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Scoring Rubric of Problem-Solving on Computing Science Learning

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Abstract

Office of basic education commission of Thailand firstly declared the indicator for computing science of the students in primary education and secondary education in 2018. The important of computing science is to develop the learners to solve the questions of computing science by using technology correctly. To gain the effective learning management in computing science, the method of evaluation is so important. This research aimed to create the test of solving on computing science for the teachers to use in school and applied in computing sciences in schools and improved better in the future. The evaluation on quality for validity of the test found that the test of solving in computing science gain the item of congruence (IOC) at 1.00 and reliability was show harmonization at the level of "much" (RAI = 0.94).

Keywords: scoring rubric of problem-solving, assessment of problem solving, test of problem-solving computing science learning, computational science

1. Background of the Study

The institute for the promotion of teaching science and Technology (IPST) specified the learning standard and indicator of computing science of science in primary education and secondary education in the core curriculum of basic education revised edition 2017 of science department. The curriculum concerned to develop the learners to gain the thinking skill, computing skill, analytical thinking, and problem-solving skill systematically and to apply the computing science, information technology and communication (IPST, 2018). The important skill for Computing science is the problem-solving skill of the learners in 21st century that composed of 7C (Partnership for 21st Century Skills, 2017). Problem-solving skill is a basic skill for other skill such as critical thinking, creative thinking and innovation skill (Canter, 2004).

The ability of problem-solving refers to the qualification of learners to apply the thinking process using knowledge and experience to reach the goal or objective by collecting information, connecting functions, using facts to successfully. The institute for the Promotion of Teaching Science and Technology (IPST, 2014) specified the behavior of problem-solving comprises 1) Understand the problem, 2) Plan to solve the problem, 3) Solve the problem and evaluation, 4) Checking for problem-solving and apply for problem-solving. The operation assessment on process of working is used to measure the problem-solving ability by the instrument for scoring the characteristics in terms of rubrics (Phuvipadawat, 2001). Rubrics are the instrument to reflex the ability of the learners in operating work. The teachers can assess the ability of learners easier and able to gain efficiency of the learning management.

As mentioned above, the researcher had studied the components of ability to solve problem and design the instrument for problem-solving skill in terms of rubrics for teachers to apply in the other courses, and use as an example in computing science learning management.

1.1 Research Objectives

To develop the scoring rubric of problem-solving on computing science learning

1.2 Research Limitation

a) The 5 experts to validate the rubric. The qualification of experts were at least senior professional teacher or assistant professor who experienced in learning management for thinking skill or computing science, derived from purposive sampling.

b) The 20 pre-cadet students of Armed Forces Academies Preparatory School who were the members of Mechatronics Club 2018.

c) The 5 rater to use rubric with empirical work of the students. The qualification of the assessors was to gain experience in computing science at least 5 years, derived from purposive sampling.

2. Operating Definition

a) Computing science referred to the specific course for computing in arithmetic and scientific method to gain the answer or result or the application of computer to do with something in process. (Cambridge Dictionary, 2018; Oxford Dictionary, 2018)

b) Computing science learning management referred to the learning process of computing science to develop the learners to gain the learning standard and indicator in the core curriculum of Thailand basic education commission 2008, revise edition 2017 in science department (IPST, 2018).

c) The ability of problem-solving in computing science referred to the qualification of learners that use the thinking process using knowledge and experience to gain the learning objectives by collecting information and connecting the functions and using facts to successfully composed of 4 steps; 1) analysis and specify the problem description, 2) planning for solving problem, 3) solving the problem, and 4) inspecting and evaluating the results (Bloom, 1956; Guilford & Hoepfner, 1971; Khammani, 2017; Weir, 1974; Jonassen, 2011).

d) Learning process of computing science using the process of engineering design and online simulation to enhance the ability of problem-solving referred to the process of learning management that learners got the problem as a question for writing program to control Micro bit board using engineering design which contained 5 steps as follow: 1) identify the problem, 2) collecting information to solve the problem, 3) design, plan and draft the flowchart of solving, 4) action on problem-solving, 5) evaluate the operation work for problem-solving. After the learners got the question of problem, the learners had to send back the project work to the teacher as follow; 1) mind mapping that reflected (1.1) the objective of writing program, (1.2) equipment in the process, (1.3) planning of the task, 2) precise flowchart for immediately use, 3) source code as flowchart designed, 4) result of program, 5) record of inspecting result and correction.

3. Research Methodology

This operation has divided the research process into steps as follows.

Step 1: Reviewed literature – to analyze and synthesize the components of developing the test of ability to solve problem using Rowley and Slack (2004) principle.

Step 2: Designed and created the rubric of problem-solving for computing science.

Step 3: Validation of the rubric of problem-solving for learning management in computing science. The 5 experts evaluate the validity of rubric of problem-solving for computing science by using the analysis of IOC: Index of Item-Objective Congruence (Wadeecharoen, 2017) and improved as the experts' suggestion.

