# Digital Classrooms for Developing Subject Knowledge, Information Literacy and Twenty-first Century Skills

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**Abstract:** A study was conducted for creating digital classrooms to support students to learn subject knowledge and develop information literacy competency as well as critical thinking skills. A total of 144 students in four Secondary 1 classes in a secondary school in Hong Kong were invited to participate in the study. In the 12 trial lessons, every three students shared a Tablet PC for learning the topic "Air Pollution Problems in Hong Kong" in the Integrated Humanities subject. After the trial teaching, the students and teachers were interviewed about their perception of the support from the designed digital classrooms. The study found that the students and teachers positively perceived the support from the designed digital classrooms on developing subject knowledge, information literacy competency and critical thinking skills. Three recommendations are made for enhancing the pedagogical designs in digital classrooms that emphasize the use of mobile technology.

**Keywords:** Critical thinking skills, information literacy, Integrated Humanities, digital classroom, secondary school

## 1. Introduction

School education in the twenty-first century is expected to equip students with both subject knowledge and the twenty-first century skills in order to meet the requirements of a vigorously changing society [1]. Information literacy and critical thinking skills are two important parts of the twenty-first century skills [1, 2]. Information literacy (IL) refers to the mastery of necessary knowledge of gathering, synthesizing, analyzing, interpreting and evaluating information; and the proper attitudes for information processing with an understanding of the rationale behind using information [3]. Critical thinking skills are the capabilities to think reflectively and judge skillfully, so as to decide what information is reliable and what actions should be taken during reasoning and problem-solving [1, 4].

Future classrooms in the twenty-first century are digital classrooms wherein students have many chances to use digital technology to access digital resources that contain information in digital form for learning subject content [5]. Inside the digital classrooms supported by mobile technology, students use mobile devices that are wirelessly interconnected for completing learning tasks, especially accessing additional learning information from sources other than textbooks [6, 7]. For the successful learning in digital classrooms, students need to apply IL competency and critical thinking skills in daily subject learning [1, 2], in order to properly process information from different sources and then critically assimilate information for subject learning. In this regard, special pedagogical designs with appropriate learning tasks should be made for students to develop subject knowledge, IL competency and critical thinking skills in digital classrooms [1, 7].

For the effective development of subject knowledge in class, the class activities should be designed to progressively promote students' active learning, constructive learning and interactive learning [8]. In this regard, teachers should arrange class activities that engage students in the processes of resource access, knowledge construction and peer interaction. Examples of those class activities include information search, mind map drawing, and group discussion.

For the effective development of IL competency in class, there are three ways potential to prepare students to skillfully process learning information [2]. In way (i), teachers integrate IL elements into class activities, such as asking students to search information for completing learning tasks. In way (ii), teachers lead students to discuss IL elements involved in learning tasks after class activities. In way (iii), teachers guide students to discover IL elements tacit in learning tasks.

For the effective development of critical thinking skills in class, there are four ways potential to prepare students to critically solve learning problems [1]. In way (i), teachers give students sufficient time to think about the problem-solving questions. In way (ii), teachers give students sufficient time to discuss the problem-solving questions with group members. In way (iii), teachers guide different groups of students to make sharing with the whole class. In way (iv), teachers explain the answers for the problem-solving questions and then guide students to make reflection. The study reported in this paper created digital classrooms to support students to learn subject knowledge and develop IL competency as well as critical thinking skills. The class activities in the study were designed in line with the suggestions from [1], [2] and [8] as above.

## 2. The Study

This paper reports an initial experience from a study in Hong Kong that created digital classrooms to support students to learn Integrated Humanities (IH) knowledge and develop IL competency as well as critical thinking skills. By purposeful sampling, a total of 144 students from four Secondary 1 classes in a secondary school in Hong Kong were invited to participate in the study. Table 1 shows the profile of students participated in the study.

