The Technology of Instructional Learning Model in Development the Problem-Solving Skill of Students in Middle School

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Abstract **- A technology in educational innovation has advanced in recent years with many innovations to support students in changing society. Teachers have a choice of approaches to suit learners' needs and local context. The four Components Instructional Design Model (4C-ID model) is an educational innovation favored by educators because of the way in which activities can be adapted for students and because it emphasizes higher-order thinking. This paper describes the development of an instructional learning model using the 4C-ID model format for teaching science in basic education to secondary students using real-life cases to develop problem solving. Results show that the model supports the problem-solving process using scenarios that encourage students' inductive learning, and teacher's helpful. When using the instructional learning model, learners demonstrated an ability to more effectively plan and solve a problem in their real life, and this was supported by more effect size.**

Keywords **- Instructional Learning Model, Problem-Solving Process**

I. INTRODUCTION

The goal of education, at the basic level, is to develop learners' ability to access knowledge and plan for solving real-life problems [1]. Instructional education for students is required so that they can apply existing information to systematically solve problems in real life [2-4]. To achieve this through instructional education, teachers and educators need to search for innovative development models that align with their learning goals and consider the social state of the learner and changing learning management techniques. The models must nurture learners and help them to select the necessary information, manage their environment, facilitate their learning and support them in meeting learning objectives. The learning management model must be flexible [5-6]. The development model of learning management is in line with these requirements and is one form of the 4C/ID model. It consists of four main components:

1) The learning task refers to the mission, activity, or situation designed for the learner with supporting information as a resource.

2) Resources may include knowledge that students can draw on or use to create new, more complex knowledge to achieve the purposes of learning management at that time.

3) Procedural information is information that students need to learn, transform old knowledge into new knowledge and structure knowledge during and after learning in each learning task.

4) Part-task practice is a sub-task of each learning task to enable the students can

develop their competencies and expertise in particular areas [7].

When learners undergo learning management in this way, they can access knowledge by choosing the right resources and applying a systematic approach to dealing with problems [8]. Research has shown success in learning management using the 4C/ID model to enhance learning achievement. The model can effectively develop learners' problem-solving abilities [9-10], and has also been used successfully in middle school students. The 4C/ID model has some limitations. It requires resources, including a talented teaching team and time to learn [5].

In addition, students must have sufficient basic knowledge, including the ability to link knowledge and choose the right resources. As learners can develop knowledge and skills in complex areas, and become specialists by themselves [7], most research has focused on higher education students.

However, researchers have recognized the advantages of the 4C/ID format in learning management to suit the needs of lower secondary school students with less basic knowledge [11], and tend to use this to plan low-level solutions. Researchers have adapted the 4C/ID model into two steps, namely the learning task, and Procedural information needed to develop problem-solving processes with science content. At each stage, the instructor needs to help the learner by applying well-researched teaching techniques to help learners grasp the lesson. The researchers reviewed relevant documents for this paper, including the concept of the 4C/ID model, learning task design and procedural information design, scaffolding and corrective feedback, inductive learning and problem-solving processes. This review provided a basis for developing the learning model and testing its performance further.

A. The Four Components Instructional Design (4C/ID) Model

The 4C/ID model was developed by van Merriënboer in 1990 [9] and is considered by instructional design specialists as one of the most influential in this field, together with Robert Gagné theory of learning conditions [12]. The theoretical framework underpinning the model is described by van Merriënboer and Kester [8]. Research has focused on how the model has been used in learning environments for the promotion of complex learning involving the integration of knowledge, skills, attitudes and the ability to co-ordinate different skills in qualitative terms and transfer what is learned to new situations. This model follows assumptions of the cognitive load theory [13] and incorporates many of the related experimental results. Methods have been developed to measure the cognitive load associated with learning tasks, i.e., direct subjective measures. Learning processes promote the transfer of learning. To implement these learning strategies, the 4C/ID model advocates the existence of four interrelated components: 1) Learning tasks, considered the backbone of the model, preferably based on authentic situation examples, 2) Support that allows the student to solve problems efficiently, promoting the bridge between previous and new knowledge, 3) Procedural information, which uses an algorithm to give information on how the most routine aspects of the tasks must be carried out, and 4) Strict organization in presenting small segments of information at the exact moment needed to encourage practice in the tasks and allow for training more routine skills.

