usually first click into the first site because it is supposed to be the most related one. Then I will read the sentence shown beside the search results. They always show clues about the websites." (Student 3, School E)

4.5.1.2 Access

The 'access' dimension attempts to evaluate students' abilities to search for and retrieve information through different means. It was observed that students were able to use various online search engines and databases to strengthen their knowledge independently, not only in general but also in subject-specific areas. In terms of the general access of information, students reported that seeking information from the web can help them enhance their domain knowledge beyond the textbook, and they learnt how to use different means to access information, as illustrated by the following excerpts from student and teacher interviews:

- "I cannot access internet at home. I found this picture from a book titled 'tropical rain forests' at my brother's bookshelf. " (Student 3, School C)

- "When I went to Hong Kong Zoological and Botanical Gardens, I used my cell phone to take photos. I did not draw because my drawing skill is poor. (Student 5, School C)

- "I usually go to the library to search for information. After doing this project I will spend more time looking for information online because it is a lot more convenient and efficient." (Student 1, School A)

- "This project has made me realize that the process of finding information online would allow you to discover lots of new pieces of information…and allow us to learn more information outside the textbook from the various of information online. " (Student 1, School G)

- "It was surprising to see that some students went beyond the scope of information that I had provided for them to find information to perform self-directed learning. They were able to find additional rich and detailed information. " (Teacher 1, School C).

Apart from the above, students also learnt new ways of collecting information:

- "In this project, we need to interview P.3 students. We never tried this before. We learn how to set up survey and gather information through interview." (Student 2, School A)

4.5.1.3 Manage

In this study, the 'manage' dimension relates to students' ability to select and use appropriate tools to manage information. In different teaching modules, students were able to manage and operate some of the advanced features in computer applications independently. Students also learnt how to organize information from different sources. The following are some of the wordings quoted from student focus group interviews:

- "Instead of using the traditional learning methods like doing assignments on paper, we have learnt how to use a software package Excel. We are happy to use the tool as it allows us to understand and analyze our data more easily." (Student 1, School H)

- "Google Map definitely helps a lot in doing our homework. It helps us to locate two places and find out both the distance and displacement easily. We cannot do this without technology." (Student 2, School J)

- "In addition to the textbook materials, the use of information technology allowed us to find more useful and interesting information online which can be used for poster presentation, or to create activities involving the use of PowerPoint or video." (Student 3, School J)

- "Knowledge from textbook is not enough. Internet is a great resource. We can gain extra information from the web and integrate these with our existing knowledge." (P6 student 1, School C)

4.5.1.4 Integrate

Students learnt to integrate different information. They learnt to select useful information and eliminate useless ones by using some strategies such as compare and contrast, drawing conclusion and summaries. As they reflected,

- "We have learnt not to merely copy and paste information when creating a PowerPoint, but to apply skills we have learned to simplify and extract out the main points to be presented." (Student 7, School C).

- "I think we need more time to analyse the information that we have gathered. Our job is not only to search for information. We also need to read and filter and organize as well as to combine with those things that we knew before

putting them on PPT. I think this is quite difficult when compared to our old style of traditional learning." (Student 2, School G)

- "After this project activity, I have learned to use a variety of websites from different newspaper [databases] to find the needed information and then draw a conclusion." (Student 6, school D)

4.5.1.5 Communicate

Using technology can substantially enhance students' communication skills. In the study, some teaching modules were incorporated with activities like forum, discussion boards, blogs or Facebook to allow students to share and communicate information with each other. It was observed that these activities provided students with the opportunity to learn how to communicate information appropriate to the context of use and communication venue.

In this study we found that some students as young as primary three knew how to use Facebook and MSN to seek help and communicate with others. The followings are the sharing from some students and teachers,

- "We are able to explore issues that we do not understand by asking others questions in the forum." (Student 1, School B).

- "The Mind Map activity allowed everyone to share each other's thoughts online and exchange useful information, hence allow us to learn more about a specific issue." (Student 3, School A).

- "I agree that incorporating student forum exercises into the lessons is beneficial to students and a good communication tool…. lower learning ability students get to participate in these online discussions after searching information online at home… students can also use these information to help them prepare for exams." (Teacher 1, School I).

- I used Facebook and MSN to ask people for help in this homework. But no one respond. I have also tried visiting game sites and ask for help there. (student 2, School C)

4.5.1.6 Create

The create dimension it concerned with the generation of information by adapting, applying, designing or inventing information in ICT environments. A variety of artifacts such as PPT, card games, posters, videos, spreadsheets as well as short essays were created by the students in the 15 case studies. Students reported that through such tasks, they understood some of the important considerations when they create any kind of products and learnt some of the techniques to enhance their presentations. The following are quotes from students,

- "I will review my work to see if there are not enough pictures. I will ask myself a few questions. Can others understand my words? Is my PPT too boring? Is the background alright? These are important." (Student 2, School F)

- "Through the presentation, I am aware that the background color and the color of the wording are also important things that need to be taken care of. If the color does not match, we cannot see at the back of the classroom." (Student 5, School F)

- "The purpose of creating PPT, poster or video is to present our knowledge to others. We need to let everyone understand our work. So it should be clear even for those people who have not learnt it before and be able to understand our work without further explanation." (Student 7, School J)

4.5.1.7 Evaluate

Evaluate refers to the ability to judge the quality, relevance, authority, point of view/bias, currency, coverage and accuracy of digital information. After the curriculum intervention, students at both primary and secondary school levels reported that their knowledge in this area has been enhanced, in particular with respect to identifying the reliability of the online information. As mentioned by a primary school student studying in School B and a secondary school student in School G:

- "…before having this teaching module, we were not aware of how to evaluate the credibility of different websites. However, afterwards we learned how to filer out irrelevant sources by choosing the more reliable official websites." (Student 4, School B)

- "I knew how to evaluate information on the Internet; we need to look for the updated information and those with authority such as government websites and

educational websites. Information provided by these websites are more reliable then Wiki." (Student 2, School G)

Besides, teachers also reported on the improvement of students' knowledge in this dimension. The following quote is from one of the teacher interviews:

- "When I pointed out that one group has retrieved wrong pieces of information from the internet, this increased students' awareness that not all online information are reliable." (Teacher 2 School G)

4.5.1.8 Ethical use

Ethical use refers to the use of information in an ethical way. Findings from the student interviews indicate that students' awareness of ethical issues in information use increased. When students were asked about their learning gains after completing the project curriculum module, they were able to describe their improved understanding about online intellectual property rights and the need to given proper credit in referencing information from different sources. Some related comments by P.5 students are included below:

- "This learning activity allowed me to understand more about respect for copyright, and the need to abide to laws of online property rights" (Student 1, School D).

- "We have learnt that we should not directly copy and paste other people's information, but should extract the useful information and then list out their sources." (Student 3, School A)

In addition to the ethical use of the information found from the Internet, students also reported that they have learnt how to ethically upload and download information from the web:

- "Before the lesson, I just download music from websites and did not think about whether it is legal or illegal. But now I will be more careful […] and understand that there is a need to ask for the authors' consents before uploading and downloading their materials…" (Student 6, School D)

- "We have leant that illegal downloading is a great offence." (Student 5, School A)

One of the most commonly mentioned learning gains in this dimension was in the area of proper referencing. At the end of a PPT, a short essay or project report, students often include a reference page. They explained:

- "After I used information from websites. I will write it down and put it on the reference list, showing the websites." (Student 5, School C)

- "I learnt the proper way to quote a reference." (Student 1, School F)

- "The most obvious observation that I have found is they now know how to make references and I believe this is already one step forward." (Teacher 2 School G)

Apart from this, students also learnt about what is internet addiction and ways of preventing it:

- "Some children spend a lot of time in playing online games. They become addicted to the internet and this will affect their studies. We should develop good attitudes and spend our time wisely." (Student 5, School A)

To conclude, we observed that students at all three levels (KS1, KS2 and KS3) have demonstrated improvements in their IL skills after the curriculum intervention.

4.5.2 Other learning gains

Apart from learning gains in the eight IL dimensions reported above, both teachers and students mentioned additional learning gains through this project. Teachers mentioned that students' learning motivation and their learning attitude have improved through their engagement in the IL learning activities. The following are quotes from the teacher interviews conducted after they have completed the implementation of their IL-related teaching modules,

- "Compared to previous experiences, it seemed that students' learning motivation has increased. Although we have only placed IL into a small section in this teaching module, it can be seen that students showed increased interests in the learning activity when asked to search online for information related to their daily lives." (Teacher 2, School J)

- " … [T]o the students, these new types of learning activities as replacement for more traditional classroom teaching methods seemed to have an impact on

some of the students, and may have an effect on their overall learning attitude, thus giving them more positive learning experiences." (Teacher 1, school I)

- "Students seemed to have greater motivation and interests in this learning activity as it allow them to look for information independently." (Teacher 3, School C)

Besides, both students and teachers pointed out that with the integration of IL activities broadened the students' perspectives in subject learning, as they said,

- "The retrieval of online information enabled us to acquire richer information to be built on our basic knowledge learned through General Studies textbooks." (Student 2, School E)

- "It is especially important to know how to use different tools to communicate and search for and manage information in General Studies subject because it might be difficult for us to absorb all information taught by the teacher." (Students 8, School C).

- "Our chemistry textbooks have provided us with a lot of basic information. We were able to relate what have been taught to us from the textbooks and expand our knowledge in those related topics through retrieving more information online." (Student 5, School J)

- "Sometimes it is hard for students to understand the application of the knowledge taught in textbooks into their daily lives. It is through other activities and online learning that students can examine their knowledge more thoroughly [….]. The information that can be found online can consolidate what students have already learned." (Teacher 1, School I)

4.6 Teachers' learning gains

Apart from the students' learning gains, teachers also reported on having benefitted from participation in this project. Such benefits can mainly be classified into three categories – enhanced competence in curriculum design, a clearer conceptual understanding of IL, and professional development on pedagogical strategies in designing and assessing IL.

