

## THE DEVELOPMENT OF AN ASSIGNMENT CODING GUIDE FOR EVALUATING ICT-USAGE IN A 21<sup>ST</sup> CENTURY PRIMARY SCHOOL IN HONG KONG

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**Abstract:** *This paper describes the development of a coding guide that was used to evaluate the use of information and communications technologies (ICT) in student assignments. Instrument design and pilot-testing was conducted in a Hong Kong Chinese primary government-subsidised school (I-School) with a school-based e-learning project. The design of the assignment coding guide was drawn from a lesson observation guide (Tam, Chan, Li, & Pow, 2014) that was developed for this e-learning project with reference to the Research Coding Guide for Student Work (2011). The research team developed the coding guide in recognition that it is important to examine not only 21<sup>st</sup> century skills, but also how teachers make use of ICT in their assignment design to enhance teaching and learning, as well as how the assignments provide opportunities for students to practice their ICT skills. The coding guide that was developed contains 14 items that measure ICT integration into assignments. These items relate to the following broad categories: (a) Student Learning Outcomes, (b) Learning and Teaching through Assignment, (c) ICT Use, and (d) ICT Enhanced Learning and Teaching. Rating was based on sample scripts of all written assignments (both paper-based and digital) in one learning unit assessed with different levels of academic performance (high, middle and low). Thirty-six sets of assignments from three major academic subjects of Chinese, English, and Mathematics between Primary Two (P2) and Primary Five (P5) were collected in the same primary school from September 2012 to December 2014. In this period, which spanned four continuous semesters, researchers discovered that the assignments developed from paper-based dominant assignments to paper-and-ICT-balanced assignments as students were required to post their assignments through the online platform (Microsoft SharePoint). Moreover, teachers provided more chances to allow students to implement their ICT skills and creativity, such as through student assignments, which transformed from simply attaching a student's drawing to attaching a relevant picture from the Internet.*

**Key words:** e-learning, information and communication technologies, teaching and learning

### Introduction

Over the last decade in Hong Kong, e-learning has been promoted at different levels. In an effort to enhance students' learning, a variety of information and communication technologies (ICT) have been incorporated into the design of student assignments. The introduction of ICT into assignments not only helps consolidate learning, deepen understanding and construct knowledge, but it helps teachers deliver interactive assignments that enhance students' learning experiences. Moreover it allows students to practice their 21<sup>st</sup> century skills when doing their homework assignments.

In 2011, the Education Bureau in Hong Kong announced that 21 projects had been selected to participate in the *Pilot Scheme on e-Learning in Schools*. Sixty-one schools involved in these projects received one-off funding to implement ICT into teaching and learning activities. Through the pilot scheme, schools in Hong Kong implemented ICT in order to enhance teaching and learning. For example, schools provided students with chances to take photos with digital devices and insert the photos into their writing compositions, assigned students to carry out self-and peer-evaluation tasks through an online platform, and allowed teachers to keep

track of the students' learning performance in an online platform (Cheung et al., 2014; Yuen, Lee, & Law, 2014). To maintain and improve the sustainability of ICT implementation in Hong Kong schools, the Education Bureau in Hong Kong proposed two actions, which it outlined in the consultation document for the Fourth Strategy on IT in Education (2014): "Enhancing the quality of e-learning resources" and "Renewing curriculum, transforming pedagogical and assessment practices."

I-School, a Hong Kong Chinese primary government-subsidised school founded in the early 1930s, was one of the schools that received funding to enhance its ICT implementation. In 2008, I-School piloted their school-based e-learning project for Primary Two (P2) classes. Prior to this time, the school did not use ICT in teaching and learning. Over the last 6 years, school administrators have built an IT-infrastructure and have revised the curriculum for ICT implementation which has made I-School one of the e-learning pioneers in Hong Kong.

In order to ensure the successful implementation of the e-learning project, school administrators clearly explained the scheme to parents who were interested in sending their child to I-School. Newly recruited teachers were also required to have basic ICT skills and be inducted into the e-learning project. In general, most of the stakeholders in I-School supported the project and the school received very little resistance in the process.