B. The Assessment of Problem-Solving

Problem solving is an important goal of education. Researchers have proposed different ways of understanding problem solving and different methods to study it [14]. Various problem-solving phases and associated learning activities have been proposed, reflecting diverse theoretical orientations such as information processing [15], cognitive science [16]. Four problem-solving steps have been presented: 1) understanding the problem; 2) devising a plan; 3) carrying out the plan; and 4) looking back at work. These activities are often combined with heuristics. Polya [17], Weir [18], and Wood, Bruner & Ross [19] introduced four problem-solving levels:

Identifying the problem level, analyzing and identifying the cause of the problem level, proposing the problem-solving method level and examining the problem-solving result level. However, inductive learning [20], scaffolding [21-22], and corrective feedback interaction [1] in class will help to master problem solving. The 4C/ID model provides scenarios to promote students' problem-solving abilities with four questions relating to each scenario: What is the problem? What is the cause of problem? What should you do to solve this problem? What is the result after the problem is solved?

Researchers developed and evaluated the validity and effectiveness of the model and carried out a study with an experimental group in the second stage. The hypothesis tested in this research was: The Instructional learning model develops students' problem-solving processes and yields a large effect size.

II. METHOD

This research consisted of two main, at first, development of instructional learning by applying the 4C/ID model, including document analysis and second, evaluation of the effectiveness of instructional learning.

A. Instructional Learning Development

Whole learning tasks were identified and organized into appropriate task classes to promote the problem-solving process with real-world or scenario-based authentic problems. The tasks within a task class should all rely on the same problem- solving process needed to complete the tasks of that task class. Difficulty of tasks within a task class was increased for the learners. The first task was worked out using a problem-solving process example, independent inductive learning, scaffolding and corrective feedback from teachers to effectively complete the task. The instructional learning support in each subsequent task of the task class was gradually faded. The last task required learners to complete it with no instructional support. Variation was provided in the learning tasks within each task class to promote problem solving in a different scenario. In the design process, learning tasks and classes are sequenced progressively from simple to complex. So the first step should include learning tasks that require students to apply only the most fundamental concepts to be learned. The last task class would introduce the least important concept in a complex task, those which should be learned, but also require the most application of the current concept and all prior concepts. By the time the learner completes the last task class, students will have mastered all the intended knowledge and skills and can apply what they have learned in an integrated manner. However, performance objectives are the performance criteria set for each task class. They are important in determining when a learner is ready to move on to a new task class. Performance criteria should be specified by the performance objectives so that mastery can be ensured. Mastery is judged by an instructor and specified as degree of accuracy or efficiency with which learners must perform the task. The next step, we designed procedural information involves the design of 'how-to' information. It specifies how to perform the recurrent aspects of the learning task and should typically be provided at the time it is needed by the learner. This procedural information delivery strategy reduces the cognitive load of the learner by not distracting students with the information until the moment it is needed.

B. Problem-Solving Process Measurement and Research Design

- **The Measurement**

The problem-solving were introduced and together, scaffolding and corrective feedback in class lead students to master the ability to solve problems. The researchers created the objectives of the assessment by listing the processes that students were required to learn through completion of tasks. The performance assessment tasks also required students to demonstrate problem-solving skill in line with explicit performance criteria which measure the extent to which students have mastered the process.

- **Research Design**

The experiment used a one-group pretest–posttest design. Students from middle schools were randomly selected for inclusion in the study. The test of problem-solving processes served as the pre- and post-test and differences were analyzed by paired t-test, and the effectiveness of the treatment by Cohen's d statistic [23].

C. Sample

The participants were students in 52 secondary schools in Bangkok in their second semester of the 2016 academic year. It was assumed that students had never experienced instructional learning by applying the 4C/ID model and problem-solving skill assessment before. They were also assumed to have the same prior educational background and be of relatively similar age. Randomized cluster sampling of 46 students took place, assigned for the experimental group using the pre–post-test design [24].

D. The Quality of Research Tools

The tasks involved problem scenarios centered on daily life as learning content. The problem-solving process consisted of the following four questions: 1) What is the problem in this situation?, 2) What is the cause of this problem?, 3) What should you do to solve this problem?, and 4) What is the result once the problem is solved? The internal consistency of treatment was examined by five Professors in their area and the test of problem-solving skills was administered. Internal reliability (α) was calculated as .72.

E. Procedure

The session involved administration of the pretest, which took about 50 minutes. This was then followed in subsequent sessions by three task classes of 90 minutes duration each. Students were free to discuss the information with each other and to consult texts more than once including the information generated by the teacher. Finally, performance post-test was evaluated in the last session of 50 minutes duration.

F. Data Analysis

We evaluated treatment effectiveness using paired t-tests and Cohen's d. The paired t-test was used to determine the difference in students' problem-solving performance scores pre- and post-test, with a significance level of 0.05. Effect size was calculated from the d statistic [23], which was computed based on reported values for t and the number of pairs. To confirm this hypothesis, the researchers created instructional learning that included a learning task and procedural information, based on components of the 4C/ID model. Scaffolding, corrective feedback and inductive learning were used with authentic problem scenarios created for students. This instructional learning was approved by five Professors were expertize in educational instruction.