4.6.1 Enhanced competence in curriculum design

Teachers reported that engagement in the curriculum design in this project has helped them to develop skills in integrating of IL elements to enrich the science curriculum. The following quotes illustrate the teachers' reflections on their experience:

- "I've learnt how to integrate those IL elements in the curriculum design. The lesson activities I conducted are various. I felt that they [students] really have learned a lot more through this kind of curriculum design. Students learn from different perspectives, not only from General Study textbooks but also through sharing with others as well as discussions within the groups." (Teacher 1, School C)

- "Joining this project has made me think continuously on whether my teaching method is the best fit to teach the content for the different topics. If I found them not fitting, I would try to integrate different IL dimensions into the lessons […] to enrich the lessons so they are not only always delivered with the same traditional methods." (Teacher 1, School J)

- "With regard to the design of the lesson plan, this project has made this teaching module to be more 'alive' and 'vivid'. Students can apply what they have learnt in the previous lesson." (Teacher 2, School D)

4.6.2 In-depth understanding of IL

In science, scientific inquiry and information literacy are inextricably linked. Embedding IL into the science curriculum has the potential to help students develop a better understanding of the nature of science and scientific knowledge (Julien and Barker, 2009). However, we found that most of the science teachers do not have a clear conceptual understanding of IL. Many of them also indicated that they had limited understanding of what IL is. As they said,

- "Before the launching of this project, I thought IL is just something like online searching skills." (Teacher 1, School C)

- "At the beginning, I thought IL is just about using information ethically." (Teacher 2, school B)

- "We knew nothing about IL in the beginning of this project. We felt confused and did not know how to do and arrange our lesson. How can we prepare a good lesson plan?" (Teacher 1 &2, School E)

It is gratifying to note that many teachers reported that they have acquired a more in-depth understanding on the meaning of "information literacy" after the implementation of this project. As they reflected,

- "Before the launching of this project, I thought IL is something like online searching skills. But after knowing it deeply from the implementation of this project, I notice that filtering out useful information is also very important, it also includes eight dimensions. Kids also need to learn how to present the found information, evaluate information and use it ethically, etc. " (Teacher 1, School C)

- "I now understand more about information literacy. Also throughout this whole process, I have been constantly thinking how I might be able to deliver my lessons in this way in the future." (Teacher 2, School F)

- "I did not know what IL was before, but attending the workshop given by HKU has expanded my knowledge of it and the whole implementation of this project is very beneficial to my professional development." (Teacher 1, School G)

- "Nowadays students always access information from the internet. I think apart from IT skills, teaching them to evaluate information is also a very important aspect in IL. " (Teacher 1, School D)

Another area that many teachers reflected on after the project related to their understanding about the relationship between learning of science and IL. Initially they did not perceive a strong linkage between them. However, through the collaborative lesson planning ,workshops offered by the project team, and their own personal teaching experience, teachers' views on the linkage between IL and scientific investigation was changed, as they reported:

- "It has been very beneficial as this is the first time for me to design lessons with IL. Throughout the whole process, I have been constantly asking myself questions and making further adjustments to improve the delivery of this teaching module." (Teacher 2, School D)

- "Throughout this project, I learnt how to incorporate different IL dimensions into the lessons. These activities can enrich students' learning on the topic of the natural environment." (Teacher 1, School C)

- "I think IL really helps a lot in learning General Studies. General Studies cover wide range of knowledge. Students need to use different methods to find information. If they do not have this skill, they cannot achieve the teacher's task requirement. " (Teacher 1, School D)

- "IL and the learning of science is highly related. When we do scientific investigations, we need to set the question first. Facing an unfamiliar question, scientists also need to find huge amounts of information. Then they will filter and evaluate the information and finally a new theory will be discovered. It is also important to make sure that the information is reliable. Therefore, I may conclude that IL is necessary during our science investigations." (Teacher 1, School H)

4.6.3 Professional development of teachers

Teachers participating in this study also reported that they have enhanced their insights in the adoption of pedagogical strategies through on-site meetings, consultations, and workshops provided by the Project Team. The following are some quotes gathered from the teacher interviews:

- "It has been a rare opportunity to be able to cooperate with different schools, HKU, and EDB to share experiences of teaching. This has allowed me to reflect upon areas for improvements in teaching and to brainstorm with others on new designs of teaching activities. There is knowledge exchange and professional growth." (Teacher 1, School I)

- "For curriculum planning, we discussed together with the researchers from HKU, they gave us professional recommendations and finally we can accomplish the whole curriculum with regard to IL implementation." (Teacher 3, School E)

- "In the beginning, I was a bit worried. Maybe the time is quite rushed. But researchers from HKU did several rounds of co-planning with our teachers and

gave us some advice. This was good because if our plan had something wrong, researchers could immediately discuss with us and correct our plan. Otherwise, it will not be that efficient. ” (Teacher 2, School D)

- “I did not have any idea about IL in the beginning of project. It is quite different from the typical teaching that I do. Actually, I am still trying to learn more about it till now. I can say that after these few months, my knowledge about IL is building up. I am able to plan other lessons by myself.”(Teacher 1, School F)

4.7 Teachers’ and students’ views on the use of self-evaluation checklists and assessment rubrics

The development of assessments for information literacy is still in its infant stage (Quellmalz, 2009; Law, Lee & Yuen, 2009). Researchers in this study developed specific self-evaluation checklists and evaluation rubrics for each of the 15 specific curriculum units in the ten case study schools. Grounded on the concept of assessment for learning, these assessment tools aim to facilitate and improve students’ learning in IL. Though these assessment tools are new to most of the teachers and students, they found it beneficial.

4.7.1 Self-evaluation checklist

Students reported that the use of checklists can help them identify their weaknesses and make improvements in the future, which consequently help will help them learn better and gain higher marks in their assignments. Even primary 3 students showed understanding of the value of self-evaluation checklists, and they welcomed the use of checklists in future learning modules. The following are comments from students on the use of self-evaluation checklist,

- “Using the checklist printed at the back of each assignment, we can review our work immediately after the task was finished. We may know better about the requirements.” (S.3 Student 1,School J)

- “I will pay special attention in the items I did not check [i.e. fail to achieve the requirement identified]. So I will improve next time. ” (P.6 Student 2, School A)

- “I chose the unhappy face in the checklist because I knew that my performance in that item is not good. I know how to improve it next time. ” (P.3 student, School C)

- "I think the checklists are fun. I hope I can get all happy faces." (P.3 student, School E)

- "The checklist lists all the necessary [quality] criteria for the work, such as during the presentation we need to speak up and the length of the video should not be too long. These items provide us with hints to do a better job." (P.5 Student 2 , School D)

Teachers also indicated that the use of self-evaluation checklists facilitated students' learning. They reported:

- "I think the evaluation checklist is a kind of review for students. And this can help teachers know better about their students and assist the less able students. And more importantly, we expect our students to answer the checklist honestly. " (Teacher 2, School D)

- "In our school, we have already established the practice of using self assessment checklist. I think using checklist can let students have more self reflection on how they learnt." (Teacher 1, School A)

- "When students checked themselves as being 'less proficient' on the self-evaluation checklist, they would reflect upon the reasons for their inadequacy; where they gave themselves a good mark, that is also good as they would be happy since this action could increase their self-confidence and enable them to continue learning." (Teacher 1, School E)

- "The self-evaluation checklist provides immediate feedback to students. If they review their own work to see if improvement can be done, this will help. Some of the kids are active learners. They will do self reflection after each assignment." (Teacher 2, School J)

- "If we distribute the checklist to students as the guidelines for assignments, they will be able to know our requirements. So they will try to meet these requirements to get higher marks. " (Teacher 1, School I)

However, some teachers also commented that as this kind of assessment is still new to the students, some of the students just filled up the list randomly, as one teacher reported,

- "I believe checklists are useful to students. But my students do not have this habit. They do not know what the uses of those checklists are. In my class, many of the students just tick boxes randomly without thinking."(Teacher 1, School G)

One solution for this problem—which was also suggested by some of the teachers—was to use the checklist not only for self-evaluation, but also for peer evaluation. This would eliminate random checking of boxes without take the evaluation criteria seriously.

4.7.2 Assessment rubrics

Teachers commented that the use of the assessment rubrics developed by the project team was helpful in assessing students' levels of IL skills and provided students' performance in detail. They reported that,

- "Through using rubrics, teachers can mark the assignments in more detail. The rubrics are specific and so teachers will not mark the students' work so subjectively. " (Teacher 1 & 3, School C)

- "As the assessment rubric is divided into sub items, it is easier for us to evaluate students' performance accordingly." (Teacher 2, School F)

We also found that some teachers would give the assessment rubrics to students before they submit their final work and students found the assessment criteria as helpful to them in improving their learning. They said,

- "I think it is beneficial for us to know the marking criteria [on the reports] before we submit our work to our teacher. Because if there were no feedbacks from teachers after handing in the assignments, you wouldn't be aware of the mistakes that you have made. However, if proper feedbacks were given, higher marks could be obtained by eliminating the faults." (P5 Student 5, School A)

- "It is consistent with the concept of assessment for learning—students knowing the criteria beforehand and they will strive for the best performance." (Teacher 1, School A)

In sum, teachers reflected that both self-evaluation checklists and assessment rubrics can help to promote IL among students and these are not difficult to implement. Nevertheless, teachers commented that it would be difficult for them to set up their own rubrics and checklists for every single task.

4.8 Results of pre- and post- tests

As mentioned in chapter two, pre- and post- tests appropriate for that three KS levels (1, 2 and 3) on IL were administrated to the students in the participating classes in all the ten case study schools before and after the curriculum unit implementation to find out whether there is any impact of the intervention. Ideally, each pair of pre- and post- test instruments should be designed and validated to be equivalent in difficulty. Unfortunately, such pairs of validated instruments are not available at this moment anywhere in the world. Due to some limitations of the project implementation, the study adopted a set of three pre- and post- test pairs designed by CITE which have not been gone through a rigorous process of validation. Hence caution has to be taken in interpreting the results. The pre- and post- test results are reported below for each of the three Key Stages.

In the following statistical results will be presented. We would like to explain some statistical symbols used in the following sections first. First the symbol "N" represents total number of valid responses. The symbol "SD" represents standard deviation**.** The symbol "*t*" gives the observed or calculated *t*-value, indicating the existence of null hypothesis between the pre-test and the post-test (Park, 2009; Tello & Crewson, 2003). In more specific, the smaller the *t*-value (approaches zero), the higher probability of having the same population means between the two samples and thus, the higher probability to hold the null hypothesis. If the *t*-value gets larger (towards infinitely in either the positive or negative direction), the probability of having the same population means gets smaller, and thus, the null hypothesis will be rejected (Marion, 2004). The positive sign of the *t*-value indicates that the mean score calculated in the post-test is larger than that calculated in the pre-test. Conversely, a negative sign of the *t*-value indicates that the post-test mean score is smaller than the pre-test mean score. The symbol "*p*" represents the significant level.

4.8.1 Findings for Key Stage 1

There were two schools in which 141 KS 1 students have taken part in both pre- and post- tests Figure 4.1 shows the mean percentage scores of the results. In the pre-test study, students' mean score percentages in all IL dimensions were below 50, with the highest mean percentage score in 'define' (43%), following by 'ethical use' (38%), and 'manage' (35%). On the other hand,

students had very low competence levels in the dimensions of 'communicate' and 'access'. In these two dimensions, the mean percentage scores were only 18% and 22% respectively. In the post-test, students' scores were greatly improved in the dimensions of 'communicate' and 'manage', both with means above 60%. On the other hand, the scores in the dimension 'evaluate' dropped from 30% to only 15%. There are a number of reasons that we can speculate about the decreased results. One possible interpretation of this would be there is not sufficient intervention in the curriculum. The other reason would be the difficulty of the pre and post measurement items in the dimensions "evaluate" and "ethical use" are not equivalent.

