Developing Digital Literacy through Collaborative Inquiry Learning in the Web 2.0 Environment – An Exploration of Implementing Strategy

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Executive Summary

This study explores a strategy for Web-based collaborative inquiry learning (WCIL) for the purpose of developing students' digital literacy (DL). In view of the problems and difficulties identified in a previously published case study of WCIL practice in a class of secondary 3 students (aged 14 to 15), another round of WCIL activity was carried out in the same class. A series of measures designed to help students deal with the identified problems and difficulties were adopted to enhance WCIL for developing students' DL. We explored the effectiveness of the implementation strategies through focus-group interview, weblog postings, and subject teacher interview. Initial findings indicated that these measures are effective in facilitating the implementation of WCIL. To sum up the measures adopted in this round of WCIL, a preliminary implementing strategy model is proposed. Although it is not sufficiently verified, and is still subject to revision and adjustment by future studies, it gives a visual and more manageable model for reference of teachers planning and implementing instructional activities of this kind.

Keywords: Digital Literacy, Collaborative Inquiry Learning, Web 2.0, Implementing Strategy Model

Background

Digital literacy (DL) is a concept that has emerged along with the development and proliferation of information and media technology in modern societies. The increasing importance of digital media and technology in daily life has resulted in steady evolution of people's understanding of the concept of DL. Consequently, research about DL and DL education has received much attention in recent years (Erstad, 2007; Fu & Pow, 2011).

Digital literacy, as conceptualised and defined by Gilster (1997), represents the ability to understand and use information in multiple formats, from a wide range of sources, when presented via a computer. Alkali and Amichal-Hamburger (2004) maintained that the current focus of DL has extended to integrate technical, cognitive, motor, sociological, and emotional skills that users need in digital environments. Martin

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(2008) proposed a more complete definition based on review of different definitions of DL:

> DL is the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyze and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action, and to reflect upon this process. (pp. 166-167)

Martin (2008) included most of the essential elements in DL, which helps delineate the boundary of the study of DL. Since this study concerns DL in educational settings, we built on Martin's definition and identified four branches of DL: [1] the ability to access, evaluate, analyze, and synthesize multi-format digital texts; [2] the ability to create media expressions using multi-format digital texts; [3] the ability to communicate online; and [4] the awareness, attitude, and ability to use digital technology appropriately.

In extant research on DL, experts have emphasized DL education also. DL was highlighted as one of the eight key competencies in the European reference framework for lifelong learning (European Commission, 2007), and it has been given a central place in several European Union research and education programmes (Søby, 2008). According to related research and DL education practices, it is widely suggested that collaborative inquiry-learning activity carried out in a digital environment is an appropriate approach to develop DL abilities in students (Doering, Beach, & O'Brien, 2007; Erstad, Gilje, & Lange, 2007; Hartley, McWilliam, Burgess, & Banks, 2008; Kuiper, Volman, & Terwel, 2009; Luce-Kapler, 2007; Midoro, 2007; Owston, Wideman, Ronda, & Brown, 2009; Søby, 2008). This suggests that Web-based collaborative inquiry learning (WCIL) activities also facilitate the development of DL among students.

WCIL is made possible by the Web 2.0 environment, which allows students to read and edit information at the same time, quickly and easily, on a single Web-based platform. Veugelers and Newrly (2009) argued that the use of innovative tools in this environment increases the incentive to use digital media more regularly in daily lives. As a type of ability, greater use of digital media means greater proficiency in it. Among the available Web 2.0 tools, wikis and weblogs are the most commonly used platforms where students can capitalize on the power of the Web for knowledge building since these publicly accessible platforms allow them not only to search for and read information, but also to participate and write information. As Pow, Li, and Fung (2009) observed, "This new and efficient mode of knowledge-building for anybody with any background to contribute has in some way played down the role of expert knowledge" (p. 108). Hence, for students to acquire a set of knowledge, skills, and attitudes to cope with the demands of today's knowledge society, "a learning process is needed that is focused on the activities that the students carry out and on the skills they acquire while performing them, rather than on the content itself" (Guitert & Romeu, 2009, p. 3). This study starts with problems and difficulties identified in a published case study of WCIL learning (Fu & Pow, 2011), explores the possible measures to deal with these problems and difficulties for full exertion of the effect of WCIL in developing students' DL, and sums these measures into a preliminary implementation strategy model.