Through its involvement with the pilot scheme, I-School received funding to enhance its ICT implementation. The school also invited a research team to conduct a comprehensive evaluation of ICT implementation in the school. The research team evaluated ICT implementation from different dimensions, including assignment analysis. At the end of the evaluation, the

research team proposed a number of actions to enhance I-School's ICT implementation, all of which were related to the two actions proposed by the Education Bureau's consultation document for the Fourth Strategy on IT in Education. The assignment coding guide that was developed proved useful for evaluating ICT-usage in Hong Kong primary school assignments. This guide could also potentially help evaluate ICT-usage in primary school assignments in different country settings.

### **Assignment Analysis**

Assignments are important components of the learning process. As learning-related tasks that teachers give to their students to complete during and after class, assignments help students (a) understand the learning objectives, (b) understand their strengths and weaknesses in learning, and (c) identify their learning needs (Curriculum Development Council, 2014). Assignment analysis provides a valuable opportunity to evaluate how teachers make use of assignments to consolidate learning, deepen understanding, and construct knowledge for students. Research shows some positive correlation between student completion of assignments and student achievement (Rønning, 2011; Trautwein, Koller, Schmitz, & Baumert, 2002). Compared with paper-and-pencil assignments, students could learn even more with ICT-facilitated assignments when immediate feedback is given (Mendicino, Razzaq, & Heffernan, 2009). Analyses of ICT-facilitated assignments not only explore how assignments help students to learn, but also evaluate how teachers can make use of ICT to provide a better learning experience for their students.

The aim of this paper is to describe and examine a coding guide that was developed to evaluate how well ICT was implemented into student assignments in order to

enhance students' learning in I-School. We suggest that this assignment coding guide could provide a foundation for researchers and teachers who wish to evaluate ICT use in primary school assignments, an exploration that has rarely been explored in existing research.

### **Development of the Assignment Coding Guide**

The research team included three university academic staff members and one research officer, all with expertise in education and/or information technology, as well as three teachers from I-School.

Both the lesson observation guide (Tam et al., 2014) that was developed for this e-learning project, as well as the *Research Coding Guide for Student Work* (Innovative Teaching and Learning Research, 2011) that was developed by the Bill and Melinda Gates Foundation's Teacher Assignment/Student Work Project informed the design of the assignment coding guide. On top of the 21<sup>st</sup> century skills that were highlighted in the guide, the research team identified that it was also important to examine how teachers made use of ICT in assignment design to enhance students' learning. In all, the assignment coding guide developed in this project measured whether students could act as active learners in their learning, as well as how ICT could enhance assignment design.

The research team piloted a draft coding guide based on two assignment sets from I-School (P2 math and P3 Chinese) in the second semester of the academic year (AY) 2011-12 (In Hong Kong, each academic year (AY) includes two semesters: first semester is September until January and second semester is January until July). Four research team members were assigned as the raters. Each rater coded the assignment sets independently by using the draft coding guide. Coding on each item was then shared and discussed in a team meeting where

consensus on the coding guide was reached. The research team modified and clarified some of the items as well as the point descriptors of the rating scale based on the raters' suggestions at the meeting. This process resulted in the completion of the first full version of the coding guide. The final coding on the two pilot cases together with a short explanation on each coding was summarized for future reference. In order to enhance rating reliability, all team members were able to refer to this coding summary throughout the project.

This assignment coding guide was used to code 36 assignment sets that were collected from the second semester of AY 2011-12 to the first semester of AY 2013-14. These assignment sets were selected based on nominations by I-School teachers who identified their respective lessons as exemplars of e-learning. Through observation and analysis of the lessons together with the assignment set of a teaching unit, the research team was able to make a comprehensive evaluation of ICT implementation in I-School. As coding proceeded, the team members also discussed and made minor justifications to the coding items.