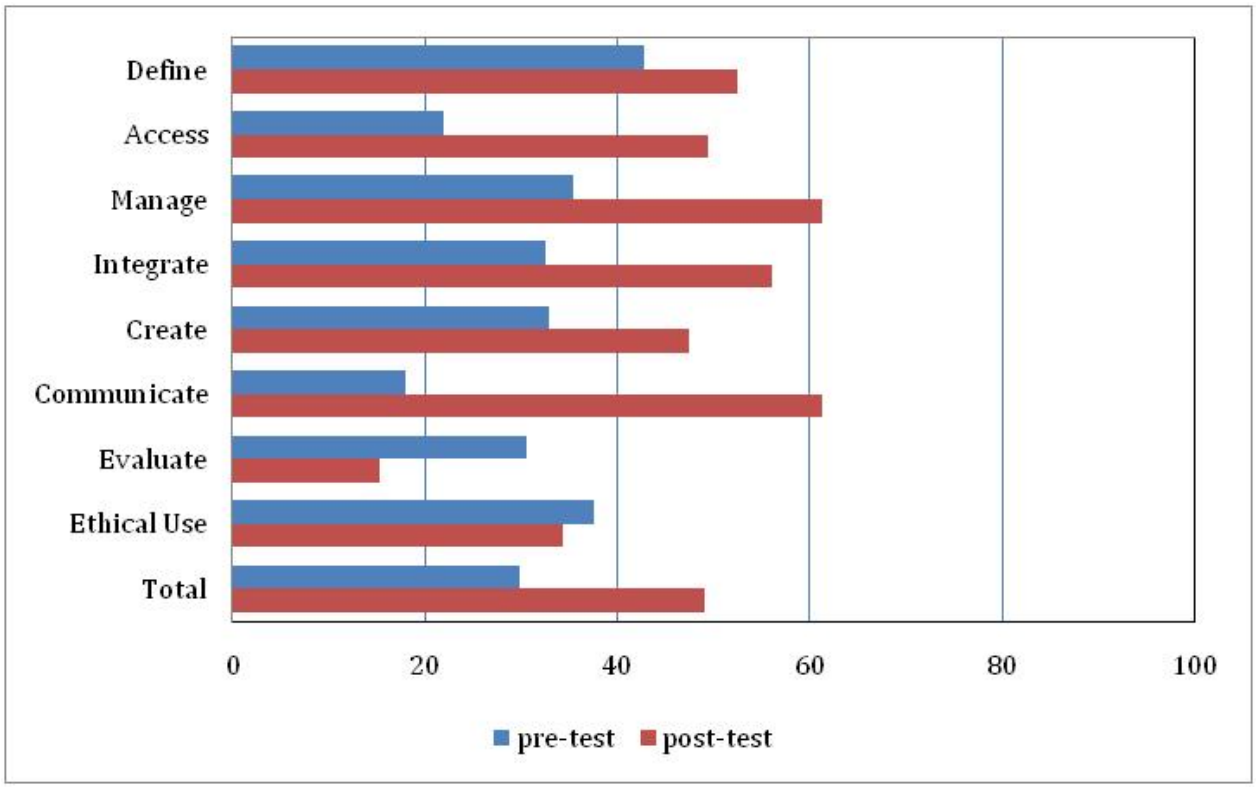

Figure 4.1 Comparisons of the eight mean percentage scores of P. 3 students in the pre- and post- tests

Table 4.3 presents the P.3 students' IL scores in the pre-test and the post-test. The results indicate that student' scores in all dimensions except 'evaluate' and 'ethical use' were enhanced. Amongst the eight IL dimensions, the greatest improvement was found in 'communicate' (43%, $t=10.47$, $p<0.001$), following by 'access' (27%, $t=10.66$, $p<0.001$) and 'manage' (26%, $t=9.29$, $p<0.001$). On the other hand, the smallest improvement was found in 'define', of which the corresponding change was only 9%. For the two IL dimensions in which students' scores were decreased, the larger decrease was found in 'evaluate' (-15%, $t=-4.33$, $p<0.001$) which is statistically significant. However, the decrease found in 'ethical use' (-4%, $t=-0.74$, $p>0.05$) was not statistically

significant. Nonetheless, students' overall scores in information literacy improved, as the 'total' mean score percentage improved from 30% in the pre-test to 49% in the post-test ($t=11.24$, $p<0.001$). If the pre- and post- tests were equivalent the changes are statistically significant and the differences of the mean standard deviation scores were only 3% (see Table 4.3), it could be concluded that, overall, students' IL skills have been enhanced after they have attended the designed teaching module.

Table 4.3 Comparison of P.3 students' IL scores in the pre-test and the post-test

	Pre-test		Post-test			
	Mean (%)	SD (%)	Mean (%)	SD (%)	***t***	***p***
Define	43	(43)	52	(44)	2.05	*
Access	22	(25)	49	(30)	10.66	***
Manage	35	(30)	61	(25)	9.29	***
Integrate	33	(32)	56	(40)	6.24	***
Create	33	(38)	48	(39)	3.80	***
Communicate	18	(31)	61	(37)	10.47	***
Evaluate	30	(35)	15	(25)	-4.33	***
Ethical use	38	(33)	34	(40)	-0.74	
Total	30	(18)	49	(21)	11.24	***

Note: N = 141

*Difference was significant at the 0.05 level (2-tailed).

** Difference was significant at the 0.01 level (2-tailed).

*** Difference was significant at the 0.001 level (2-tailed).

4.8.2 Findings for Key Stage 2

A total of 312 students primary 5[3] and 6 students (52 primary 5 students and 260 primary 6 students) from the four participating primary schools took part in both the pre- and post- tests. As we are not reporting the findings for students at the two grade levels separately, we will refer to them as KS2 students for simplicity. Figure 4.2 shows the respective percentage scores for the two tests. As shown in the figure, in the pre-test, students had high scores in the dimensions of 'define', 'evaluate', 'access', and 'manage', with corresponding mean scores of 85%, 63%, 53%, and 52% respectively. On the other hand, students' scores in the dimensions of 'communicate' and 'integrate' were only 32% and 33%. In the post-test results, the highest mean score was found in 'define' (56%), following by 'access' (55%) and 'ethical use' (55%), and the lowest scores in 'create' and evaluate', with means of 37% and 40% respectively. There are a number of reasons that we can speculate about the decreased results. One possible interpretation of this

[3] In the proposal only primary 6 students were involved in this study. However, one primary school can only implement this project at primary 5 level and one primary school implement this project in the extra-curriculum activities which involved both primary 5 and 6 students, therefore both primary 5 and 6 students take the same test.

would be there is not sufficient intervention in the curriculum. The other reason would be the difficulty of the pre and post measurement items in the dimensions “evaluate” and “define” are not equivalent.

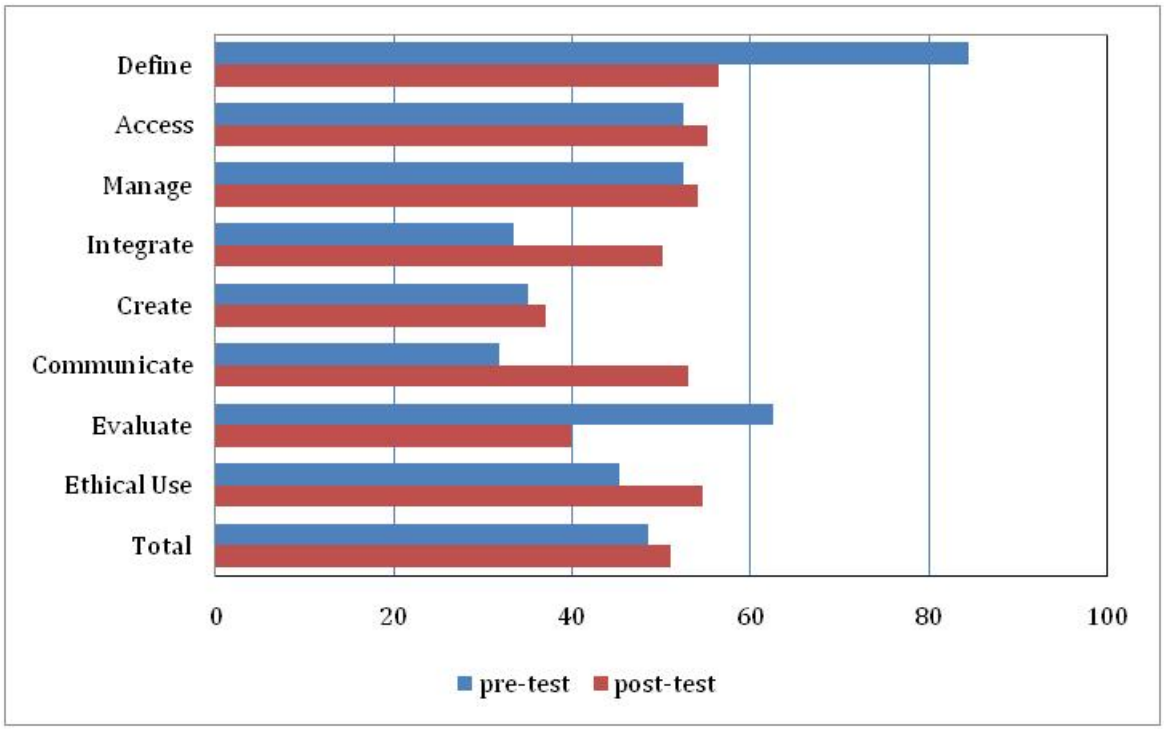

Figure 4.2 Comparisons of the eight mean percentage scores of KS2 students in the pre- and post- tests

Table 4.4 presents the pre-test and the post-test results. An increase in score was found in the dimensions of ‘communicate’ (21%, $t=7.83$, $p<0.001$), ‘integrate’ (17%, $t=8.69$, $p<0.001$), and ‘ethical use’ (10%, $t=4.99$, $p<0.001$). On the other hand, a decrease was found in the dimensions of ‘define’ (-29%, $t=-13.52$, $p<0.001$) and ‘evaluate’ (-23%, $t=-8.06$, $p<0.001$). For the remaining three dimensions , i.e. ‘access’, ‘manage’, and ‘create’, the score differences were small and were not statistically significant. Nonetheless, students’ overall IL score have improved slightly from 49% in the pre-test to 51% in the post-test, and the difference was found to be statistically significant ($t=2.8$, $p<0.01$).