*Table 1: Profile of students participated in the study*

| | **Class A** | **Class B** | **Class C** | **Class D** |
|---|---|---|---|---|
| Number of students | 36 | 36 | 36 | 36 |
| Ratio of boys to girls | 8:28 | 10:26 | 20:16 | 18:18 |
| Mean age in years | 12.6 | 12.3 | 13.1 | 13.2 |

A trial teaching on the topic "Air Pollution Problems in Hong Kong" in the IH subject was conducted for each participating class. The trial teaching amounts 960 minutes, with 12 lessons of each lasted for 80 minutes. The two IH teachers of the four participating classes were responsible for the trial teaching. The years of teaching experience for the teacher of Class A and Class B was seven; while for the teacher of Class C and Class D was 13.

The students in each participating class were divided into groups of three for class activities. In a typical trial lesson, each group of students mainly used the Tablet PC provided for completing worksheets specially designed for the trial teaching. These worksheets aimed to lead students to properly process information from different sources and critically assimilate information on target topic in class. The students were first asked to answer worksheet questions by referring to the paper-based textbook and the selected e-learning resources on the school-based e-learning platform. The students then discussed worksheet questions with their group members. In the discussion activities, the students

needed to apply critical thinking skills such as identifying keywords in the worksheet questions for problem-solving, and to apply IL competency such as searching information from reliable websites. After the discussion activities, the students were guided by their teachers to present and discuss their works with the whole class. In the trial teaching, the teachers integrated the three ways suggested by [2] and the four ways suggested by [1] for developing students' IL competency and critical thinking skills, respectively. The study focused on two research questions:

(1) How do the students perceive the support from the designed digital classrooms on developing IH knowledge, IL competency and critical thinking skills?
(2) How do the teachers perceive the support from the designed digital classrooms on developing IH knowledge, IL competency and critical thinking skills?

## 3. Methods

Semi-structured interviews were conducted with the students and teachers participating in the study for investigating their perception of the support from the designed digital classrooms on developing IH knowledge, IL competency and critical thinking skills. Two groups of students were randomly selected from the four participating classes for two group interviews. The two teachers participating in the study were invited for two individual interviews. The semi-structured interviews focused on three aspects, namely the school-based approach of developing IH knowledge in class; the three suggested ways of developing IL competency in class; and the four suggested ways of developing critical thinking skills in class. The invited students and teachers were asked about their experiences, comments and expectations of learning and teaching in the designed digital classrooms.

## 4. Results and Discussion

In general, the students and teachers perceived that the designed digital classrooms could support the development of IH knowledge, IL competency and critical thinking skills.

*Table 2: Major interview feedback on the development of IH knowledge in the trial lessons*

| | **Major interview feedback** |
|---|---|
| Experiences | • The students and teachers indicated that the school-based e-learning platform was used in class to support the convenient access to additional resources and easy drawing of mind maps.<br>• The students pointed out that the trial teaching emphasized much on the use of mobile devices and e-learning resources, but less on the use of school-based textbook.<br>• The teachers reflected that they were unable to give their students sufficient time and guidance to interpret the key contents of the additional resources within class time. |
| Comments | • The students and teachers agreed that the use of additional resources and the drawing of mind maps were effective for supporting concept building and knowledge consolidation.<br>• The students indicated that after trial teaching they were able to link the knowledge learned to other topics of the same subject, such as economic development and ecology system.<br>• The teachers suggested that the additional resources selected should match students' learning stage, avoid lengthy and complicated documents that students cannot fully comprehend. |

Table 2 shows the major interview feedback from students and teachers on the development of IH knowledge in the trial lessons. The results showed that the teachers were able to implement the school-based approach of developing IH knowledge in trial lessons,

with a focus on class activities of accessing e-learning resources and drawing mind maps for subject learning. The students and teachers valued the many chances to access update learning information and exchange subject knowledge in the class activities, which promoted students to better understand the target topic and link knowledge among different topics in the target subject. The students and teachers expected for the use of more additional e-learning resources that match the level and need of students in learning within class and after school.