### **Structure and Content of the Coding Guide**

The assignment coding guide includes 14 items. Using these items, the research team assessed the assignment design by determining how well ICT was integrated into teaching and learning and what opportunity students had to apply ICT skills. The coding guide begins with an overall introduction and detailed instructions to guide the raters. The guide also requires the raters to list the category of the assignment that was included in the assignment sets.

The 14 items in the coding guide include:

- five items on student learning outcomes: *collaboration, knowledge building, real-world problem-solving &*

- *innovation, creativity, & innovation, and students' use of digitalized media;*
- two items on learning and teaching through assignment category: *self-regulated learning and handling individual differences;*
- three items on ICT use: *use of ICT for learning, use of ICT for designing assignments, and use of interactive ICT components;* and
- four items on ICT enhanced learning and teaching: *ICT use in collaboration, ICT use in real-world problem-solving & innovation, ICT use in students' creativity and innovation, and handling individual differences in ICT-supported learning environments.*

The items in the coding guide are designed for global rating. Rating on each item is based on the highest score achieved by the written assignments (both paper-based and digital) in one learning unit completed by different academic level students (high, middle and low). All items are coded on a 4-point (1 to 4) scale with detailed item-specific descriptors at each point. The coding scale for teaching and learning items is structured as follows:

1. The target behaviour/outcome is not observed in the assignment set.
2. The target behaviour/outcome is minimally observed in the assignment set.
3. The target behaviour/outcome is somewhat observed in the assignment set.
4. The lesson demonstrates optimal manifestation of the target behaviour / outcome in the assignment set.

The coding scale for ICT enhancement items is structured as follows:

1. ICT is not used in the assignment set for the target behaviour/outcome.
2. ICT is used in the assignment set but the target behaviour/outcome can be achieved without the support of ICT.
3. ICT use in the assignment set enhances the target behaviour/outcome.
4. ICT use in the assignment set is

essential for the target behaviour/outcome

One sample coding item and the respective point descriptors are included in Appendix A. Adjustments in ratings are applied based on the grade level of the students.

### **Research Design, Data Collection, and Reliability Issues**

This study used a descriptive research design to evaluate the ICT-usage on students' assignments. In the four consecutive semesters from the second semester of AY 2011-12 to the first semester of AY 2013-14, the research team collected 36 sets of assignments from I-School, with 12 sets collected from each of the 3 major academic subjects of Chinese, English and Mathematics. As shown in Table 1, twelve sets were from P2, twelve sets were from P3, nine sets were from P4, and three sets were from P5. These assignment sets were coded by the same two research team members who used the assignment coding guide developed in this research. Based on the coding results, the research team could evaluate the ICT-usage on students' assignments in I-School.

Each assignment set included the plan of the lesson chosen for observation and nine copies of students' work completed for that particular teaching unit. The research team encouraged teachers to provide all evidence of students' work for accurate coding. Since this study focused on evaluating assignments for selected lessons and teaching units, the research team did not collect cross-academic-subject assignments, project learning assignments, or exercises supplied by external providers. In order to observe how individual differences were handled in assignments, we collected students' work at different levels of academic performance (high, middle, and low) within each set of assignments. The research team took note of the fact that I-School grouped students with similar academic performance in the

same class at each grade level. This streaming arrangement informed lesson design and teaching, as teachers could adjust their teaching based on the overall class ability rather than students' individual

learning needs. Consequently, in this project students' work was collected from different classes and different grade levels in order to include students at different academic ability levels.

Table 1  
*Distribution of Assignment Sets Collected from I-School*

	2 <sup>nd</sup> Sem./ AY 2011-12	1 <sup>st</sup> Sem./ AY 2012-13	2 <sup>nd</sup> Sem./ AY 2012-13	1 <sup>st</sup> Sem./ AY 2013-14
P2	Chinese, English, & Math	Chinese, English, & Math	Chinese, English, & Math	Chinese, English, & Math
P3	Chinese, English, & Math	Chinese, English, & Math	Chinese, English, & Math	Chinese, English, & Math
P4		Chinese, English, & Math	Chinese, English, & Math	Chinese, English, & Math
P5				Chinese, English, & Math
Number of assignment sets	6	9	9	12

To establish inter-rater reliability, all 36 sets of assignments were double-coded by the same two research team members throughout this project. Inter-rater agreement was found to be 90.28% (455 out of 504 item-rating), while 94.23% inter-rater disagreement was found to be within a one-point difference.