Table 4.4 Comparison of KS2 students' IL scores in the pre-test and the post-test

	Pre-test		Post-test			
	Mean (%)	SD (%)	Mean (%)	SD (%)	***t***	***p***
Define	85	(25)	56	(31)	-13.52	***
Access	53	(27)	55	(29)	1.44	
Manage	52	(25)	54	(24)	1.26	
Integrate	33	(25)	50	(34)	8.69	***
Create	35	(29)	37	(25)	1.18	
Communicate	32	(39)	53	(43)	7.83	***
Evaluate	63	(42)	40	(42)	-8.06	***
Ethical use	45	(28)	55	(26)	4.99	***
Total	49	(18)	51	(19)	2.80	**

Note: N = 312

*Difference was significant at the 0.05 level (2-tailed).

** Difference was significant at the 0.01 level (2-tailed).

*** Difference was significant at the 0.001 level (2-tailed).

4.8.3 Findings for Key Stage 3

A total of 270 S3 students in the five participating secondary schools took part in both the pre- and post- tests. Figure 4.3 shows the resulting mean percentage scores. In the pre-test, students had high scores in the dimensions of 'access', 'manage', and 'define', with mean scores around 60%. However, the scores in the dimensions 'communicate', 'create', and 'ethical use' were only 12%, 22%, and 26% respectively. For the post-test results - the three highest mean scores were 84%, 67% and 63% in the 'define', 'access', and 'manage' dimension respectively, and the lowest mean scores were also found in 'communicate', 'create', and 'ethical use'. Among the eight dimensions only the score in "evaluate" dimension drop from 38 to 32. There are a number of reasons that we can speculate about the decreased results. One possible interpretation of this would be there is not sufficient intervention in the curriculum. The other reason would be the difficulty of the pre and post measurement items in the dimensions "evaluate" is not equivalent.

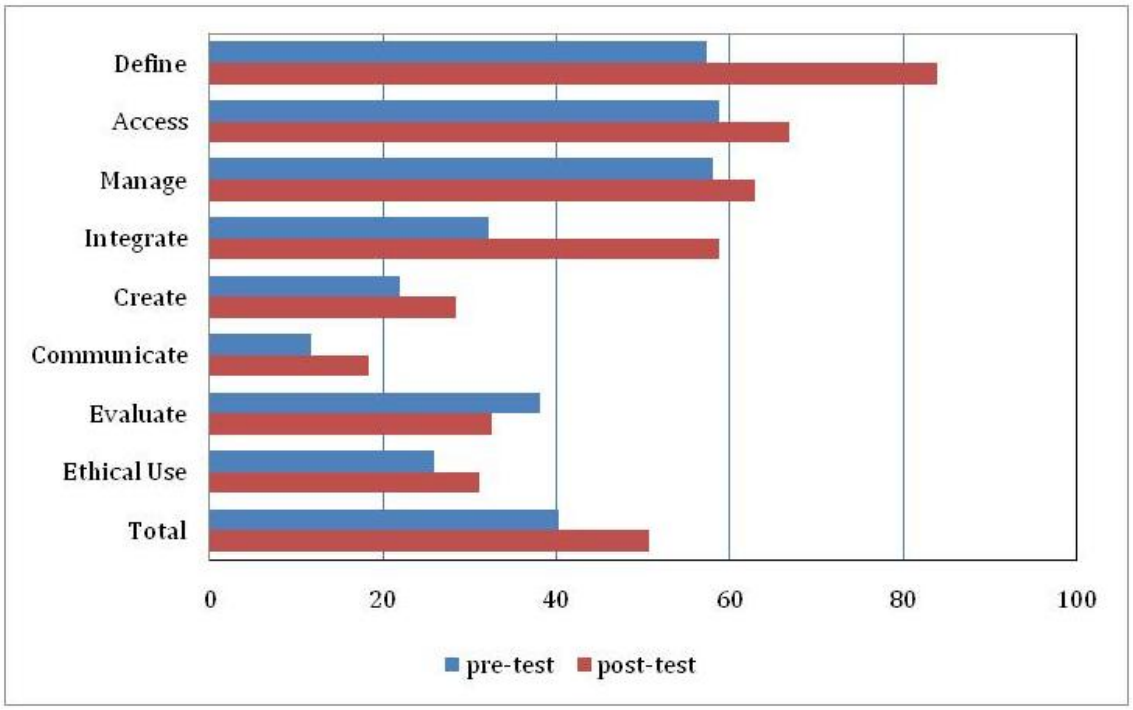

Figure 4.3 Comparisons of the eight mean percentage scores of S3 students in the pre- and post-tests

Table 4.5 presents the mean percentage scores for the pre- and post-tests. The results show an increase in all dimensions exception 'evaluate' (-6%, t=-2.42, p<0.05). The mean 'total' score increased from 40% in the pre-test to 51% in the post-test, and the difference was statistically significant (t=10.78, p<0.001).

Table 4.5 Comparison of S.3 students' IL scores in the pre-test and the post-test

	Pre-test		Post-test			
	Mean (%)	SD (%)	Mean (%)	SD (%)	*t*	*p*
Define	57	(19)	84	(20)	16.29	***
Access	59	(34)	67	(29)	3.33	**
Manage	58	(26)	63	(27)	2.99	**
Integrate	32	(20)	59	(29)	14.93	***
Create	22	(20)	28	(21)	4.23	***
Communicate	12	(22)	18	(26)	3.40	**
Evaluate	38	(26)	32	(35)	-2.42	*
Ethical use	26	(18)	31	(22)	3.36	**
Total	40	(14)	51	(18)	10.78	***

Note: N = 270

*Difference was significant at the 0.05 level (2-tailed).

** Difference was significant at the 0.01 level (2-tailed).

*** Difference was significant at the 0.001 level (2-tailed).

4.9 Difficulties encountered by teachers in project implementation

Teachers reported encountering the following difficulties during the project process:

4.9.1 Unfamiliarity with information literacy

The project team found that the science teachers participating in this project were not familiar with information literacy. As aforementioned in Section 4.6.2, they did not have a full understanding of what IL is. Some of them also think that IL has nothing to do with the learning and teaching of science. The following quote provide some insight into this problem,

- "I found putting IL in science to be quite difficult. I am a science teacher. I wonder if students should have learnt IL in computer lessons rather than in science lessons. Do we really need to spend time on teaching students IL during science lessons? I think it is a little devious. Computer teachers have the responsibility to teach students the basic knowledge. " (Teacher 2, School H)

As it is important for teachers to have a comprehensive understanding on what is IL, many teachers expressed that more formal professional development activities such as refresher training courses and workshops for teachers on what is information literacy and how it is related to their subject area would help teachers to gain a better understanding of IL:

- "The most important thing is for teachers to first know what information literacy is, because it would be very difficult if teachers do not know. In the beginning, I did not understand it either, it was through the discussions and examples provided by the Project Team that we were able to begin to understand the concept and later develop our own activities." (Teacher 1, School C)

- "Many [teachers] find it difficult to integrate IL in the subject because it is a really new concept and not many teachers are able to grasp it. I think professional training in this along with how it could be assessed is important." (Teacher 3, School A)

- "Teachers must first learn to understand the IL content and its related concepts." (Teacher 1, School H)

4.9.2 Unfamiliarity with the curriculum and assessment design for fostering IL

Some teachers pointed out that as they were not familiar with the IL concept and it is hard for them to design curriculum that incorporates IL elements and assessment elements:

- "Actually our school teachers showed their worries in the beginning. They may think that adding IL to their teaching may affect their original lesson plan. After the communication with Dr X, we are more familiar about it. I would like to thank HKU for explaining a lot to us and help us design activities. Our teachers have overcome their worries. Maybe IL is still a new thing to science teachers. So they found difficulties in the beginning of this project." (Teacher 3, School F)

The project team offered two training workshops on the concept and definition of IL, how to design curriculum activities in science to incorporate IL elements in the different dimensions, and how to design and implement assessment tools that evaluate students' IL. Teachers reported that they would prefer the training to be extended over a longer period of time and to include more practical curriculum exemplars in the science subject area:

- "It would definitely require a certain degree of understanding on how to integrate the elements into the lessons. To be honest, I believe I do not have sufficient knowledge. Sharing of some concrete IL implementation examples could make it easier for teachers to see what the 8 dimensions are." (Teacher 1, School F)

- "The most important thing would be to know what information literacy is. Professional training should take place over a longer time, preferably over a course, and not in just three hours." (Teacher 1, School B)

- "Training that instructs teachers on design of IL implementation would be beneficial.[…] We can sit together to design one specific unit, or if given more training time, it could be done on the whole teaching module. It might be easy to think of certain activities, but it is necessary to discuss in detail the learning impact of those activities on students." (Teacher 1, School J)

4.9.3 Short curriculum implementation period

Data from the project end interview revealed that many teachers commented that the implementation period they allocated to the implementation was too short. They generally opted

for incorporating IL in one short curriculum module on a topic for the project. At the end of the project, many indicated a preference for incorporating IL elements throughout the whole school year, or have a systematic year plan for the whole school:

- "I suggest putting the whole idea of IL into a long period [of curriculum implementation]. We should use IL whenever the items are matched, rather than use all dimensions in one single topic. The implementation will be greatly restricted if we are limited to only 10 lessons. I think it would be more efficient if do it over a longer period. " (Teacher 1, School J)

- "I prefer a longer-lasting project. I think one single module is not enough. Maybe half or one whole year would be more suitable. So students can learn IL stage by stage. They would have more freedom to explore and this will be better." (Teacher 2, School J)

- "The implementation time is very short. For example, I taught 3 lessons in this way, but since time was too short, students might not have learned as much as they could have. It was also harder to tell whether students really have acquired these skills." (Teacher 1, School G)

4.9.4 Computer room arrangement and access problems

Teachers found difficulties in arranging the computer room for lessons and for conducting the pre- and post- tests. Especially for secondary schools, usually the timeslots for computer room or MMLC room access are fully booked. A few of the students still did not have internet access at home, and they had to stay behind and use the computers after lessons at school to complete their learning tasks. In addition, there were technical and access problems:

- "I have originally planned to use MMLC to do the pre- and post- tests. But we found that the MMLC cannot support the server [access bandwidth for the whole class]. So we need to arrange the computer room again and separate [students] into two groups to do the test. Other teachers [who had booked the computer room] had to move their class back to classroom. I felt sorry to disturb other teachers because this will affect their teaching. " (Teacher 1, School G)

4.9.5 Low bandwidth for internet access

The project team is surprised to find out that in one of the schools, the bandwidth for internet access for the entire computer room was only 3MB. Due to the low bandwidth, the project team could not carry out the pre- and post- tests for an entire class as normally conducted in all other schools, but had to divide students into small groups to take the tests. Hence many more test sessions had to be conducted. This issue of low internet bandwidth poses difficulties not only for the conducting of tests, but also for conducting whole class learning activities involving student use of the internet.