Findings of a Case Study

Since the main purpose of the present study is to explore ways to improve the effect of WCIL in developing students' DL, it starts from the problems and difficulties students encounter in WCIL, which were identified in a previous case study conducted in Hong Kong by the authors (Fu & Pow, 2011). The main aim of this case study was to clarify two questions by investigating WCIL activities carried out in a real school setting: [1] what are the effects of WCIL activities on student DL levels? and [2] what problems might students encounter during WCIL activities?

The Fu and Pow (2011) case study randomly divided 42 secondary 3 students (aged 14-15) into 10 groups and invited them to participate in a set of WCIL activities to explore a topic they were interested in (Table 1). All six activities needed to be finished on a weblog, a typical Web 2.0 platform that can encourage reflection, critical thinking and rigorous writing composition (Lui, Choy, Cheung, & Li, 2006). Since different media can be easily embedded into a weblog, it was chosen as the platform for students to share inquiry data, record learning diaries, and publish inquiry-learning reports. The entire WCIL process lasted nearly a whole term (about five months), with eight tutorial lessons every two weeks of 1–1.5 hours each to provide students the necessary support and facilitate their progress in inquiry learning. Students were asked to report in class on the progress of their tasks and the difficulties they had encountered every two weeks. In doing so, they could receive suggestions and advice from the course teacher on resolving problems they had encountered during WCIL.

Table 1: WCIL activities

1. Collecting multi-format information and choosing inquiry topic
2. Generating an inquiry question
3. Formulating an inquiry plan
4. Implementing inquiry (collecting multi-format inquiry data)
5. Organizing and analyzing data
6. Composing a digital inquiry report

Adopted from Fu and Pow (2011)

The results of this case study showed that WCIL was useful in engaging students in DL practices and also helped improve student DL levels across three of the four branches of DL described above; only the online communication branch showed no further improvement since Hong Kong students already possess a high level of online communication skills. The case study also identified problems and difficulties students encountered in this round of WCIL. The main problems encountered by both the students and the teacher during WCIL were categorized into three dimensions, namely, collaboration problems, inquiry-learning problems, and DL problems.

Problems related to collaboration were mainly caused by poor collaboration between group members, low participation in WCIL, and difficulty in making decisions when different ideas were put together. Possible explanations included low motivation and initiative regarding WCIL, poor leadership provided by group leaders, and lack of basic knowledge and skills for collaborative learning. In the case of inquiry-learning, students feel challenged when [1] formulating an appropriate inquiry topic or question; [2] choosing an appropriate inquiry method; [3] designing inquiry tools, such as questionnaires or interview lists; [4] analyzing collected inquiry material appropriately; and [5] presenting the inquiry results effectively in the inquiry report. The problems and difficulties caused by deficiency in DL levels include [1] finding accurate information for inquiry topics; [2] analyzing and synthesizing collected inquiry materials; and [3] using comparatively simple information search strategies, for example, being overly dependent on the Internet (Fu & Pow, 2011).

Measures to Improve WCIL Implementation

In view of the identified problems and difficulties students encountered during their WCIL, we formulated some measures to improve the implementation of WCIL.

Collaboration

Literature about collaborative learning sheds light on formulation of measures to improve the process of WCIL. Collaborative problems mentioned in the previous WCIL study were mainly caused by deficiency in motivation, lack of collaborative experience and weak leadership. According to the theories and literature of collaborative learning, the measures we formulated are as follows.

Motivation measures

Irrespective of how well a learning activity is designed, students' having motivation to participate in it is a prerequisite. As reported in the earlier study (Fu & Pow, 2011), the low participation problem observed in this study was a result of low motivation among some students for learning and the lack of a sense of responsibility about the need of learning.