### Overview of Collected Assignment Sets

Assignment sets reviewed in this study included student work for both in-class activities and homework assignments. In general, paper-based assignments dominated each assignment set. Paper assignments included individual and group worksheets containing multiple choice, matching, fill-in-the-blanks and short answer questions. ICT-integrated assignments were used in some in-class activities. For example, students were required to answer teachers' questions on Microsoft SharePoint, an online platform developed by Microsoft for file sharing and collaboration. In what follows we provide an overview of the assignment types and

formats that were used within each of the three academic subjects.

For the Chinese language subject, some of the assignment sets incorporated ICT into students' in-class exercises. One of the exemplar assignment sheets required students to work in pairs to construct a metaphor sentence. For example, students were required to select one of the Hong Kong attraction photos prepared by the teacher on Microsoft SharePoint and then insert the photo into the assignment worksheet that matched the sentence they had made. Some of the assignments also required students to submit their sentence-making work through Microsoft SharePoint, and higher-ability students were expected to attach photos to their submission.

The implementation of ICT in the English language subject assignment sets was similar to the implementation of ICT in the Chinese language subjects. Each set of English language assignments contained a number of paper-based worksheets. In some assignment sets, students used a

collaborative worksheet, which required online submission during class through Microsoft SharePoint, although students also needed to submit an individual version after the lesson. Microsoft SharePoint was also used for pre-lesson activities in some lessons, for example, when teachers invited students to vote online before the lesson started and then incorporated the results of the vote into the lesson. Moreover, teachers posted revision questions on SharePoint to evaluate students' learning outcomes.

Mathematics assignment sets also included a number of paper-based worksheets and supplementary exercises. Some of the digital homework assignment sheets included accessible weather-related hyperlinks so that students could retrieve up-to-date weather information and then give answers on the assignment sheets. In an exemplary assignment, teachers provided a chance for students to practice generic skills by drawing a digital greeting card (Microsoft Word document file) as an assignment.

In general, it is observed that although the I-School had made considerable effort to integrate ICT-usage into the lesson and lesson activities, few ICT elements had been integrated into students' assignments. The 36 sets of assignments across the three major academic subjects (Chinese, English and Mathematics) in I-School were mostly paper-based assignments with a similar format. The use of ICT in the assignments

was mostly limited to retrieval and uploading of files and photos.

It was also observed that in paper-based homework assignments, teachers provided suggested words as a hint for lower-ability students to complete their assignments, while higher-ability students were required to answer the questions without any hints. In ICT-integrated homework assignments, photos were provided to lower-ability students to insert into their assignment, while higher-ability students were asked to search and insert a photo from the Internet into their assignments.

### **Assignment Coding Findings**

The coding analysis focused on comparing ratings on the 36 assignment sets across academic subjects and across academic levels. Cronbach's Alpha of the 14 items in the coding guide for these 36 assignment sets was reported to be 0.82.

### **Overall Analysis by Assignment Coding Category**

As shown in Table 2, data drawn from these 36 assignment sets indicated that Student Learning Outcomes items ( $M=2.21$ ,  $SD=0.56$ ) obtained the highest average score and ICT Enhanced Learning and Teaching items ( $M=1.53$ ,  $SD=0.52$ ) obtained the lowest average score across categories.