Chapter 5 Summary and Recommendations

This chapter provides a summary of the key outcomes from this project. First, a report is made on the deliverables derived from this project that can be used by teachers, school leaders and educators interested in fostering students' IL development through integrating appropriately designed curriculum activities and assessment tools in different KLAs. These deliverables, though especially relevant to implementation in the science KLA, also provide more general insight to teachers in other KLAs and to those interested in teacher professional development and management of innovation related to the development of IL. Next, the major difficulties encountered during the project implementation process are described and discussed. It then summarizes the key findings with respect to the four research questions set out in chapter 1. Finally, a number of recommendations is provided on strategies to further develop students' IL through appropriate curriculum and assessment innovation.

5.1 Project deliverables: curriculum and professional development resources

During the project implementation, the project team conducted four training workshops for teachers, two on introducing IL and the design of learning and teaching activities that integrate IL elements, and two on how to design evaluation tools for assessing students' IL performance. The team also made a total of 79 school visits to the ten schools to provide support to schools. A total of 22 meetings for the co-lesson planning were conducted, 24 lessons observations and 33 school visits for conducting the pre-test and post-test. Four dissemination seminars were also held towards the end of the project to introduce the key outcomes of the project to interested teachers in primary and secondary schools in Hong Kong. In order that the rich resources and experiences gained through this project as well as the key research findings can be disseminated more effectively to anyone interested in this area, the project team has constructed a project website to provide an overview of the project and its key findings, and sets of implemented exemplars. These are briefly described below.

5.1.1 The project website

A project website (http://iltools.cite.hku.hk/revamp) has been developed to provide an overview on the key concepts and outcomes from this project. It is to be used as teacher professional development package for promoting learning IL among students. Figure 5.1 presents the layout of the website.

Figure 5.1 Layout of the project website

This website contains the following sections:

An introduction

It briefly introduces the aim of the project and the participating schools. It also includes the research framework and methodology, the research findings and recommendations as well as references and recourses.

Information literacy

It introduces what is information literacy, framework of information literacy and the relationship with scientific investigation as well as the respective learning and teaching strategies observed in 15 cases in this project. It is hoped that these information can provide a brief conceptual understanding for IL and kinds of activities that promote students' IL.

Science investigation

It introduces the learning outcome framework of the science investigation strand as launched by EDB. It contains 12 competencies that students are expected to develop in primary and secondary science studies.

Assessment design

It describes the assessment design in this study and introduces the two assessment rubrics developed by the research team. These two rubrics act as guidelines for developing task specific assessment rubrics in accordance to the eight IL dimensions. Besides, procedures for creating task specific rubrics and checklist were also described.

Curriculum design

It briefly describes the curriculum planning procedures in this study so that it may provide ideas of how the implementation gets started.

Exemplars

It lists out 15 exemplars. The purpose is to provide vivid practical examples for the curriculum implementation and details will be described in the subsequence section.

Implementation strategies

It provides various strategies in integrating IL in the science curriculum as found in this study at school level. Though this, it gives an ideas of how school can implement the IL in science curriculum.

Important frequently ask questions

It lists out those questions encountered by teachers and answers that teachers share with us. It provides and ideas of those questions that teachers are concern during the implementation process.

5.1.2 Curriculum exemplars

Instead of developing eight curriculums exemplars as stated in the proposal, the project team has developed a total of 15 curriculum exemplars (2 at KS1, 4 at KS2 and 9 at KS3). An exemplar website has been created for the purpose of providing practical curriculum exemplars that illustrate how IL can be integrated in science as a specific subject discipline and how to design lesson activities and conduct the assessment that can inform and facilitate students' learning in the eight dimensions of IL skills. Figure 5.2 presents the layout of the exemplar website. Each exemplar includes the following sections:

An Introduction

A brief introduction which provides a general description of the exemplar including the learning objectives, scientific investigation skills and IL skills concerns in the learning unit. It aims to provide an overall view of the learning unit.

Instructional design

It lists out the detailed planning for each lesson; the curriculum related materials as well as assessment rubrics were included. It aims to provide those learning and teaching strategies that promote IL skills among students.

Resources and preparations

It lists out the learning resources and preparation needed in each exemplar. Teachers may browse those related materials for their lesson planning.

Assessment tools

It includes all the assessment rubrics and self-evaluation checklists used in the exemplar. Sample of students' authentic works were also included for illustrating levels of students' performance, if possible. It is hoped that through these exemplars can give some ideas of how to design the assessment rubrics with regards to the eight dimensions.

Implementation strategies

It describes a variety of strategies used in classroom level as well as school level for the implementation of IL. It intends to give some concrete strategies and tips that fit for different schools' situations.

Lesson videos, students' reflections and teacher reflections

It provides some videos clips on actual lessons and students reflections and teacher reflections for the whole implementation were also included. It aims at providing information on the impact of students' learning in IL as well as the impact on the strategies and pedagogies development for enhancing IL among students.

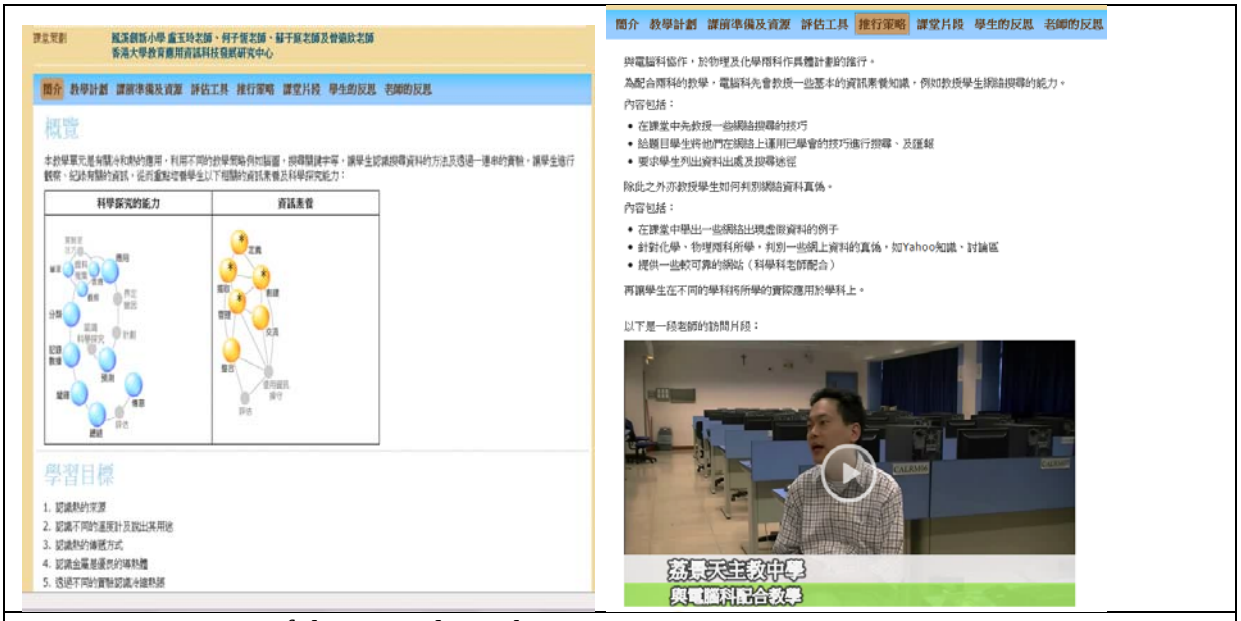

Figure 5.2 Layout of the exemplar website

5.1.3 Generic IL rubric and Key stage rubric

An important aim of this project is to develop self-evaluation tools for assessing students' information literacy and promoting information literacy among students. Two sets of generic rubrics were developed by the project team. They are the generic IL rubric and Key stage rubric (Appendix 3.3 and 3.4 respectively). The former one illustrates the general progression of students' development along each dimension of IL. The latter one provides a description of the expected level of performance along each of the eight IL dimensions exhibited by students at the end of KS1, KS2, and KS3. These two sets of rubrics provide guidelines for the development of teaching and learning activities, and assessment tasks in the curriculum design for integrating IL in science learning. These two sets of rubrics also provide the basis for the development of the task specific assessment rubrics and self-evaluation checklists.

5.1.4 Self-evaluation checklist and assessment rubrics

To put the ideal of assessment for learning into practice, assessment tasks were designed as an integral part of curriculum design in this project. Hence, the project team worked with teachers to develop the self-evaluation checklists and assessment rubrics that were appropriate for assessing students' IL outcomes based on the learning activities in the respective curriculum units. These two types of assessment tools help to provide qualitative descriptions of students' performance and provide feedback on the next level of progression. The self-evaluation checklist is to be used by students for self- and peer- assessment. The assessment rubrics provide more in-depth descriptions on students' levels of performance and are generally used by teachers, but can also be used by more mature students. Thus, apart from the self-evaluation tool as required in the tender specification, the project team made additional efforts to develop specific assessment rubrics in collaboration with teachers as an integral part of the complete cyclic design research process. Table 5.1 presents the number of self-evaluation checklists and assessment rubrics developed and implemented at each key stage. Samples of students' work illustrating students' different levels of performance based on these rubrics were also displayed, wherever possible.

Table 5.1 Summary of the number of self-evaluation checklist and assessment rubrics developed in Key Stage 1-3

Key Stage	Self-evaluation checklist	Assessment rubrics
1	14	14
2	27	27
3	36	36
Total	77	77

5.2 Difficulties encountered

Teachers reported that five main difficulties were encountered during the project implementation. They were:

Unfamiliarity with the concept of IL

Both Science and General Studies teachers who are involved in this project pointed out that they were not familiar with information literacy and they did not have a comprehensive understanding on what is IL and how it is related to their subject.

Unfamiliarity with the curriculum and assignment design that foster the development of IL

Teachers also pointed out that as they did not know the IL concept well, it is very difficult for them to design curriculum that include IL elements and assessment elements. Through the project team has provided two training workshops for teachers, they would prefer training to be extended over a longer period of time.

Short implementation period

Teachers usually incorporating IL in one short curriculum module and by the end of project implementation, many indicated that it would be much better if IL elements are included throughout the whole school year, or have a systematic year plan for the whole school.

Computer room arrangement and access problems

Teachers reflected that it is very difficult in arranging the computer room for lessons and conducting the pre- and post-test. Also, there are access problem among students in some schools as students did not have Internet access at home, they need to complete the learning task at school. Technical problems were also reported by some schools. Low bandwidth for Internet access and the availability of the computer room were mentioned.