A fundamental way to motivate learners is to make them recognize the limitation of or gap in their knowledge (Schank, 1983). It is indeed difficult to motivate individual students to proactively post information on weblogs and to comment on others' work. Therefore, after having considered the importance of pairing of peers for effective collaboration (Kumar, 1996), we grouped together students who had interest in a same topic so as to build a sense of ownership thereby motivating them to engage in WCIL activities. In order to help students develop awareness and habits of participating and collaborating with others, and eventually enhance awareness of being part of the group in learning, the teacher required students to post content on the group weblog or to comment on other members' postings at least once a week. This has gradually built up students' interest in learning.

Inter-group competition was also used to motivate students. The teacher arranged to put the weblog addresses of all groups onto a single web page so that all group weblogs were visible to everybody. Additionally, he selected one or two weblogs that had been doing well in the past two weeks and recommended them to the students with the hope that this would facilitate mutual learning between groups and progress of each group's WCIL, by using the inter-group competition.

Advice on collaborative learning

Responding to the lack of collaborative skills among the students, the teacher collected and sent through email and the weblogs some collaborative learning advice thought to be helpful for students in overcoming the problems they encountered in WCIL. Advice on various collaborative skills was included. For instance, how to distribute job duties among group members, how to communicate and show respect to other group members, how to meet deadlines, and how to offer help to other group members.

Inquiry learning

In response to problems related to inquiry learning, we developed two strategies. The first was scaffolding for an inquiry-learning project. The second strategy was case analysis of typical WCIL projects.

Scaffolding for the students' inquiry-learning project

Scaffolding is a strategy extensively used in inquiry learning to release the cognitive load and navigate students' learning in complex domains (Cindy, Duncan, & Clark, 2007; White, Shimoda, & Frederiksen, 1999). In response to the need to improve students' inquiry-learning skills, the teacher offered the students the structure of an inquiry-learning report, through which we hoped to assist the inquiry-learning process and the composition of their reports.

A step-by-step guide was sent to all groups so that they knew what to do in the given time frame to complete the learning tasks. These were as follows:

(Step 1) Identify the inquiry topic. Provide students techniques for brainstorming as well as divergent and convergent thinking.

(Step 2) Present background information and related key concepts. Show students how to present background and related concepts and why such information and concepts are important in a project.

(Step 3) Set the inquiry purpose. Let students become familiar with the direction of their work and the way to achieve their purpose.

(Step 4) Formulate focus questions for the inquiry project. Drive students to think of concrete questions to be answered in order to help them determine appropriate data collection methods.

(Step 5) Establish a hypothesis (if applicable). Push students to translate their focus questions into inquiry questions that are answerable by means of statistics. This in turn will help them fine-tune their focus questions.

(Step 6) Establish an action plan for inquiry work. Offer some time-management and collaborative advice to assist students in planning their work and push them to assign duties among group members at an early stage of WCIL.

(Step 7) Reflect upon their work. Throw the students some questions to make them think of ways of better completing their learning tasks in the future.

Case analysis

Inquiry-learning experiences and skills are a barrier for WCIL and, therefore, we employed case analysis to develop students' inquiry-learning abilities. Some typical inquiry-learning cases were collected and placed on the WCIL Web page for students' reference. For instance, a link to the Inquiry Study Award Scheme (a competition organized by Hong Kong Education City), which included many outstanding digital multimedia inquiry reports, was embedded in the WCIL Web page to offer students more ideas on and insights into conducting an inquiry project. Teacher also analyzed some of these cases together with students in class. Additionally, more detailed scaffolding was provided to support inquiry learning, such as templates for inquiry plans and digital inquiry reports and guidelines or tools that could be used to choose an inquiry method.

We expected this measure to provide students with more references and experience in doing inquiry-learning projects.

Digital Literacy

Problems with respect to DL, mentioned by the group leaders in the published case study included [1] inaccuracy in collecting information and [2] difficulty in collating, analyzing collected inquiry materials, and synthesizing useful information into a well-organized inquiry report. Two strategies were introduced to address these problems, viz. [1] the Big6 strategy; and [2] support and practice in data analysis for students.