III. RESULT

This study the researchers applied the 4C/ID model for instructional learning including scaffolding and corrective feedback. The effect size was calculated and mean scores for pre-test and post-test performance were compared. The hypothesis tested was: Instructional learning developed students' problem-solving skill and showed a large effect size. The structure of the instructional learning model that resulted from this development work is shown in Fig. 1.

A paired samples t-test was conducted to evaluate the impact of the problem-solving process on performance scores. There was a significant increase in scores from pretest (mean = 4.783, SD = 1.99) to posttest (mean = 8.152, SD = 2.556), $t = 8.140$, $p < .001$ one-tailed), and the mean under paired difference was also reported (mean = 3.370, SD = 2.808, df = 45). The effect size for dependent t-test ($d = 1.20$) showed a large effect size. The hypothesis was accepted as follows: The instructional learning developed the students' problem-solving processes and had a large effect size.

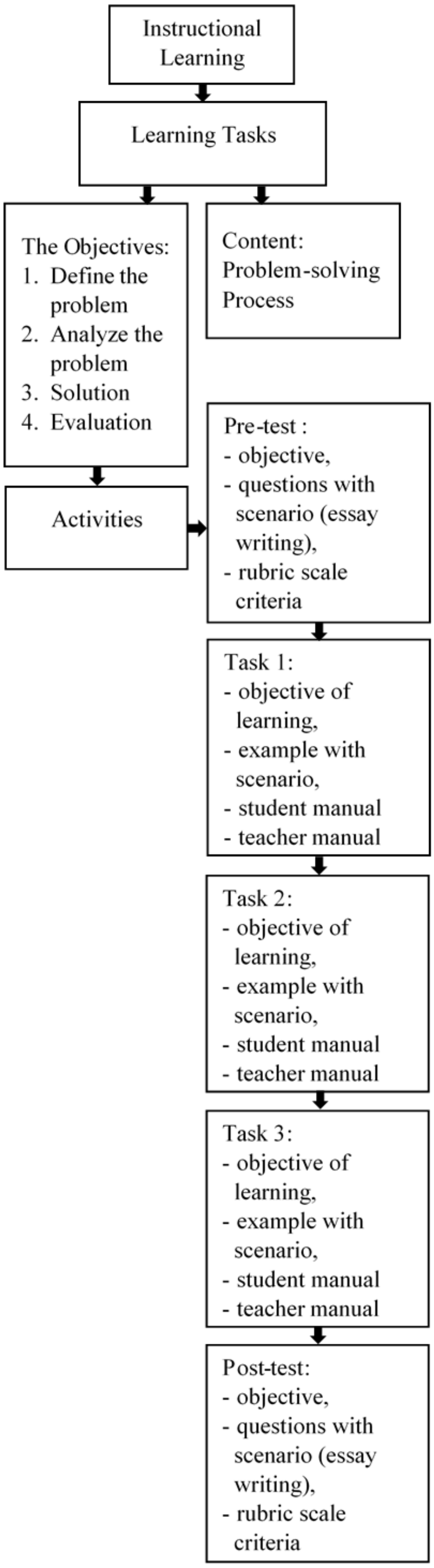

Fig. 1 Structure of the Instructional Learning

IV. DISCUSSION AND CONCLUSION

The results support the hypothesis that instructional learning can develop students' problem-solving skill and produces a large effect size. Results indicated that performance post-test was better than pre-test, with the ability to solve real world problems improving after the instruction. Many researchers [9, 10, 25] have found that the 4C/ID model promotes integration of knowledge and skills. The results of the statistical test applied to the students' problem-solving skill showed a better performance post-test. This could be explained by the fact that the instructional learning covered a wide variety of learning tasks suitable for the context. Van Merriënboer and Sweller [13] pointed to the benefits of task variability on learning transfer. Another possible reason for the superior transfer of performance may be related to the emphasis of the 4C/ID approach on promoting schema construction for generalized problem-solving, a process that can be used for solving a problem in different situations [10]. In the 4C/ID approach the correct feedback system informs learners that there was an error and gives reasons for this, but does not simply supply the correct action. As predicted, learners in the 4C/ID approach showed a significantly higher level of effectiveness on performance tests. These findings suggest that the 4C/ID approach was not only effective for problem-solving processes, but also yielded a large effect size. The findings of this study have one main practical implication in the area of instructional design: the use of learning tasks and information designed using the principles of the 4C/ID model was more effective on problem-solving skill of secondary students. The research results demonstrate the effectiveness of instructional learning by helping students learn problem solving in the context of science curricular content. To increase students' problem-solving performance, teachers ought to sequence tasks from easy to difficult by reducing assistance from the teacher. The next step would be for teachers to start students' inductive learning in the first task as well. However, novices will need more help and time to develop their problem-solving skill because problem solving.

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(Arranged in the order of citation in the same fashion as the case of Footnotes.)

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