5.3 Summary of research findings

In this project, four research questions guiding this study. They are:

1. What are the strategies that can enhance students' information literacy skills?
2. What changes, if any, can be observed in student's IL skills through the project process?
3. What recommendations can be made with regard to the development of a coherent strategy to integrate the development of IL skills in different KLAs based on the experience in this project on involving teachers in pedagogical and assessment design and implementation in this project?

4. What changes can be observed in teachers' knowledge of IL before and after the implementation of this project?

In order to find out the answers for the above questions, a total of 15 cases have been conducted in five primary schools and five secondary schools to develop strategies/pedagogies and assessment tools that can enhance IL among students in General Studies and Science education.

5.3.1 Strategies that enhance students' IL skill

With regard to research question one "What are the strategies that can enhance students' information literacy skills?" Two categories of strategies were identified among the 15 cases. They are described as follows:

5.3.1.1 Strategies for promoting IL at classroom level

It is observed that within the 15 cases, there were some common learning activities that foster students' development in eight IL dimensions. In chapter 4, Table 4.2 (section 4.2.1) presents a summary of the commonly used activities in each dimension. It was also found in the lesson observations and teacher interviews that particular strategies such as providing full URL and hints and breaking down the complex task did facilitate the process of defining and retrieving information for KS 1 students.

Two kinds of learning tasks were found in promoting IL among students. One refers to short assignment task which complete within the lesson or submit in one or two days after the lesson. The other one refers to project work which extends a period of time and also includes some sub-tasks. It was discovered that for those project work it usually requires students to exhibit a wider range of IL skills but for those short task, it focuses on one particular dimension of IL only.

5.3.1.2 Strategies for promoting IL at school level

A variety of strategies have been observed for promoting IL at school level. First, three types of subject involvement were observed. They were single subject trail, coordinating with computer studies and interdisciplinary approach. For single subject trail it is usually found in secondary schools. There were only two primary schools and one secondary school taken the approach in collaboratively work with computer studies. The interdisciplinary approach, such as including the library studies, Mora and civic education and extra-curriculum activities, was only found at primary schools.

Apart from this, it was also interesting to find out that schools also differ in the selection of students groups. For all the secondary schools they selected single class trail. However, primary

schools have more flexibility in terms of selection of students. Some used single class, some use whole grade level and some use cross-grade grouping.

5.3.2 Changes in students' IL skills

For question two "What changes, if any, can be observed in student's IL skills through the project process?" The following findings were observed.

5.3.2.1 Results of the pre-test and post-test

By comparing the results of the pre-test and post-test, it was revealed that in general after the curriculum intervention students' overall competence in IL has been significantly improved. For primary three students, all eight dimensions except the "ethical use" and "evaluate "dimensions have shown significant improvement. For those primary 5 and 6 students, significant improvement has been found in "integrate", "communicate", "evaluate", "ethical use' and the overall performance. For secondary three students except "evaluate" dimension, there are significant improvement for all the other seven dimensions.

5.3.2.2 Students' learning gains

Both students and teachers indicated that the curriculum intervention has some impacts on students' learning. In particular learning gains in regards to the eight IL dimensions were mentioned. Other learning gains such as increase motivation to learn and broaden the curriculum perspective were also mentioned.

5.3.3 Changes in teachers' knowledge of IL

Regarding to research question four "What changes can be observed in teachers' knowledge of IL before and after the implementation of this project?" the following changes have been observed.

5.3.3.1 Changes in pedagogical practice that cum with IL

Teachers reflected by working collaboratively with the project team expended their knowledge and skills in curriculum design that cum with IL. Besides, teachers also reported that students take a more active role in their learning. Apart from this, teachers also reported that there are changes in the assessment design. That is more space and autonomy were given to students and teachers are not the only one who assess students' work. Students also take up the responsibility to evaluate their own work.

For teachers, enhanced competence in curriculum design that encompass with IL was reported. A better understanding of IL and its relationship to scientific investigation were mentioned. Apart

from these, professional development on pedagogical practices as well as various designs of assessment tools and enrichment of curriculum design were also mentioned.

5.3.3.2 Views on the assessment tools

Both students and teachers reflected that the use of self-evaluation checklist and assessment rubric were helpful in facilitating students' IL development and assessing these skills. However, teachers also pointed out that it was a bit time consuming in designing those evaluation tools and these tools were new to them. Teachers reflected that they need to have professional development training on how to design these tools. Once they grasp these knowledge and skills there is no problem for them in developing these assessment tools.

5.3.4 The use of technology in Science Education

It was observed that teachers in both primary and secondary schools were mainly using general ICT tools such as using Internet for searching, Microsoft office for creating artifacts and not much opportunity in using science specific tools such as modeling/ simulations or data-logging tools for learning science.

5.4 Recommendations

Research question three asks "What recommendations can be made with regard to the development of a coherent strategy to integrate the development of IL skills in different KLAs based on the experience in this project on involving teachers in pedagogical and assessment design and implementation in this project?" The following recommendations are made on the basis of findings from the present study. It includes the recommendations for students, science teachers, IT teachers, teacher librarians, school principals and EDB.

5.4.1 Recommendations for students when they are engaged in online activities

In this project it was observed when students were tackling tasks given by teachers which were related to information literacy students would usually engaged in the following online activities: information searching, online discussion and seeking help online by using forum, blog and Facebook, uploading files and downloading files from a website, and doing multimedia presentation. All these activities may involve integrity of information, privacy, and attitude, social and ethical issues. During the project implementation, those self-evaluation checklists and generic rubrics as well as key stage rubric actually provide some suggestions and guidelines for students. Here, the project team would like to list out some guidelines and suggestions as from the literature and the experiences gained in this project as a whole.

Concerning searching information online it concerns the integrity of information. According to the literature (Ercegovac, 2008; Neely, 2006; Ryan & Capra, 1995) as well as the experiences gained in this project we suggest students to check the authority, accuracy objectivity, relevance currency and coverage. Table 5.2 shows the guidelines for helping students to evaluate the integrity of information on the web.

Table 5.2 Guidelines for evaluating integrity of information on the web

Authority	1. Are the author's credentials available? 2. Is the information in the website reliable? For example by checking the domain name, usually .gov and .edu websites are more reliable
Accuracy	1. Are there any spelling errors or grammar mistakes? 2. Is the purpose of the web clearly stated? 3. Is the source trustworthy? How do you know? 4. How reliable is the information? Can the information be verified against other sources? 5. Does it include a bibliography, references or links to additional sources to consult?
Relevance	1. Is the information related or useful for your own work? 2. Does the information contain the breadth and the depth needed? 3. Does the information contribute something new to your knowledge?
Objectivity	1. Does the information present only in one-sided view? 2. Does the information only express opinions rather than facts? 3. Does the information present in objective manner without political, cultural, or religious biases?
Currency	1. Is there a date on the web that indicates when the webpage is created? 2. Is the information on the webpage outdated? 3. How many dead links are on the webpage? 4. Are the links current or updated regularly?
Coverage	1. Is the web page intended for the general public, scholars, practitioners, children, etc.? 2. Does the webpage provide a full coverage of information you needed?

Regarding online discussion and seeking help online by using forum, blog, MSN and Facebook, we suggest students to pay attention to the content, attitude, safety and reaction. For the content, safety and reaction are more concern about the self-protection and privacy. For attitude, it focuses

on the netiquette. Table 5.3 summarizes the guidelines for students when they engage in online discussions and communications.

Table 5.3 Guidelines for appropriate behavior when engaging in online discussions and communications

Content	1. Check your message before you post it 2. Do not post any image and information that could harm the society. 3. Do not post any images and information that might embarrass, hurt, or affect someone. 4. Do not post anything rude, offensive, or intimidating. 5. Do not post/send/forward any images and information that could harm yourself, embarrass you, or damage your future, such as • inappropriate pictures and videos.
Attitude	1. Respect other people online. 2. Be positive when offering advice. 3. Do not take anyone's personal information and use it to harm his or her reputation.
Safety	1. Set up security measures when using some online communication applications • be aware of the privacy setting in Facebook. • block someone you don't know on MSN. 2. Do not post any personal information publicly, such as • cell / home phone numbers • home address
Reaction	1. If someone shares different opinion or object my viewpoint, do respect him or her and make response politely. 2. If someone makes you feel uncomfortable or someone is impolite or offensive, • do not respond him or her. • save the evidence. • tell your parent, guardian, or another trusted adult. • report to the website master .

When students are engaged in project work, they usually need to prepare multimedia presentations (e.g. PPT presentation, videos), it may involve ethical issues in using information such as the intellectual property right and providing evidences of the claims and citations. From the experience gathered in this study, we suggest students to pay attention to the image, text as

well as data appears in the contents, and make proper referencing. Table 5.4 shows the suggestions.

Table 5.4 Guidelines for preparing multimedia presentations with regard to ethical issues

Content	1. Support your claim with evidence. 2. Provide appropriate and clear content, such as provide an overview of your presentation and use point form to indicate your main ideas. 3. Provide appropriate images and text to support your points. 4. Get the permission of the authors before using their products such as images, videos in the presentation.
Referencing	1. Follow a proper format for referencing 2. Acknowledge the sources of information

When doing the project work, students usually need to uploading information and downloading information from a website. Apart from the integrity of information; it also includes safety and ethical issues. We suggest students to pay special attention to intellectual property right and safety issue with regard to this activity. Table 5.5 shows the guidelines for students when uploading or downloading materials such as word files/photos/music/videos online.

Table 5.5 Guidelines for uploading or downloading materials online

Content	1. Make sure it is legal to download the files. 2. Check if the downloaded file is intellectually protected. 3. Make sure you own the copyright of the uploaded materials or obtain the permission from the copyright owners (such as publishers of books and publishers of music) before uploading any copyrighted material onto the web. 4. Check whether the content of the uploaded files is appropriate or not. 5. Check whether the content contains anything that would embarrass, hurt, or affect yourself or someone else before uploading the file.
Safety	1. Save the file instead of opening it directly and use the antivirus software to check the file.

5.4.2 Recommendations for science teachers - widen implementation to a broader curriculum coverage

In this project, one curriculum unit was selected for project implementation by each of the participating teachers. Usually such a unit lasted for 3 to 10 lessons. The teachers reported during interviews that there were lots of restrictions in achieving significant learning outcome within one

single curriculum unit. It is thus suggested that if the project implementation period can be extended to a longer period of time, then wider coverage of the subject content can be made in accordance with eight IL dimensions.

5.4.3 Recommendations for IT teachers – look for collaboration opportunities with teachers in other KLAs

Throughout the project, some IT teachers expressed that even when they have taught students some knowledge and skills in IL, they would not have an authentic situation for students to apply their knowledge. They were pleased that this project provided an opportunity for IT teachers to work collaboratively with the science/GS teachers to develop students' competence in IL. Therefore, it is suggested that in promoting IL among students, IT teachers should look for collaboration opportunities to work with teachers in other subject disciplines, so that students can have a real and authentic task context to apply their IL skills learnt in the computer lessons. Further, difficulties associated with accessing computer rooms by subject teachers may also be reduced somewhat as some of the subject KLA learning tasks requiring computer access can be done during IT lessons.

