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Development of training model on robot programming to enhance creative problem-solving and collaborative learning for mathematics-science program students

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Abstract

The main objective of research was to develop the training model on robot programming to enhance creative problem-solving and collaborative learning for mathematic-science program students. The research methodology was Model Research Type II by Richey & Klein divided into 3 phases as 1) model development phase, 2) model validation phase, and 3) model use phase. The research findings were as follows : 1) T-R2C Model which was newly developed training model consists of 3 main steps; Pre-training, Training and Post-training. 2) The validity and appropriateness of training model on robot programing were "Acceptable" (IOC = 0.98) and "Most" ($\bar{x}$ = 4.90, S.D. = 0.19) respectively. 3) The training outcome of creative problem solving on the trainees assessing with scoring rubrics was at the level of "Very good" (= 9.03, S.D. = 0.78). 4) The training outcome of collaborative learning on the trainees was self-assessment at the level of "Very good" (mean = 4.74, S.D. = 0.52). 5) The training outcome of the satisfaction of the trainees was at the level of "Highest" ($\bar{x}$ = 4.70, S.D. = 0.58). In conclusion, the T-R2C Model model is appropriate in terms of instructional design for training on robot programming to enhance creative problem-solving and collaborative learning.

Keywords: training, creative problem-solving, collaborative learning, robot programming

1. Introduction

Training is some specific learning activities to improve and enhance a cognitive skill or expertise. It can change in behavior and attitudes about a particular subject according to the objective of training [1–3]. Therefore, training is a method can be developed to use in the current situations. Training model should be developed in the field of education.

Creative Problem Solving (CPS) is a teaching method that teachers propose topics or situations to the students and let the students figure out what the problems, how to solve them, and make the most appropriate decision. Integrating CPS in training and teaching can promote and develop cognitive skills, affective skills and metacognitive skills [4–6]. An effective way in integrating CPS in training or teaching by working with other people.

Collaborative learning (CL) is a method of teaching that focuses on small group work and the members of the group are of different proficiency and/or expertise. This is to help the members learn from each other and increase the chance of achievement [7–9]. Moreover, according to P21 Framework for 21st Century Learning, CPS and CL are the skills that learners in the 21st century should possess.

Robot programing is the process of commands and algorithms to get robots to recognize and follow orders. Usually, robot programming is in plain text format but the robots do not understand. In order for the robots to understand, the plain text must be compiled and converted to machine language before uploading the command to the robots. [10, 11] Robot programing is a suitable tool that can be used to improve students' skills. This is because robot programing combines knowledge of science, mathematics, engineering and technology as well as knowledge of communication between people and robots. These knowledge and skills necessary for learners in the 21st century.

As mentioned, the researchers are interested in developing training model on robot programming to enhance creative problem-solving and collaborative learning, and using this model to be guidelines for trainers who use robots for developing skills in the 21st century.

2. Research Objectives

2.1 To develop the training model on robot programming to enhance creative problem solving and collaborative learning for mathematic-science program students.

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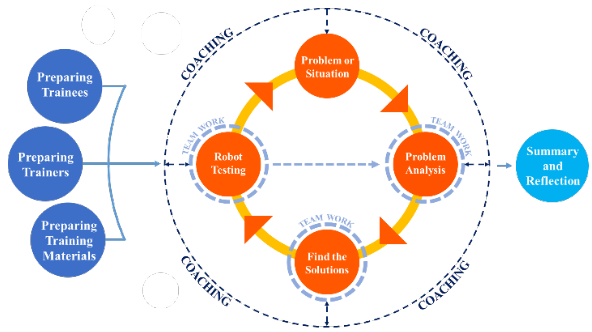

Figure 1 Training model on robot programming to enhance creative problem-solving and collaborative learning

Table 1 Validity and appropriateness of the training model

Item	N	Validity		Appropriateness		
		IOC	meaning	$\overline{x}$	S.D.	meaning
1. Pre-Training						
1.1 Preparing training materials	5	1	acceptable	5.0	0.00	most
1.2 Preparing trainers	5	1	acceptable	4.8	0.45	most
1.3 Preparing trainees	5	0.8	acceptable	4.6	0.55	most
2. Training						
2.1 Problem or situation	5	1	acceptable	5.0	0.00	most
2.2 Problem analysis	5	1	acceptable	5.0	0.00	most
2.3 Find the solution	5	1	acceptable	5.0	0.00	most
2.4 Robot testing	5	1	acceptable	5.0	0.00	most
3. Post-Training						
3.1 Reflection	5	1	acceptable	4.8	0.48	most
Overall		**0.98**	**acceptable**	**4.9**	**0.19**	most

2.2 To evaluate the validity and appropriateness of the training model on robot programming.

2.3 To study the creative problem-solving of the trainees in the training model on robot programming.

2.4 To study the collaborative learning of the trainees in the training model on robot programming.

2.5 To study the satisfaction of the trainees in the training model on robot programming.

3. Methods

The research methodology was Model Research Type II by Richey & Klein divided into 3 phases [12] as follow:

3.1 Phase 1 – A development of the training model

1) Literature review relevant include; the training, problem-solving, collaborative learning and robot programing.