Table 2  
*Mean Score and Standard Deviation Achieved by the 36 Sets of Assignments*

	Mean	SD
<b>Student Learning Outcomes</b>	<b>2.21</b>	<b>0.56</b>
Collaboration	2.69	1.08
Knowledge building	2.50	0.99
Real-world problem-solving and innovation	2.25	0.92
Creativity and innovation	2.24	1.11
Students' use of digitalized media	1.39	0.49
<b>Learning and Teaching through Assignment</b>	<b>2.00</b>	<b>0.66</b>
Self-regulated learning	1.93	0.68
Handling individual differences	2.07	0.84
<b>ICT Use</b>	<b>1.90</b>	<b>0.54</b>
Use of ICT for learning	2.13	0.75
Use of ICT for designing assignments	1.89	0.52
Use of interactive ICT components	1.69	0.74
<b>ICT Enhanced Learning and Teaching</b>	<b>1.52</b>	<b>0.52</b>
ICT use in collaboration	1.79	0.99
ICT use in real-world problem-solving and innovation	1.60	0.62
ICT use in students' creativity and innovation	1.36	0.83
Handling individual diff. in ICT-supported learning environments	1.36	0.59

For individual items, collaboration ( $M=2.69$ ,  $SD=1.08$ ) and knowledge building ( $M=2.50$ ,  $SD=0.99$ ) obtained higher mean ratings (higher than 2.50), while low mean ratings (less than 1.50) were reported for students' use of digitalized media ( $M=1.39$ ,  $SD=0.49$ ), ICT use in students' creativity and innovation ( $M=1.36$ ,  $SD=0.83$ ), and handling individual differences in *ICT*-supported learning environment ( $M=1.36$ ,  $SD=0.59$ ). The major reason for the relatively high scores on student learning outcomes items is that the assignment sets included students' in-class activity assignments. Because of this, when a teacher performed an in-class activity that allowed collaboration or knowledge building, the rating for the assignment coding would be high. Based on the above scores, it could be concluded that *ICT* could be used to digitalize paper-based assignments, but *ICT* only made slight changes in assignment design and process and in the enhancement of learning and teaching.

### Overall Analysis by Academic Subject

The 36 assignment sets collected from three academic subjects shared similar score profiles on a number of coding categories

(see Table 3). Using a mean rating difference greater than 1 as the threshold, ratings on all *ICT* Use and Enhancement items were found to be similar across academic subjects. Additionally, ratings were reported to be similar across academic subjects on learning and teaching through assignment and student learning outcomes, while the mean score difference obtained on knowledge building was larger than 1 between Chinese language ( $M=1.96$ ,  $SD=0.81$ ) and Mathematics ( $M=3.00$ ,  $SD=0.88$ ).

Subject-specific profiles were observed in relation to learning outcomes and to *ICT* use and enhancement. In regard to subject-based Student Learning Outcomes, Chinese language assignment sets obtained higher rating on creativity and innovation ( $M=2.50$ ,  $SD=0.72$ ), while English assignment sets obtained higher rating on knowledge building ( $M=2.54$ ,  $SD=1.02$ ) compared with other learning outcomes. Moreover, mathematics assignment sets obtained higher scores on knowledge building ( $M=3.00$ ,  $SD=0.88$ ) and real-world problem-solving and innovation ( $M=2.83$ ,  $SD=0.63$ ), which indicated that mathematics assignment sets were useful for developing students' subject

knowledge, problem solving skills, and creativity.

For ICT Use and Enhancement on Learning and Teaching items, mathematics assignment sets obtained higher mean scores in ICT use. Scores on use of ICT for learning (M=2.33, SD=0.76) and use of interactive ICT components (M=2.00, SD=0.72) were higher than Chinese language and English language subjects. For ICT Enhanced Learning and Teaching items, English assignment sets (M=2.17, SD=0.96) obtained higher scores than Chinese (M=1.50, SD=0.98) and Mathematics (M=1.71, SD=0.95) on ICT use in collaboration. However, all three academic subjects obtained low scores in ICT use in real-world problem-solving and innovation and ICT use in students' creativity and innovation.