5.4.4 Recommendations for teacher librarians – provide KLA specific professional support and IL resources to subject teachers

School librarians have a role to play in developing an information literate school by providing resources not only for the students but also professional support and resources for teachers. Research has pointed to the need for greater collaboration and mutually supportive professional learning among school librarians and subject teachers in the development of information literacy. There is empirical evidence of positive impact on student learning when teachers and librarians work collaboratively to support the promotion of information literacy and reader development (Lance, 1997; Zweizig & Hopkins, 1999). It is recommended that inclusion of school librarians can be one of the key steps in taking information literacy forward in schools in developing learning activities conducive to information handing. Through a range of interactions between teachers and librarians, these two groups can coordinate to diagnose information problems faced by students, to provide meaningful support to information literacy activities, and to brainstorm integrated strategies for information literacy development within the curriculum for maximum benefit. In addition, the school librarians may also take a more active role in helping the subject teachers to source relevant online and offline resources related to topics for student inquiry.

5.4.5 Recommendations for school principals

Through the study, it was found that in order to achieve smooth project implementation, support for the innovation at the leadership level and ensuring synergistic development is very important. The following recommendations are for school principals interested in facilitating IL implementation in schools.

Whole school approach in teaching ethical issues in information literacy

Technology brings advances in everyday life as well as creates ethical dilemmas. To help students become thoughtful information literate persons, it is not sufficient just to develop their technical competence, but to also foster proper attitudes and awareness in using information. Hence "evaluate" and "ethical use" are important IL dimensions. Although activities in these two dimensions such as identifying the integrity of information, respecting intellectual property rights through proper referencing, introducing Internet etiquette as well as ideas and concepts on Internet addiction have been included in the learning and teaching activities designed in this study. However, not all aspects of these two dimensions can be tackled to the desired depth through learning tasks in the Science curriculum. In particular, at the secondary school level, there is less curriculum flexibility due to greater specificity of subject matter content in the curriculum. In order to get students fully aware and educated in this aspect, a whole school approach is recommended. As there are already some useful learning and teaching materials developed by NGOs and the EDB, teachers can adopt various approaches such as project learning, debate, drama, interactive games, design tasks and competition in various subject areas to foster the development of adequate awareness and proper attitudes in the ethical use of information.

Cultivating cross- and within- subject collaboration in promoting IL

Results from the teacher interviews indicated that the implementation of IL that involved communities of practice would pave way for the sustainable development of curriculum innovation. Besides, through this project, some teachers also perceived that it is not sufficient to just promote IL in one subject discipline. This IL competence should be across subjects. Therefore, it is recommended that while promoting the development of IL among students, a cross-disciplinary approach is encouraged so as to provide more opportunities for students to learn those IL skills in a more meaningful way and also to foster the collaboration cross subject and eliminate overlap. There should also be a whole school plan for fostering students' IL development across years. Coordination of teachers within the same subject to ensure smooth transition is also useful. In particular the collaboration between computer teachers and subject teachers is deem necessary as it may provide technical help for the subject teachers for the curriculum implementation as well as to solve the difficulties in booking the computer room.

5.4.6 Recommendations for EDB

Throughout the project, there is strong evidence that teachers need professional development opportunities to understand the key concepts about IL, as well as the relationship between IL and learning in different KLAs, that IL can be integrated and fostered through learning in the different KLAs, and through whole school strategic implementation and inter-disciplinary collaboration. It is clear that while IL has been identified as one of the four key tasks in the curriculum reform launched in 2001 (CDC, 2001), progress in achieving the IL curriculum goals (EDB, 2005) is still very inadequate. There has not been systematic and strategic approaches to the provision of professional development opportunities for helping teachers develop the recommended professional IL standards (EDB, 2007). Further, policy-makers need to have a clear understanding that the above goals can only be achieved over a sustained period of time, and that such developments are best achieved through engaging teachers in the curriculum and assessment innovation and design process.

Providing professional development opportunities for teachers

Findings in Chapter four reveal that Science subject teachers and General studies teachers in this study did not have a clear understanding of IL or its role in the school curriculum, which is critical before teachers can have the capability to design different IL-related learning tasks and assessment tools. Therefore, it is suggested that two types of refresher teacher training courses or workshops should be conducted. They are:

1. IL introductory courses

   These courses should aim to introduce the concept of IL as one of the essentials skills for 21st century and its relevance to the overarching goal of education—*Learning to Learn*, the key IL dimensions and the expected levels of student IL performance at different Key Stages, and to provide learning opportunities for teachers to attain a basic level of IL compatible with the recommended IL competence for teachers (EDB, 2007).

2. Action learning and professional community building on curriculum and assessment design and implementation for fostering students' IL competence in different KLAs.

   While the introductory course described above will provide teachers with good background information and skills on IL, it is not adequate to prepare teachers for undertaking the curriculum and assessment innovation necessary to integrate IL in their teaching in the different KLAs. Action learning and professional community building around this theme would be necessary for the professional development to have sustained impact on curriculum and assessment practice in schools. The curriculum exemplars developed in this study (described above) would be a valuable resource for this type of professional development activity.

Providing longer time for curriculum and assessment innovation and implementation

While the teachers we collaborated with in this project agree that embedding information literacy within the curriculum is beneficial, they also find it to be very challenging, given the short period for project implementation. Many of the teachers identified time and flexibility in curriculum implementation to be the major concerns. The limited amount of time together with the rigidity in curriculum content specification, especially at the secondary level, has put constraints on the implementation. It is recommended that if the same kind of R&D project on curriculum and assessment as the present one is to be conducted in different KLAs, the duration of the project should be longer so that teachers can have time to master the basic ideas and concepts of IL before embarking on the design and implementation aspects. It is suggested that a 2-year project cycle would be more appropriate, allowing for reflection and improvement as a design feature for implementation.

Providing clear guidelines for the use of technology and the role of IL in science curriculum documents

Results from this study indicate that teachers were not aware the relationship between IL and scientific inquiry at the beginning of the project. The use of science-specific technology tools was rarely observed during lesson observations. These observations may not be surprising given the fact that there is also no specific mention of the use of ICT in the science education curriculum guide. This lack of reference to the important of IL and science specific IT tools also contributed to the difficulties encountered by the project team in recruiting science teachers in to the project. Therefore it is suggested that the science curriculum section of the EDB should include these elements in the science curriculum guides (as is done in the UK through the National Curriculum in Science (DfEE, 1999)) and contribute to the organization of professional development activities and facilitate community building of science teachers around this theme.

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Appendix 3.1a Questions for the First Teachers' interview

About the lesson planning

1. Which topic would you chose for the implementation?
2. How many classes will be involved?
3. How many students will be involved?
4. How many teachers will be involved?
5. Apart from General Studies, is there any other subject involved in this project?
6. What are the learning objectives for this learning unit?
7. How many lessons for this learning unit?
8. Which IL dimensions will be involved?
9. Are there any specific technology used in this unit?

About the concept of IL & scientific investigation

1. Can you briefly explain to me your understanding of IL?
2. Do you know the 12 competencies of scientific investigation?
3. Is there any relationship between IL and learning science?

About the assessment

1. Can you tell me the assessment mode in GS/Science in your school?
2. Are there any innovative assessment tools that your school has been used? If yes, can you briefly describe it with us?

Appendix 3.1b Questions for the Second Teachers' Interview

About the lesson

1. What are the teaching goals in these 2 lessons?
2. Which IL dimensions did you focus on?
3. Do you think students have reached your expectations?
4. Can you describe to me the situation and teaching plan of your previous lessons?
5. How were the students' performances?
6. Up till now, have you encountered any difficulties?

Appendix 3.1c Questions for the Third Teachers' Interview

Teachers' background

1. How long have you been a teacher?
2. How many years have you been teaching General Studies/ Science Subject?

Situation of school's implementation

1. How many teachers and classes in total were involved in this project?
2. Is one subject teacher or are there other arrangements for teacher's involvement in this scheme? Why is such an arrangement done?
3. How much time was used from the lessons preparatory process to the actual teaching practice?

Teaching design/ Lesson planning

1. Have you ever integrated IL elements into your teaching in the past? If so, which area? Please give examples.
2. Is there any difference between the teaching designs of classroom teaching this time compared to previous ones?
3. Why was there such an idea?
4. With regards to the design of this teaching module, what preparations are needed?
5. What difficulties have you encountered during the actual carry out of the lessons? How did you solve them?
6. Have you tried to employ any special teaching methods during the teaching process?

Students' response

1. What were the overall responses and reactions of students to this teaching unit?
2. Is there a difference between students' actual performances and your expectations?
3. Many IL elements were considered while designing this teaching module. In which areas do you think students performed better? Worse?

Knowledge of IL

1. Before joining this project, what did you think Information Literacy was?
2. What do you think Information Literacy is now? Is there a conceptual change of IL before and after this project?
3. Was it hard to integrate IL elements (define, access, manage, integrate, create, communicate, evaluate, ethical use) into Science/ GS? Out of the 8 IL dimensions, which do you think was the most difficult to integrate into your lessons? Why?

Evaluation Tools

1. What assessment method do you use when evaluating students?
2. In this teaching module, you have used assessment rubrics to assess students' IL. Do you think these assessment rubrics are useful (able to distinguish student levels)? Why?
3. The assessment rubrics were provided by HKU Project Team this time. Do you think it would be difficult if you were asked to design your own for next time? Why?
4. Besides those assessment rubrics, self-evaluation checklists were also provided. Do you think these checklists have helped students' learn how to complete the tasks? Why?
5. Would it be hard if you were asked to design your own self-evaluation checklists? If yes, how?
6. Did you make any amendments to those evaluation tools we have provided? If yes, why?
7. ** We know that you have also used some of these rubrics for peer assessment activities in class. Why was there such an arrangement?

Reflections and conclusion

1. Do you think there is any room for improvement with regards to the arrangements of this teaching module?
2. On the whole, do you think IL could promote students' learning in Science?
3. Overall, do you think taking part in this project has benefitted you? Please explain.
4. If this project were to be implemented by other colleagues as well, which area of professional training do you think would be needed most as of now?
5. Do you have any other comments with regards to this research project?

Plan for coming year

1. Will implementation of Information Literacy learning be done in the same subject (GS/ Science) next year?
2. Would you continue to try using similar teaching method to teach in the future? Why?
3. If yes, how would you implement it? Would there be any difference from this year? Would you try on different classes/grade levels?