The use of Big6 skills

"The Big6 is an information problem-solving process and a set of skills which provide a strategy for effectively and efficiently meeting information needs" (Eisenberg, Johnson, & Berkowitz, 2010, p. 27). Since collecting digital multimedia information and creating multimedia expressions are very important to WCIL and DL development of students, the teacher used the Big6 model to guide inquiry information collection, analysis and synthesizing in WCIL. The steps in this model

include task definition, information-seeking strategies, location and access, use of information, synthesis and evaluation (Eisenberg, Berkowitz, Darrow, & Spitzer, 2000). It is believed that only through application can students understand the properties of different media formats in expressing different types of information and in planning and creating digital multimedia expressions in WCIL.

Support and practice in data analysis for students

The data analysis part of WCIL not only reflects the students' DL levels, but also demonstrates some higher level thinking skills, such as critical thinking and logical induction and deduction. Thus, introducing common data analysis approaches, tools and more practice in these areas would be advantageous for implementing WCIL. To further cope with the problem of student's inexperience in handling data, the teacher put together materials related to data analysis that the students could easily refer to on a WCIL Web page specially constructed to support students. The teacher also offered tutorials and exercises in data analysis on this page so that students could study the materials and simultaneously practice with them.

Method

This study aims to gain a clearer picture of how to facilitate implementation of WCIL activities for students' DL development. Hence the same WCIL activities as in the previous case study (Fu & Pow, 2011) were carried out again in this study. The measures mentioned above were implemented to see whether they were effective for facilitating students' DL development.

We collected data mainly through focus-group interviews with group leaders, using their group weblog postings as an important supplementary data source. We chose group leaders as interviewers because they were the ones who knew all the details of the group work – from initial task assignments to final report writing. Hence we expected that they could better describe and explain the real situation of their group learning. The interview was intended to see whether any improvement occurred in the implementation of WCIL activities which, in turn, facilitated students' DL development. Ten group leaders were randomly divided into two groups (five leaders in each group) and focus-group interviews were conducted in each group to further explore their views concerning the differences between this round of WCIL and the round before. All interviews were recorded and transcribed into text. ATLAS.ti was used to analyze the transcripts. By reviewing the interview transcriptions, a range of themes were generated, under which all the codes were made. The codes of interview transcriptions were produced according to themes such as "Improvement in digital literacy" and "Improvement in WCIL". After all the codes were identified under these themes, codes under each theme were grouped into sub-themes to present concrete details of the theme. All codes were named after the group leader who revealed the content of the code. For example, if a code was from the discourse of the leader of Group 6, it was named as GL6.

Results

Improvement in Digital Literacy

We categorized interview transcriptions into four themes, namely, [1] the ability to access, evaluate, analyze, and synthesize multimedia digital texts; [2] the ability to create multimedia expressions; [3] the ability to communicate online; and [4] the awareness, attitude, and ability to use digital technology appropriately.

Ability to access, evaluate, analyze, and synthesize multimedia digital texts

We used 18 codes to indicate improvement in students' DL, illustrating the contribution of WCIL in fostering students' abilities in this theme. Eventually we grouped these codes into six categories, as given below.

First, any improvement in accuracy of information collection was compared with the previous case study; in other words, whether they were able to collect information better.

> *GL6: "Last time, we often found it difficult to collect useful information on our inquiry topic, or sometimes we found wrong information or collected some information that we later found was not that useful, but this time things were better."*
>
> *GL10: "This time we were able to choose materials closely related to the inquiry topic. Our ability in this respect was improved."*

Second, students became aware of features of different search engines when collecting information.

> *GL7: "There are different search engines with different features available. With them, we were able to find lots of different materials. The materials we collected were sufficient."*

Third, students' awareness of and ability to evaluate information improved. The students reported they were now more experienced in evaluating information and began screening content before posting it.

> *GL1: "We would screen, one by one, all the pieces of information collected."*
>
> *GL4: "We got more experience in evaluating information. For example, we tried to cross-check the information collected with other Web sites."*

Fourth, the students came to realize the importance and complexity of analyzing information. In the earlier case study, students took the work of collecting and analyzing information as a whole, but in this study they regarded information analysis as a separate task and a complex job for inquiry learning.