Based on the average mean scores obtained by the three academic subjects (English, Chinese and Mathematics), the design of the assignments allowed students to

enhance their learning outcomes and provided chances for students to practice their ICT skills. Mathematics assignment sets performed better than other subjects on knowledge building, real-world problem-solving and innovation, creativity and innovation, use of ICT for learning and use of interactive ICT components. These scores reflect the fact that mathematics assignments were able to make connections between subject content and learning outcome. Therefore, students were allowed to demonstrate their subject knowledge, problem solving skills, and creativity when ICT was embedded into the learning and teaching. On the other hand, the mean score differences between academic subjects could be explained by variations in subject content, objective, and teaching method. For instance, Chinese assignments had better performance on students' creativity and innovation by including different presentation methods in the assignments like drawing or inserting a digitalized photo together with a short composition.

Table 3  
*Mean Score and Standard Deviation by Academic Subject*

	Mean (SD)		
	Chinese	English	Mathematics
<b>Student Learning Outcomes</b>	<b>2.11 (0.33)</b>	<b>2.10 (0.62)</b>	<b>2.42 (0.64)</b>
Collaboration	2.75 (1.11)	2.75 (0.99)	2.58 (1.18)
Knowledge building	1.96 (0.81)	2.54 (1.02)	3.00 (0.88)
Real-world problem-solving and innovation	1.91 (0.97)	2.00 (0.83)	2.83 (0.64)
Creativity and innovation	2.50 (0.72)	1.75 (1.03)	1.45 (0.51)
Students' use of digitalized media	1.41 (0.50)	1.45 (0.51)	1.25 (0.44)
<b>Learning and Teaching through Assignment</b>	<b>2.00 (0.64)</b>	<b>2.04 (0.67)</b>	<b>1.95 (0.67)</b>
Self-regulated learning	1.95 (0.75)	2.00 (0.59)	1.83 (0.70)
Handling individual differences	2.04 (0.69)	2.08 (0.97)	2.08 (0.88)
<b>ICT Use</b>	<b>1.89 (0.51)</b>	<b>1.73 (0.61)</b>	<b>2.08 (0.45)</b>
Use of ICT for learning	2.13 (0.68)	1.92 (0.78)	2.33 (0.76)
Use of ICT for designing assignments	1.95 (0.46)	1.79 (0.72)	1.92 (0.28)
Use of interactive ICT components	1.58 (0.65)	1.50 (0.78)	2.00 (0.72)
<b>ICT Enhanced Learning and Teaching</b>	<b>1.51 (0.54)</b>	<b>1.54 (0.52)</b>	<b>2.53 (0.52)</b>
ICT use in collaboration	1.50 (0.98)	2.17 (0.96)	1.71 (0.95)
ICT use in real-world problem-solving and innovation	1.67 (0.64)	1.33 (0.48)	1.79 (0.66)
ICT use in students' creativity and innovation	1.50 (0.88)	1.17 (0.56)	1.41 (0.97)
Handling ind. diff. in ICT-supported learning environments	1.38 (0.49)	1.50 (0.78)	1.20 (0.41)



### Overall Analysis by Grade Level

In the 36 assignment sets collected from I-School, 24 sets were collected from junior primary teaching units (P2 to P3), and 12 sets were collected from senior primary teaching units (P4 to P5) (see Table 4). Using a mean rating difference greater than 1 as the threshold, ratings were reported to be similar across academic level, while senior primary assignment sets performed better than junior primary sets in some specific items.

By comparing student learning outcomes items across academic level, senior primary assignment sets ( $M=2.71$ ,  $SD=1.30$ ) obtained higher scores on creativity and innovation than junior primary assignment sets ( $M=2.00$ ,  $SD=0.92$ ). However, it was observed that teachers more often included tasks that allowed students to illustrate their creativity in senior primary assignment sets. Although both academic levels obtained low scores on students' use of digitalized media (junior,  $M=1.23$ ,  $SD=0.42$  and senior,  $M=1.67$ ,  $SD=0.48$ ), senior primary assignment sets obtained higher scores than junior primary assignment sets as more assignments required students to insert digital resources, i.e. photos, into their assignments.