Appendix 3.2 Questions for the Student Focus Group Interview

Students' post-lessons interview

1. What activities did you do in the class just now?
2. What have you learned today?
3. Are you satisfied with your /your group's performance? Why or why not?
4. Do you think the self-evaluation checklist has helped you on the activity in any way? Please explain and describe.
5. Do you think the peer assessment activity has helped your learning in any way? (If given any)
6. How did the teacher assess your work?
7. Is there any difference between the way your work was assessed this time compared to before?
8. For activities similar to XXX, how often were they done during class before this time?
9. Did you encounter any difficulties while doing this exercise? How did you solve it?
10. Is any anything else you would like to tell us related to this project?

Apart from the questions above, further questions will be asked on other class activities related to IL.

Appendix 3.3 Generic IL Rubrics

Define		**Novice**	**Basic**	**Proficient**	**Advanced**
The ability to use ICT tools to identify and appropriately define the information needed to tackle the problem/task.		Student cannot explicitly define what information is needed to tackle the problem.	Student is independently able to define a little of the information that is needed to tackle the task; he/she misses many key issues.	Student can independently and explicitly define much of the information needed to tackle the problem; he/she misses a few key issues.	Student can thoroughly and explicitly identify the information needed to tackle problems.
Access		**Novice**	**Basic**	**Proficient**	**Advanced**
The ability to collect and/or retrieve information. This includes the ability to identify likely digital information sources and to get the information from those sources.		Student is unable to independently use technology (e.g., online databases) to find information and enhance searches.	Student is able to use a few electronic sources (e.g., online search engines) to find information and enhance searches.	Student can independently use a moderate range of electronic sources (e.g., online search engines and online databases) to find information and enhance searches.	Student can independently use a wide range of electronic sources (e.g., various search engines and online databases) to find information and enhance searches.
Manage		**Novice**	**Basic**	**Proficient**	**Advanced**
The ability to master basic computer operation and apply an existing organizational or classification scheme for data management. It includes the ability to identify preexisting organizational schemes, select appropriate schemes for the current usage and apply the schemes.	Basic computer operation	Student is unable to operate a computer (e,g, switch on /off computer, save files).	Student is able to operate a computer and to use basic computer applications (e.g. , saving a document in an appropriate location, open and use an office package,).	Student can independently to operate a computer and to use some of the advanced feature of those basic computer applications.	Student can independently operate a computer and to explicitly demonstrate an excellent usage of the advanced features of those basic computer applications.
	Data manage ment	Student does not recognize when organization of information is ineffective. Even when the organization is clear, it does not meet the demands of the task. He/she does not possess a wide enough range of organization methods to change them.	Student requires time and assistance to organize information, change them as needed and to meet the demands of the task.	Student recognizes fairly quickly when organization of information is ineffective, requiring prompting to organize information only occasionally. He/she has a wide range of organization methods and can revise them as needed.	Without prompting, student quickly can recognize when organization of information is ineffective, and is able to revise them efficiently and independently.
Integrate		**Novice**	**Basic**	**Proficient**	**Advanced**
The ability to interpret and represent digital information. This includes the ability to use ICT tools to synthesize, summarize, compare and contrast information from multiple digital sources.		Student fails to understand the information he/she finds, and is not able to use ICT tools to synthesize, summarize, compare and contrast information from multiple digital sources.	With prompting and assistance, student can use ICT tools to synthesize, summarize, compare and contrast information from multiple digital sources.	With minimal assistance, student can use ICT tools to synthesize, summarize, compare and contrast information from multiple digital sources.	Student can independently use ICT tools to synthesize, summarize, compare and contrast information from multiple digital sources.

Create	**Novice**	**Basic**	**Proficient**	**Advanced**
The ability to generate information by adapting, applying, designing or inventing information in ICT environments.	The student creates works that are exclusively representational; often just follows the teachers' instruction. These products are limited to the simplest use of technology (e.g., digital cameras, clip art, or paint programmes).	The student is able to incorporate his/her own idea in products in very simple ways. These products are created using tools that range from simple to mid-level sophistication (e.g. productivity tools, presentation software, paint programmes, and images in word documents).	Products are created with the inclusion of some of the reflections of the learning process. With guidance, students are moving towards more sophisticated digital tools that enable them to design systems, run simulations, and formulate solutions.	The student's products reflect a sophisticated understanding of subject, digital media, and design techniques in light of the domain that he/she is studying. The student creates products by using authentic tools similar to those of professionals.
Communicate	**Novice**	**Basic**	**Proficient**	**Advanced**
The ability to communicate information properly in its context of use for ICT environments. This includes the ability to gear electronic information for a particular audience and communicate knowledge in the appropriate venue.	Student is unable to present information accurately, concisely, or clearly. He/she is unable to use technology to enhance communication.	Student is able to present information somewhat accurately, but the presentation is neither clear nor compelling. He/she attempts to use technology to enhance the communication, but is largely unsuccessful.	Student is able to present information accurately and efficiently, but the presentation is not entirely compelling. He/she is able to enhance the communication somewhat through the use of technology.	Student is able to present information accurately, efficiently, and in a compelling manner. He/she is able to substantially enhance communication through the use of technology.
Evaluate	**Novice**	**Basic**	**Proficient**	**Advanced**
The ability to determine the degree to which digital information satisfies the needs of the task in ICT environments. This includes the ability to judge the quality, relevance, authority, point of view/bias, currency, coverage and accuracy of digital information.	Student is unable to evaluate the quality of his/her work, and is unaware of judging the quality, relevance, authority, point of view/bias, currency, coverage and accuracy of digital information.	Student requires substantial assistance to identify specific strengths and weaknesses of his/her work; aware the quality, relevance, authority, point of view/bias, currency, coverage and accuracy of digital information.	With some assistance, student is able to identify specific strengths and weaknesses of his/her work. He/she has an adequate understanding of the quality, relevance, authority, point of view/bias, currency, coverage and accuracy of digital information.	Student is able to identify specific strengths and weaknesses of his/her product independently and accurately. He/she has a sophisticated and critical understanding of the quality, relevance, authority, point of view/bias, currency, coverage and accuracy of digital information.
Ethical use	**Novice**	**Basic**	**Proficient**	
The ability to understand and model the positive and ethical technology uses.	The student is unfamiliar with social and ethical issues relating to the use of technology. No thought is given to an ethical dimensions when using technology	The student has limited awareness of the social and ethical issues relating to the use of technology. With significant direction, he/she can discuss and model ethical use, but this has not been internalized	Student has a good awareness of a significant number of social and ethical issues relating to the use of technology. With minimal direction and support, he/she can both discuss and model ethnical use.	Student is extremely perceptive in recognizing and discussing ethical issues relating to the use of technology, often introducing issues independently. He/she makes significant effort to both model ethical use and encourage it in others

Appendix 3.4 Key Stage IL Rubrics

		KS1	KS2	KS3
Define The ability to use ICT tools to identify and appropriately define the information needed to tackle the problem/task.		• Identify and express the main idea in a problem under the guidance of teachers • Use pre-search strategies (eg, brainstorming, mind-mapping) under the guidance of teachers	• Identify and express the main idea in a problem independently • Use keywords to develop search statements	• Use logical operators to perform search • Formulate appropriate questions and make reasonable predications and hypotheses • decide whether to use evidence from first-hand experience or secondary sources for the inquiry
Access The ability to collect and/or retrieve information. This includes the ability to identify likely digital information sources and to get the information from those sources.		• Able to collect/ retrieve information from given digital sources (1-3 sources).	• Able to use search engine to collect/ retrieve information from a list of digital sources	• Able to identify a range of possible information sources such as relevant data based to collect/ retrieve information
Manage The ability to master basic computer operation and apply an existing organizational or classification scheme for data management. It includes the ability to identify preexisting organizational schemes, select appropriate schemes for the current usage and apply the schemes.	Basic computer operation	• Basic operation of computer such as turn on and off the computer, saving a document in appropriate location • input Chinese characters with a • handwriting recognition device	• Basic operation of the computer • input Chinese characters with devices and the aid of an input method • Able to use common office tools which include Words, excels and PPT	• Basic operation of the computer • input Chinese characters with an input method • Able to use general ICT tools and specific scientific tools to collect, classify, and organize information independently
	Data management	• Able to use ICT tools to collect, classify, and organize one set of information according to pre-defined scheme (e.g. place materials and objects in a sequence or in groups according to one or more attributes)	• Able to use ICT tools to collect, classify, and organize two sets of information according to pre-defined scheme (e.g. classify living or non-living things according to observable features)	• Manage few sets of data • Select appropriate scheme to collect, organize and classify information (e.g. classify according to external features and observed chemical and physical properties).
Integrate The ability to interpret and represent digital information. This includes the ability to use ICT tools to synthesize, summarize, compare and contrast information from digital sources.		• Interpret simple conclusions to from a single source	• Compare and contrast information to identify trends and relationships from multiple sources	• synthesize, summarize, compare and contrast information from multiple sources • identify similarities, differences, patterns or relationships in a variety of forms of data
Create The ability to generate an artifact by adapting, applying, designing or inventing information in ICT environments.		• Able to use ICT tools to create a free-form drawing / text document	• Able to use ICT tools to create an artifact which includes: diagrams, drawings, tables, bar charts, broken line graphs, pictures and sound	• Able to use ICT tools to create an artifact which includes: diagrams, drawings, tables, bar charts, broken line graphs, pictures, video and

	KS1	KS2	KS3
		files.	sound files and • able to select the appropriate forms to represent the information.
Communicate The ability to communicate information in its context of use for ICT environments. This includes the ability to gear electronic information for a particular audience and communicate knowledge in the appropriate venue.	• Students can communicate information verbally and present their idea using simple text /free-form drawing	• Able to use e-mail to share and communicate information with others • Able to use different forms (such as PPT, photos, chart) to present their ideas/information	• Able to use various communication tools such as Chat, forum, discussion board and e-mail to share and communicate information with others • Able to use a range of different forms to present idea/information and able to select the right communication tools and forms appropriately (eg. Website, PPT)
Evaluate The ability to determine the degree to which digital information satisfies the needs of the task in ICT environments. This includes the ability to judge the quality, relevance, authority, point of view/bias, currency, coverage and accuracy of digital information.	• distinguish between obvious fact and opinion • distinguish the relevance of information under teachers' guidance	• cross reference other sources to determine the reliability of the information • Identify common authoritative sources (e.g. Government) and less trustworthy sources	• verify and evaluate the accuracy reliability , points of view/bias and coverage of digital information using a set of criteria/ strategies
Ethical use The ability to understand and model the positive and ethical technology uses	• Demonstrate the safe and proper healthy use of computer	• Recognize the need for protecting oneself in the internet • Be aware of intellectual property rights, copyright and privacy • Be aware of indecent elements in computer network and other media	• Beware of the legal, social and ethical responsibility in using IT • Behave ethically in applying IT in information processing such as using citation and referencing