Step 4: Managed the learning process of computing science using the engineering design and online simulation to enhance the problem-solving ability for the pre cadet students.

Step 5: Inspected the reliability of the rubric of problem-solving for learning management in computing science. The 5 rater the rubric with the empirical work of the pre cadet students by random selecting only 4 empirical works from 20 students by using the analysis of the RAI: Rater Agreement Index (Burry-Stock et al., 1966).

4. Research Findings

The test of ability on problem-solving for computing science was designed and created in scoring rubrics of 4 levels. The teacher observed the evidence of learning, empirical works, and behavior reflecting the practical work of the students. The evaluation was operated in any loop of learning on problem-solving and the criteria of evaluation on ability of problem-solving composed of 4 components:

1) Analysis and specification of problem description – this step was to understand the description, limitation of problem.

2) Planning for solving problem – this step was to think of the process of problem-solving step by step to gain the result.

3) Practical of problem-solving – this step was to do solving problem in action.

4) Inspecting and evaluating the results – this step was parallel with the step of problem-solving. If the problem was not solved, the students had to go back and repeat the step of problem-solving until reaching the complete

result.

After the validation of the rubric, the 5 experts evaluated the quality of the rubric was show in table.1 and the tryout of the reliability by 5 experts from the 4 empirical works was show in Table 2.

Table 1. The result of evaluating the validity of the rubric of problem-solving on computing science learning

The ability of problem-solving approach	Result of evaluation							
	Expert					Total	IOC	Meaning
	1	2	3	4	5			
1. Analysis and specification of problem description, understanding of condition of problem and condition on limitation of problem	1	1	1	1	1	5	1.00	Gain the validity and harmonized to the objectives
2. Planning for problem-solving, the finding of problem-solving process form starting until finishing and gain the result	1	1	1	1	1	5	1.00	Gain the validity and harmonized to the objectives
3. The practice of problem-solving, the process of applying the process in practice l	1	1	1	1	1	5	1.00	Gain the validity and harmonized to the objectives
4. The inspection and evaluating the result, the parallel step of practical in problem-solving. If the result was not complete, go back to practice along the process again until reaching a complete result	1	1	1	1	1	5	1.00	Gain the validity and harmonized to the objectives

From Table 1 the validation of the rubric score that evaluated by 5 experts has IOC = 1.00 meaning is the validity and harmonized to the objectives.

Table 2. The result of evaluating the reliability of the rubric score of problem-solving on computing science learning

	Results of the evaluation																			
	Expert 1				Expert 2				Expert 3				Expert 4				Expert 5			
Item of evaluation on the ability of problem-solving	Empirical work of no.1	Empirical work of no.2	Empirical work of no.3	Empirical work of no.4	Empirical work of no.1	Empirical work of no.2	Empirical work of no.3	Empirical work of no.4	Empirical work of no.1	Empirical work of no.2	Empirical work of no.3	Empirical work of no.4	Empirical work of no.1	Empirical work of no.2	Empirical work of no.3	Empirical work of no.4	Empirical work of no.1	Empirical work of no.2	Empirical work of no.3	Empirical work of no.4
1. Analysis and identification of problem description	2		3	4	2	2	3	4	2	2	3	4	2	2	4	4	2	2	3	4
2. Planning for problem-solving	2	3	3	3	2	3	4	3	2	3	4	3	2	3	4	3	2	3	4	3
3. Practical in problem-solving	3	3	4	3	3	3	4	3	3	3	4	3	3	3	4	3	3	3	4	4
4. Inspection and evaluation	2	2	4	4	2	3	4	4	2	2	4	4	2	3	4	4	2	3	4	4

From table 2 the reliability of the rubric score that evaluated by 5 rater has RAI = 0.94 meaning the harmonization at the level of "much".

5. Discussion

Measurement of problem-solving ability (high-order thinking skills) should be used to judge the skills of the

students by measuring the effect on the students to act out. Or in other words, call as "authentic assessment" (Xu et al., 2013) in which it is difficult to give the instructor to assess and judge the workpiece precisely. It is necessary to have scoring, quality standards (Gao & Grisham-Brown, 2011). Therefore, after scoring rubric of problem-solving on computing science has designed and created. It has to verify the validity and found that the index of item-objective congruence (IOC) was 1.00 can interpret the validity that is accepted, which implies that this scoring rubric has set the measurement issues correctly and appropriately. It can be used practically. According to Rovinelli and Hambleton (1976), commenting on the construction of any measure should be checked before being used. In addition, this scoring rubric of problem-solving on computing science has been evaluated for the rater agreement indexes that were 0.94. There is a very high consistency of the assessor. This indicates that scoring rubric is reliable in actual applications. Müller et al. (2005) explained that evaluating of measuring instruments by using multiple evaluators can tell the accuracy of the instrument. Which the accuracy of the measurement is very much needed to measure the ability of learners with authentic assessment (Burry-Stock et al., 1966). Consistent with Segal et al. (2003), who has used many evaluators to create learning behavior measurement tools which can provide reliable results in the measurement and evaluation of learners' reactions as well.