*Table 3: Major interview feedback on the development of IL competency in the trial lessons*

| | **Major interview feedback** |
|---|---|
| Experiences | • The students and teachers indicated that all the three suggested ways were adopted in class, with way (ii) was adopted most frequently; way (i) followed; and then way (iii).<br>• The students were impressed that the teachers often adopted way (ii) to lead the whole class to discuss effective ways of information search after completing every group task.<br>• The teachers reflected that they did not have sufficient time to adopt way (iii) to guide students to discover IL elements tacit in the worksheets questions. |
| Comments | • The students and teachers thought that way (ii) was most effective for supporting junior secondary students to develop IL competency, with way (i) the second and way (iii) the least.<br>• The students indicated that after trial teaching they often tended to search and compare information from various reliable websites for judging the suitability of target information.<br>• The teachers suggested that junior secondary students should be provided with more guidance on the rationale behind IL. |

Table 3 shows the major interview feedback from students and teachers on the development of IL competency in the trial lessons. The results showed that all the three suggested ways for developing IL competency were implemented in trial lessons, with different levels of frequency and effectiveness. The way of teacher-led discussions about IL elements after learning tasks was most frequently implemented and regarded as the most effective way to support junior secondary students to develop IL competency in class. The students and teachers generally perceived that these three suggested ways made students become more aware of the necessary knowledge and proper attitudes for processing information. The teachers hoped to provide more guidance for junior secondary students to explore and reflect on the IL elements tacit in the process of learning tasks in class.

*Table 4: Major interview feedback on the development of critical thinking skills in trial lessons*

| | **Major interview feedback** |
|---|---|
| Experiences | • The students and teachers indicated that way (i) and way (iii) were adopted in almost every lesson; while way (ii) and way (iv) were often omitted because of time limit.<br>• The students were impressed that the teachers often adopted way (iii) and provided special hints for question interpretation, as well as award incentives to peer discussions in class.<br>• The teachers reflected that their students lacked sufficient time for discussions in problem-solving tasks, and lacked sufficient guidance in thinking exercises. |
| Comments | • The students and teachers thought that way (iii), which emphasized sharing and discussion among students, was very helpful for the development of critical thinking skills.<br>• The students and teachers indicated that the trial teaching gradually promoted skills in critical thinking, such as distinguishing keywords “relieve” and “resolve” for problem-solving.<br>• The students and teachers expected for the provision of clear guidelines and sufficient time for group discussion in class in future. |

Table 4 shows the major interview feedback from students and teachers on the development of critical thinking skills in the trial lessons. The results showed that all the four suggested ways for developing critical thinking skills were implemented in trial lessons, with different levels of frequency and effectiveness. The way of teacher-guided sharing and

discussion among students was most frequently implemented and regarded as the most effective way to support junior secondary students to develop critical thinking skills in class. The students and teachers generally perceived that these four ways made students become more aware of the process and skills in critical thinking, such as distinguishing different keywords “relieve” and “resolve” for problem-solving. The students and teachers expected for more time and guidance for the whole class to discuss and reflect on the process and products of critical thinking in subject lessons.

## 5. Conclusion

The study found that students and teachers in general positively perceived the support of the designed digital classrooms on facilitating the learning of IH knowledge and the development of IL competency as well as critical thinking skills. Based on the results of the study, three recommendations are made for the future development of digital classrooms using mobile technology in school education. First, the teachers in the interviews made a reflection that there was insufficient time for students’ discussions in trial lessons. Teachers are therefore recommended to increase time for interactive learning in digital classrooms. Second, the teachers in the interviews made a reflection that they did not make sufficient guidance in the use of e-learning platform for promoting students to develop IL competency and critical thinking skills. Teachers are therefore recommended to increase the use of e-learning platform and enhance their work on guiding students to develop IL competency and critical thinking skills before and after class time. Third, the teachers were observed to have difference in the mastery of pedagogies for promoting students to develop IL competency and critical thinking skills. Schools are therefore recommended to provide support of teacher professional development related to digital classrooms, so as to prepare teachers for the teaching work in the twenty-first century.

The second round of the study is conducting to collect quantitative data on the achievement and perception of students in learning the target topic in the designed digital classrooms. More results related to the impact of mobile technology supported classrooms on formal subject learning will be further reported.

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