2) Synthesis the theoretical framework and the conceptual framework.

3) Prototyping of the training model under the conceptual framework.

4) Interviewing the 5 instructional designers for improving the training model.

5) Improving the training model on the recommendation of 5 instructional designers.

3.2 Phase 2 - Validity of the training model

1) Proposed as the prototype of training was newly developed (Figure 1) with 5 instructional designers from Department of educational communication and technology; Chulalongkorn University and KMUTT. for validity and appropriateness.

2) Checking the robot programming content was evaluated with 3 robotics developers from Institute of field robotics (FIBO), KMUTT.

3) Checking materials, the training model was evaluated with 3 training experts from Institute of field robotics (FIBO), KMUTT.

3.3 Phase 3 – Use of the training model

1) The data of creative problem-solving, collaborative learning, and satisfaction was collected during the training process.

Table 2 Evaluation of quality on robot programming content

Item	N	Quality		
		$\bar{x}$	S.D.	meaning
1. Text	3	5.00	0.00	Very good
2. Picture	3	4.67	0.57	Very good
3. Video	3	4.33	0.57	Good
Overall		**4.66**	**0.38**	**Very good**

Table 3 Evaluation of quality on materials

Item	N	Quality		
		$\bar{x}$	S.D.	meaning
1. Computer and Robot set	3	5.00	0.00	Very good
2. A manual for robot construction and programing	3	5.00	0.00	Very good
3. A robot's test field.	3	4.67	0.57	Very good
4. Workshop Sheets	3	4.67	0.57	Very good
5. Website	3	4.60	0.55	Very good
Overall		**4.78**	**0.33**	**Very good**

Table 4 Creative problem-solving outcome of the trainees

Training outcome	N	$\bar{x}$	S.D.	Meaning
1. Problem analysis step	10	9.50	0.70	Very good
2. Find the solution step	10	9.30	0.82	Very good
3. Robot testing step	10	8.30	0.82	Good
Overall		**9.03**	**0.78**	**Very good**

2) The data was analyzed by mean and standard deviation. After that the research was summarized.

4. Result and discussion

4.1 The training model that developed consists of 3 steps;

1) Pre-training had 3 sub steps include; Materials Preparation, Trainers Preparation, and Trainees Prepa-ration.

2) Training had 4 sub steps include; Problem or Situation, Problem Analysis, Find the Solution, and Robot Testing.

3) Post-Training was Reflection.

Training model on robot programming to enhance creative problem-solving and collaborative learning for mathematic-science program students (T-R2C) was shown in Figure 1.

4.2 The evaluation of the training model that developed by 5 instructional designers using Index of item Objective Congruence (IOC) according to the concept of Rovinelli and Hambleton [13] and using Appropriateness according to the concept of Boonchom Srisaad [14] was shown in table 1.

From table 1, the evaluation of validity and appropriateness of the training model, the validity was 0.98 that was acceptable, and the appropriateness was at the level of "most". (mean = 4.90, S.D. = 0.19)

4.3 The evaluation of quality on robot programing content of the training model by 3 robotics developers using the mean ($\bar{x}$) and standard deviation (S.D.) of the 5-point Likert scale was shown in table 2.

From table 2, evaluation of quality on robot programing content of the training model, the quality was at the level of "very good". (mean = 4.66, S.D. = 0.38)

4.4 The result of evaluation of quality on materials of the training model by 3 training experts. Using the mean ($\bar{x}$) and standard deviation (S.D.) of the 5-point Likert scale was shown in table 3.

From table 3, evaluation of quality on materials of the training model, the quality was at the level of "very good". (mean = 4.78, S.D. = 0.33)

4.5 The result of Creative Problem-Solving outcome of 10 trainee's groups using the mean ($\bar{x}$) and standard deviation (S.D.) of the 5 level by 10-point Interval scale was shown in table 4.

From table 4, creative problem-solving of the trainees was score at the level of "Very good". (mean = 9.03, S.D. = 0.78)

4.6 The result of Creative Problem-Solving outcome of 40 trainees using the mean ($\bar{x}$) and standard deviation (S.D.) of the five-point Likert scale was in table 5.