For ICT Use in the assignment sets, senior primary assignment sets obtained higher scores in use of ICT for learning and use of interactive ICT components than junior primary assignment sets. It was observed in senior primary assignments that a variety of ICT elements had been provided for students, such as Flash and Wikipedia, to

enhance students' motivation to complete their assignments. On the other hand, teachers also required students to insert or modify digital resources as a part of the students' work.

Finally, both junior and senior academic levels obtained low scores on ICT Enhanced Learning and Teaching (junior,  $M=1.47$ ,  $SD=0.54$  and senior,  $M=1.65$ ,  $SD=0.47$ ). However, senior primary assignment sets ( $M=2.00$ ,  $SD=0.93$ ) obtained higher scores on ICT use in collaboration than in junior primary assignment sets ( $M=1.69$ ,  $SD=1.01$ ). This is because I-School taught their students to use online discussions in SharePoint during the second semester of P2. Senior level students were used to working on the online discussion platform after having more than one year of practice; most of the senior students could retrieve material for their collaboration by themselves. Hence, the use of ICT for collaboration did not affect the progress of the lesson, as teachers were more likely to use ICT for students' collaboration.

In all, assignments of both the junior and the senior academic levels showed similar score profiles, while senior primary assignment sets obtained better achievement on creativity and innovation, use of ICT for learning, use of interactive ICT components, and ICT use in collaboration. This finding reflects the fact that senior primary (P4 and P5) students were more mature, which allowed teachers to have a larger variety for ICT implementation into assignment design.

Table 4  
*Mean Score and Standard Deviation by Grade Level*

	Mean (SD)	
	Junior Level (P2 & P3)	Senior Level (P4 & P5)
<b>Student Learning Outcomes</b>	<b>2.12 (0.51)</b>	<b>2.39 (0.63)</b>
Collaboration	2.63 (1.16)	2.83 (0.92)
Knowledge building	2.54 (0.87)	2.42 (1.21)
Real-world problem-solving and innovation	2.21 (0.99)	2.33 (0.76)
Creativity and innovation	2.00 (0.92)	2.71 (1.30)
Students' use of digitalized media	1.23 (0.42)	1.67 (0.48)
<b>Learning and Teaching through Assignment</b>	<b>1.96 (0.71)</b>	<b>2.08 (0.55)</b>
Self-regulated learning	1.88 (0.70)	2.04 (0.92)
Handling individual differences	2.04 (0.62)	2.13 (0.68)
<b>ICT Use</b>	<b>1.86 (0.56)</b>	<b>1.99 (0.50)</b>
Use of ICT for learning	2.02 (0.73)	2.33 (0.76)
Use of ICT for designing assignments	1.79 (0.50)	2.08 (0.50)
Use of interactive ICT components	1.77 (0.69)	1.54 (0.83)
<b>ICT Enhanced Learning and Teaching</b>	<b>1.47 (0.54)</b>	<b>1.65 (0.47)</b>
ICT use in collaboration	1.69 (1.01)	2.00 (0.93)
ICT use in real-world problem-solving and innovation	1.56 (0.62)	1.67 (0.64)
ICT use in students' creativity and innovation	1.29 (0.74)	1.50 (0.98)
Handling ind. diff. in ICT-supported learning environments	1.33 (0.63)	1.41 (0.50)

### Conclusion

The research team's analysis, which used the assignment coding guide that was developed for this study, found that the implementation of ICT in assignments has not significantly transformed students' learning and teaching in I-School. Based on the average scores obtained by these 36 assignment sets, most were lower than 3.00 over 14 coding items, whether they were grouped by subject or by grade level. Moreover no item in ICT use and ICT enhanced learning and teaching obtained higher than 3.00 when they were grouped by subject or grade level.