> *GL8: "This time, I found that collecting and analyzing information are two different things. We can now tell what these two tasks are, that is, we know more clearly the difference between information collection and information analysis."*
>
> *GL8: "It won't cost you too much effort to collect abundant information, but you have to consider many things when you analyze it, and do lots of things to draw the conclusions, so I felt we have made progress in this respect."*

Fifth, the students were more experienced in processing and synthesizing collected inquiry materials. They reported that they were better able to extract useful information from collected materials and organize it into a unified report.

> *GL3: "We've learned how to synthesize information of many different aspects into one report, that is, the ability to synthesize."*
>
> *GL7: "We've learnt how to process a large amount of resources."*
>
> *GL3: "We now understand how to better organize the results of our inquiry learning."*

Like the reports students wrote, inquiries posted on group weblogs were also more integrated and cohesive with respect to content, illustrating the students' ability to learn processing and synthesizing of inquiry materials.

Finally, students' awareness of information management improved. Instead of posting collected inquiry materials haphazardly, they screened the material and uploaded useful information in a better organized manner.

> *GL1: "We often organize the resources we collected first, and then upload these resources to our group weblog in batch mode."*
>
> *GL4: "After our discussion, we upload the screened resources to our group weblog. By doing this, we can put our uploaded materials in good order, and make them easy to read."*

Ability to create multimedia expressions

In this theme, student improvement embodied three aspects. First, progress in awareness and ability of students to choose expressive modes (video, audio, picture, or text) and use of multimedia were shown. In this round of WCIL students demonstrated stronger awareness of multimedia materials and were found more competent in choosing appropriate expressive mode according to the content and properties of information.

> *GL4: "It is improper for the foul language of trendy expressions to appear in videos. So we have to be very careful in editing our videos."*
>
> *GL9: "We recorded a sound clip, but because of technical problems, we didn't put it into our group weblog."*
>
> *GL3: "We thought about using video at the beginning, but the owner of the rights did not want to reveal her identity. So we could only record the sound instead."*
>
> *GL7: "Because multimedia was recommended by our teacher this time, we tried to use different media in our inquiry report. Therefore, our ability and experience in multimedia expression improved."*
>
> *GL8: "Our ability to take photos has developed."*

Second, the students' identification with multimedia expression was strengthened by its convenience and effectiveness.

> *GL8: "Doing inquiry learning with the computer is much more convenient and the expressive modes available are more diversified and flexible. It's better than before."*
>
> *GL7: "I think making an inquiry-learning report with the computer is more convenient than doing it manually [in paper form]."*

Third, the students' practical skills and experiences in using weblogs and creating digital multimedia expressions were enhanced. They were now able to develop their weblogs and better organize their postings, and made their weblogs look nicer. This demonstrated an improvement in their digital skills.

> *GL5: "I've learned how to create and put materials on a weblog, meaning that I've learned to construct our group's weblog and make it look tidy."*
>
> *GL4: "When we posted things onto our weblog in the beginning, it looked really disordered. We needed some skills to make it tidy. As a result, we started to learn these skills."*
>
> *GL3: "Now, we can make our weblog more beautiful, that is, visually pleasing."*
>
> *GL7: "We used more videos in the inquiry report this time. Our ability and experience in multimedia expression has increased. And multimedia can also make our reports more attractive, because young people nowadays like to watch videos."*

Ability in online communication

Since the participants in this study were all digital natives (Prensky, 2001) and were already used to communicating via digital tools and technology, they did not demonstrate significant changes in their skills and attitudes when communicating online. Still, some students reported that they did not like giving feedback in weblogs for the purpose of discussion because these were asynchronous. Instead of being a tool for discussion, for them weblogs were more suitable for presenting inquiry materials. On the other hand, the students did become more dependent on instant messaging, such as with Windows Live Messenger, to discuss their WCIL tasks, since it was synchronous and more efficient in organizing a whole-group discussion.

The awareness, attitude, and ability to use digital technology appropriately

First, WCIL developed the students' ability to use digital technology flexibly according to their needs and the properties of the technology. For example, they were now capable of choosing the right tools.