From table 5, Collaborative learning of the trainees was score at the level of "Very good". (mean = 4.74, S.D. = 0.52)

Table 5 Collaborative learning outcome of the trainees

Training outcome	N	$\overline{x}$	S.D.	Meaning
1. Work for the team on time	40	4.83	0.40	Very good
2. Help the team	40	4.76	0.47	Very good
3. Listen to the idea of teammate	40	4.64	0.68	Very good
4. Share idea with team	40	4.86	0.42	Very good
5. Treat teammate with equable	40	4.65	0.62	Very good
Overall	**4.74**		**0.52**	**Very good**

Table 6 Satisfaction of the trainees who have trained

Item	N	Satisfaction		
		$\overline{X}$	S.D.	Meaning
1. Problem or situation step	40	4.71	0.59	Highest
2. Problem analysis step	40	4.64	0.68	Highest
3. Find the solution step	40	4.68	0.61	Highest
4. Robot testing step	40	4.83	0.42	Highest
5. Refection	40	4.65	0.62	Highest
Overall		**4.70**	**0.58**	**Highest**

Figure 2 Used of the training model

4.7 The result of satisfaction of 40 trainees using the mean ($\overline{x}$) and standard deviation (S.D.) of the 5-point Likert scale was shown in table 6.

From table 6, the satisfaction of the trainees was at the level of "Highest". (mean = 4.70, S.D. = 0.58)

5. Conclusion

5.1 The training model on robot programming to enhance creative problem-solving and collaborative learning for mathematic-science program students composed of 3 steps; (1) Pre-Training which 3 sub steps include 1.1) Trainers Preparation 1.2) Materials Preparation 1.3) Trainees Preparation, (2) Training which 4 sub steps include 2.1) Problem or Situation 2.2) Problem Analysis 2.3) Find the Solution 2.4) Robot Testing and (3) Post-Training which 3.1) Reflection. Which developed training model using a group process in problem analysis step, find the solution step and robot testing step.

5.2 The 5 instruction designers evaluated the validity and appropriateness of the developed training model and found that the validity was acceptable and the appropriateness was at the level of "most". The 3 robotics developers evaluated quality of robot programing content of the training model at the level of "very good". and the other 3 training experts evaluated quality of materials at the level of "very good". This might be because the research has followed the theoretical model of training process and the recommendation from the evaluators. The suggestion of the instructional designers was essential for improvement of the training model.

5.3 For creative problem-solving(CPS), the scoring rubric from trainees was at the level of "Very good". This might be because the developed training model integrate CPS in training process. This finding is in line with a study by Pornsawan Vongtathum [15] who studied CPS skills for 21st century. The research concludes CPS is the process of thinking to solve complex problems from ideas variety. Contain the convergent thinking that a knowledge and previous experience and divergent thinking from creative thinking in terms of fluency, flexibility and originality view to promote the solve problems creatively skills in 21st century. In addition Isaksen, Dorval & Treffinger [16] developed creative problem solving (CPS Version6.1): a contemporary framework for managing change. The CPS Version 6.1 framework includes 4 components; 1) understand the challenge 2) generating ideas 3) preparing for action 4) planning your approach.

5.4 For collaborative learning, the self-assessment from trainees was at the level of "very good". This is because the researchers applied the group process of a study by Gerlach [17] to design in the training model. This consists of problem analysis step, find the solution step and robot testing step. By these group processes, the trainees can develop the collaborative learning. Moreover, the findings by Supalak Bunson [18] shows that group process was able to create an environment of exploratory learning, promote higher class engage-ment, learning outcome and a team approach to problem solving.

5.5 The satisfaction of the trainees who have trained in the developed training model was at the level of "Highest". This was harmonized to the study of Pornsak Thongma, [19] about the satisfaction of the learners that learners have the satisfaction in using technology for learning by doing. Thorne & Kaye [20] explain that the learning root can be created by using the participative training technique, individual, and group working and the variety of media using. The study also used motivation to stimulate the learners to learn continually and to be satisfied with the training process.

5.6 The developed training model most appropriate in terms of instructional design for training on robot programming to enhance creative problem-solving and collaborative learning for mathematic-science program students.

5.7 The robots was a materials of the developed training which can be integrated in STEM Education include; science, technology, engineering, mathematics.

5.8 The training model on robot programming (T-R2C) was a modern training. This is because it able to enhancing the creative problem-solving and collaborative learning of the learners. Its harmonized to the P21 Framework for 21st Century Learning Moreover T-2C Model can be promoting higher class engagement.

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