In general, I-School teachers balanced their use of paper-based and computer-based assignments so that students would have ample chance to practice their hand-writing and computer skills. However, nearly half of the computer-based assignments could be described as a "digitalized paper-based assignment": for example, asking students to answer a question, construct a sentence, or upload the completed worksheet to the online platform. ICT implementation could help teachers to better handle students'

assignments and could allow teachers to provide feedback in the online platform. However, it could not enhance students' learning by commenting on other students' work on the online platform or enhance their learning motivation through audio or visual support or through instant feedback to the students.

When teachers are planning to implement ICT into assignments, they should think about how to foster new learning experiences and learning outcomes that can only be achieved by using ICT. Further, ICT implementation should not only be involved in assignment design; it should also be involved at the curriculum level. According to our findings, teachers should put effort into enhancing students' learning outcomes with respect to three areas: student's use of digitalized media, ICT use in students' creativity and innovation, and handling individual differences in ICT-supported learning environments. To improve performance in these three areas, teachers may encourage students to search, edit, and attach Internet resources, such as photos, into their assignments. Moreover it was observed that students within the same

class received identical assignments and that these exercises seldom provided variation in attainment of learning outcomes for students. Teachers should make use of ICT to prepare and distribute suitable assignments for students that cater to students' individual's academic abilities.

### **Challenges, Contributions, and Further Development**

A number of challenges were faced during the development of this coding guide and in collecting and coding assignment sets. First of all, assignment set collections required considerable human resources. Even though I-School staff on the research team were responsible for data collection, assignment sets were only available several weeks after the teaching unit was completed. It took a long period of time for I-School research team members to retrieve the assignment sets from their colleagues. Second, I-School teachers were not always sure what should be included in the assignment sets. In the first and second academic year of assignment collection, the research team encouraged teachers to include as much evidence as possible to allow flexibility for teachers. However, it was observed that some of the assessment activities listed in the lesson plans were not included in the assignment sets submitted to the research team. To address this challenge, the research team prepared a guideline for I-School teachers in the final semester of data collection, which listed all

common assignment formats. Teachers could then check against the list before submitting the assignments to the research team. Third, double-coding 36 assignment sets took considerable time and placed heavy demands on human resources since each assignment set included nine students' work. Raters were required to read through each student's work to explore how teachers handled individual differences between different classes.

The assignment coding guide was developed to appraise how ICT facilitates learning and teaching through assignments in the I-School. Based on the ratings that were generated, the research team provided a report with suggestions to school administrators and teachers so that they may improve assignment design with better ICT integration. The coding guide not only focused on how to digitalize paper-based assignments; it also aimed to examine how teachers implement ICT in assignment design to enhance students' motivation, consolidate learning, deepen understanding, construct knowledge, handle individual differences, and practice their ICT skills (Tam, 2009). The coding guide will potentially be beneficial to primary schools in Hong Kong and has provided direction for how ICT should be integrated into assignments. Further work will be needed in order to establish the psychometric qualities of the instrument, including predictive validity.

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## Appendix A Sample Coding Items

### 1. Collaboration

Question: Does the assignment allow students to work with others in pairs or groups on some portion of the task to develop a joint product, design, or answer to a complex question?

(Collaboration occurs when a student works with others in pairs or groups on some portion of the assignment to develop a joint project, design, or answer to a complex question. Collaboration is more than simply helping each other: students must have shared responsibility for the work and jointly own the task).

0	1	2	3	4
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Remarks:

**0** = There is not enough information to code the assignment.

**1** = The assignment **does not involve pair or group work**: students work individually. If working together is not explicitly mentioned in the assignment, assume that it is not required.

**2** = The assignment **requires students to work together** in pairs or groups, BUT students do not share responsibility for a joint outcome or product.

**3** = The assignment **requires collaboration with other people**: they have **shared responsibility** for joint outcome or product, BUT the assignment does not require students to make substantive decisions together: it is feasible for students to complete the assignment without coordinating and negotiating with their teammates about important aspects of the assignment.

**4**=Students have **shared responsibility** for a joint outcome or product, AND the assignment requires students to make **substantive decisions** together about the content, process, or product of their work.

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