> *GL1: "The weblog is not for discussion. We often discuss our inquiry project on Live Messenger, since it is easy to see if your group members are online. If they are all online, we can start our discussion."*

> *GL1: "Usually, we do not go to our group weblog deliberately to see if there are any updates or feedback. But when we are discussing our inquiry project on Live Messenger, we log onto the weblog, because we can update, revise and improve our group weblog at the same time."*

To cross-check this assertion, we compared the proportion of weblog postings receiving feedback with those in the case study and found that it had decreased from 26% to 14.5%. This showed that the students were becoming wiser in choosing the appropriate digital technologies that best suit their needs.

Second, the students became more aware of their own responsibility for Web postings. Some even claimed that they would check the content for appropriateness before posting.

> *GL4: "They [the other group members] think I just directly post the information they have sent to me in our group weblog. Actually, this is not the case. Everything posted in our group weblog is carefully screened by me. Only relevant inquiry materials are posted on our group weblog."*

Third, the students' confidence in controlling themselves while using the Internet was strengthened.

> *GL1, 7, 8 (in similar wording): "When I am using digital technologies to finish my learning tasks or solving problems in my life, I think I am not distracted by other undesirable things on the Internet."*

Improvement in WCIL

Besides the improvement in the students' DL development, the adopted measures also helped improve their inquiry-learning skills. It was evident that their WCIL skills also improved after the teacher applied the aforementioned strategies. The groundedness of the code "Improvements in inquiry-learning ability" was 22. These improvements included [1] familiarity with the procedure for inquiry-learning projects; [2] higher proficiency in setting the inquiry scope and identifying appropriate inquiry topics – it was obvious from the second focus-group interview that these topics were more concrete and focused than in the previous case study (Fu & Pow, 2011); [3] better

capability in employing an appropriate inquiry approach; [4] employment of better inquiry tools, such as the design of a questionnaire or interview questions, and the like; [5] better inquiry skills, such as interview skills or the making of comparisons and observations to investigate inquiry topics from different perspectives; and [6] higher proficiency in drawing, clarifying, and organizing conclusions. What follows are some typical codes:

> *GL2, 3, 7 (in similar wording): "We now know what WCIL means, and what we should do for a WCIL project."*
>
> *GL7: "We know now that we should consider more topics before we locate our inquiry topics, and should choose one from among them. Then we should try to narrow the chosen topics and generate a reasonable inquiry topic."*
>
> *GL3: "We now know how to make our inquiry report clearer and well-organized."*
>
> *GL3, 4, 7 (in similar wording): "We got experience in choosing topics, doing interviews and surveys, and so forth."*

Implications

Digital Literacy Education

Although activity-based approaches have been widely been accepted in the literacy field and extensively used in both media and information literacy education, the destination of these learning activities remains to be further analyzed. What are the best strategies for implementing these activities? Since the connotations of different types of literacy are closely related to social context, this question can be answered only by more qualitative case studies and teaching practices. This study instead summarizes the common features of DL learning activities as a reference for designing learning activities of this nature. Through two rounds of WCIL, our study identified major problems in implementing WCIL activities and generated corresponding measures to cope with these problems. Although restricted to the secondary school level, the study's findings may still have important implications for designing and implementing DL and other literacy-learning activities.

Collaborative Inquiry Learning

In the digital age, restraints on traditional collaborative inquiry learning, as embodied in technologies for communicating with others, collecting and sharing information, analyzing data and presenting results can easily be overcome. Collaborative inquiry-learning activities in a digital environment (especially the Web 2.0 environment) can increase student efficiency in inquiry learning as well as heighten motivation for collaborative inquiry learning and DL. The results of the present study serve to some degree as evidence for this tantalizing vision, as well as a valuable case study providing references and implications for future collaborative inquiry learning in different curricula with the purpose of developing DL.

Integrating Digital Literacy into Other Curricula

Because inquiry learning is now widely applied in different educational settings, and since sufficient resources are now available on the Internet for almost any curriculum, WCIL can be used as an applicable model for teachers in other curricula to integrate DL into their teaching, improving teaching performance at the same time. Although the inquiry topics in this study did not belong to any specific discipline, the findings still have a certain reference value for teachers wanting to integrate DL education into their courses.