From the process of inspection until it appears that this scoring rubric of problem-solving on computing science has the straightness and reliability of this instrument. The researcher can explain which was caused by the researcher had synthesized the definition of computing science , limitation of in the core curriculum of thailand basic education commission 2008, revised edition 2017 of science department, and studied the definition and components of problem-solving skill and collecting the steps of problem-solving matching with the indicator of computing science (IPST, 2018) by applying the method of creating rubrics score for authentic assessment (Phuvipadawat, 2001) that composed of steps; 1) identifying the good results of empirical works by pro and cons, 2) discussion on the results or empirical works of the learners and summarized as a criteria 3) qualification level by description of the empirical works: best, average and poor. In addition, the rubric that researcher was created can be applied to evaluate the computational thinking (Supaluk, Khlaisang, & Songkram, 2018) that the composition is classified into parts as follows 1) Decomposition: Breaking down data, processes, or complex problems into smaller. 2) Pattern Recognition: Observing patterns, identifying similarproblems, and regularities in data. 3) Abstraction: Identifying the general principles that generate these patterns or focusing only on the details and 4) Algorithm Design: that are important, whilst irrelevant information is ignored. Moreover, this tool should be used as a part of the computing science project-based learning that also enhances the cognitive and critical thinking in engineering problem solving among students (Rahman et al., 2009), which is expected to show more efficiency of this kind of learning management.

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Appendix A

Table A1. Table of indicators of criteria for ability of problem-solving

Point	1	2	3	4
Analyze and specify the problem description	a. The learner was not able to set the objective for problem-solving. b. The learner was not able to identify limitation of the problem.	a. The learner was able to set the objective for problem-solving. b. The learner was not able to identify limitation of the problem	a. The learner was able to set the objective for problem-solving. b. The learner was able to identify limitation of the problem	a. The learner was able to set the objective for problem-solving. b. The learner was able to identify limitation of the problem. c. The learner was able to identify knowledge or related information of the problem.
Planning for problem-solving	a. The learner was not able to create system flowchart. b. The learner was not able to create flowchart program. c. The learner was not able to create algorithm of program.	a. The learner was able to create system flowchart. b. The learner was able to create program flowchart. c. The learner was able to create the algorithm program but the algorithm was ambiguous. d. The learner was able to use the symbol of writing flowchart less than or equal 50% of international criteria	a. The learner was able to create system flowchart. b. he learner was able to create program flowchart. c. The learner was able to create the algorithm program but the algorithm was not ambiguous. d. The learner was able to use the symbol of writing flowchart over 50% of international criteria	a. The learner was able to create system flowchart. b. The learner was able to create flowchart program. c. The learner was able to create the algorithm program but the algorithm was not ambiguous. d.The learner was able to use the symbol of writing flowchart over or equal 80% of international criteria
Practical of problem-solving	a. he learner was not able to operate the work as the system flowchart b. The learner was not able to write the program as the program flowchart.	a. The learner was able to operate the work as the system flowchart less than 50%. b. The learner was able to write the program as the program flowchart less than or equal 50%.	a. The learner was able to operate the work as the system flowchart over 50% but less than 80%. b. The learner was able to write the program as the program flowchart over 50% but less than 80%.	a. The learner was able to operate the work as the system flowchart over or equal 80%. b. The learner was able to write the program as the program flowchart over or equal 80%.
Inspection and evaluation	a. The learner was not able to record the inspection and evaluation of working.	a. The learner was able to record the inspection and evaluation of working more than one time.	a. The learner was occasionally able to record the inspection and evaluation of working. b. The learner was able to evaluate the cause of error but incorrectly.	a. The learner records the inspection and evaluation of working more than one time and inspects the result occasionally. b. The learner was able to evaluate the cause of error correctly.
* The full score is 16 points		lower than 6 points	mean	should be improved
		6-9 points	means	fair
		10-13 points	means	good
		14 points or more	means	very good

Appendix B

The empirical works of the students for evaluating for the reliability test were brought from the project works of the pre-cadet students via computing science learning management using engineering design and online simulation to enhance the ability on problem-solving. The samples were 30 students but researcher random 4 empirical works for reliability test by rater agreement index (RAI).

Formula for Rater Agreement Index (RAI)

$$RAI = 1 - \frac{\sum_{k=1}^{K}\sum_{n=1}^{N}\sum_{m=1}^{M}\left|R_{mnk} - \bar{R}_{nk}\right|}{KN(M-1)(I-1)}$$

R_{mnk} represents the score of the expert m, empirical work n, in the item of evaluation k

R_{nk} represents the mean score of the empirical work of student n, in the item of evaluation k

K represents the number of all item for evaluation

N represents the number of empirical work of all students

M represents the numbers of expert (assessors)

I represents the numbers of impossible score