Conclusion

In accordance with the problems and difficulties identified in the previous case study of WCIL, this paper formulated a series of measures to improve the implementation of a new round of WCIL and to further exploit the potential of WCIL in developing students' DL. Although natural development is an unavoidable element in the progress students made in the new round of WCIL, the results of this study still indicate that the measures we have taken in this study were effective to a large extent. To summarize these seemingly scattered measures into a more reasonable and understandable way, which may be more useful as a reference for teachers planning and implementing similar instructional activities, we have formulated the following strategy model (Figure 1) to sum up the measures we've taken to support the implementation of WCIL for fostering DL among secondary school students.

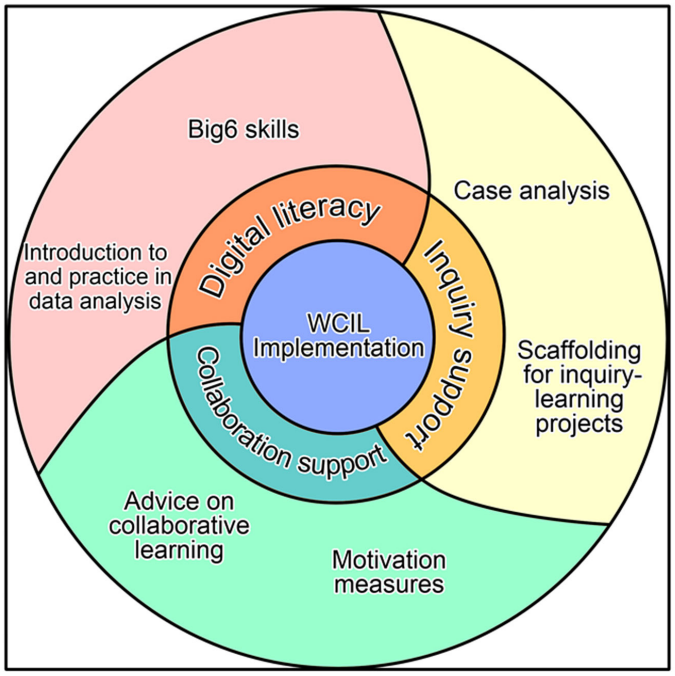

Figure 1: Support strategy model for supporting WCIL implementation

The support strategy model presents a visual representation of all strategies and elements that teachers need to consider when implementing WCIL for DL development. "WCIL implementation" serves as the core of this model. The second circle from the inside shows the three strategies that are important for implementing WCIL and the three directions to consider for doing so effectively. The outer circle shows concrete strategies and measures that should be considered or adopted when dealing with problems encountered during WCIL. For its effective implementation, all elements in the outer circle should be used to support student DL development, inquiry learning, and group collaboration. Our expectation is that the model can facilitate teachers' planning and implementation of WCIL activities for fostering students' DL. The thing that needs to be noted is that this model is only a summary of a series of measures which are verified by an individual study; it still needs to be developed and verified by other studies.

The findings of this study may apply only to students at junior secondary levels, and so further research is needed to explore the possibilities of transferring them to DL education of other types and phases. Moreover, since DL is a broad concept that is constantly evolving, its fostering is a long and continuous process, consisting of developing not only knowledge and skills, but also

appropriate awareness and higher level thinking skills. Therefore, incorporating WCIL into the education process of other disciplines and courses is a reasonable direction for DL development. Although the question of how best to effectively integrate DL education into the curriculum may need further research, educators should always keep the key purpose of DL in mind: DL is not just for grasping certain knowledge and skills, but also for helping students develop their ability to survive and develop in this digital society. Most importantly, DL develops students' abilities to employ these digital technologies for generating constructive social practices.

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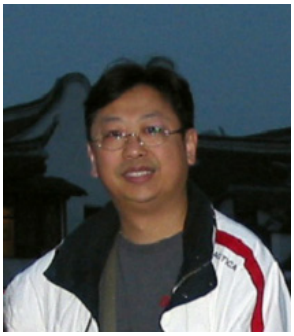

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