



The Development of research-based learning model to promote the critical thinking skills in measurement and evaluation education

Pornwilai Sukmak, Kanyawit Klinbumrung*

Department of Teacher Training in Electrical Engineering, Faculty of Technical Education, King Mongkut's University of Technology North Bangkok, Bangkok 10800, Thailand

Article Info

Article history:

Received 11 July 2023

Revised 16 April 2024

Accepted 18 April 2024

Available online 28 March 2025

Keywords:

critical thinking skills,
measurement and evaluation education,
research-based learning model

Abstract

This research aimed (1) to develop the research-based learning model to promote critical thinking skills in measurement and evaluation education; (2) to study the results of using the research-based learning model; and (3) to study the satisfaction of participants through the research-based learning model. The instrument consists of the research-based lesson plan, learning management evaluation form, student satisfaction assessment form, achievement test, and analytical thinking skill form. The sample group was 38 participants who were bachelor students at King Mongkut's University of Technology North Bangkok (KMUTNB), Thailand. The research results showed that (1) the quality of the research-based learning model was at a high level ($M = 4.39$, $SD = 0.15$); (2) the quality of the instrument was at a high level ($M = 4.24$, $SD = 0.41$); (3) the comparison of learning achievement between the pre-test and the post-test found that was different, statistically significant at the .05 level; (4) Critical thinking skills of participants had an average of 12.79, representing 85.27 percent of the full score. There were 29 participants who received a passing score of 75 percent or higher, representing 76.32 percent of all students with determination of the goal and problem skill ($M = 3.37$, $SD = 0.67$), the determination of the hypothesis skill ($M = 3.34$, $SD = 0.67$), conclusion skill ($M = 3.18$, $SD = 0.77$) was at a high level, and the evaluation skill ($M = 2.89$, $SD = 0.65$) was at a fair level; and (5) the participant's satisfaction with the developed learning and teaching process was at a high level ($M = 4.29$, $SD = 0.19$).

© 2025 Kasetsart University.

* Corresponding author.

E-mail address: kanyawit.k@fte.kmutnb.ac.th (Klinbumrung, K.).

<https://doi.org/10.34044/j.kjss.2025.46.1.33>

2452–3151/© 2025 Kasetsart University.

This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Teaching and learning in Thailand have an education reform that changes the concept of teaching and learning with a student-centered approach, which had the principle that the teaching and learning process focuses on seeking knowledge, developing abilities naturally to their full potential, encouraging practice in real working situations, and creating skills to connect what was learned with the situation outside the classroom. Activities and learning processes were characterized by promoting analytical, synthesized, evaluative and creative thinking skills (Inyaya & Thongyod, 2018; To-im & Waichalad, 2020). According to the National Education Act B.E. 2542 (1999) and the amendments (Version 3) B.E. 2553 (2010), Chapter 4, Section 2, specifying the learning process management guidelines “Teachers should organize content and learning activities in line with learners’ interests and aptitudes, focusing on skill training, thinking processes, management, and situational confrontation. and the application of knowledge used to prevent and solve problems where research could be used as a part of the learning process” (Office of National Education Commission, 1999).

Therefore, it is important to develop a guideline for teaching and learning activities that maximize benefits for students. In higher education, research-based learning (RBL) is another method that focuses on research process skills, developing thinking, and integrating knowledge content, and applied, it could be used for a variety of different subjects (Srikoon et al., 2018; Timroon & Linjalern, 2021; Wichadee, 2011). From the analysis of the results of the Ordinary National Educational Test (O-NET) to develop teaching and learning for 6th-grade students in Mathematics, suggestions are proposed to enhance and develop teaching management for subsequent levels to promote efficiency in problem-solving skills, analytical thinking for problem consideration, and skills in application and finding solutions which is a fundamental aspect of the critical thinking process, characterized by using reasoning to consider thoroughly and comprehensively in the domains of assessment and evaluation in education. In addition, the research-based learning management principles were consistent with the aims and principles of education management. According to the National Education Act, (2010), research-based learning management (Research-based Learning: RBL) could promote student achievement and create new knowledge by oneself. This is important for teaching and learning to build the skills of the 21st century that students need very much (Boonchit, (2022); Nillapun (2015)).

The goal of teaching and learning in Industrial Education (Technical Education) was to “produce students with teaching skills for future careers as industrial teachers”, with skills in measuring and evaluating learning outcomes being important skills for students. The students must have the knowledge and practical skills of measuring and evaluating appropriately to guide the assessment of the learners’ progress toward the required learning standards. From the rationale and importance of promoting knowledge and practical skills in the measurement and evaluation of students in the curriculum in industrial education, in the curriculum of the Bachelor of Engineering Program in Electrical Engineering and Education, there is a provision for teaching educational measurement and evaluation subjects in the first-year curriculum. The researcher studies and applies research-based learning to teaching and learning to promote learners’ knowledge and operational skills in measurement and evaluation, which had the characteristics of teaching and learning that students have to study and research applying their knowledge to practical work in the form of measurement and evaluation research step by step. As a result, the learners develop critical thinking skills and have a good attitude towards applying the research process to develop their own learning potential appropriately. From the above guidelines and importance, the researcher, therefore, studied a research-based learning model to promote critical thinking skills for learning in the educational measurement and evaluation to be used for skill training, measurement and evaluation processes at the class level and provide teaching activities that are in line with learning in the 21st century, that can encourage students to develop critical thinking skills that could effectively integrate knowledge in different fields.

Literature Review

Phakhaphamongkholchai and Sirisamphan (2018) studied research on the development of critical thinking skills using research-based learning. The sample used in this research were 40 Matthayomsuksa 5 students, and the instruments included lesson plan and the critical thinking skills test. The research results revealed that (1) the critical thinking skills of students after the use of the research-based learning were higher with statistical significance at .05; and (2) the critical thinking skills were at the highest level. From the above research, it was found that the use of the research-based teaching model with the learning management plan was appropriate and consistent with the content and the student level used in teaching and learning with steps and systematic

process of educating and organizing activities that allow learners to practice, making learners develop higher order thinking (analyze, synthesize, make rational decisions), resulting in learners learning and solving problems in the operation appropriately.

Phimpawee and Suppaluk (Suwanno & Sintana, 2018) carried out research on the study of learning achievement and research skills of fourth year students at Yala Rajabhat University with the learning and teaching focused on research-based learning; the sample used 43 undergraduates chosen by simple random sampling who were enrolled in the course of education research. The instruments used in this study were comprised of a 40 item learning achievement test, lesson plan and an evaluation questionnaire of research skills. The research results revealed that (1) the students' average of learning achievement was 76.74 percent of the total number of students; and (2) the students' average scores of research skills were 86.04 percent of the total number of students. From the said research, it was found that the research-based teaching model was suitable for teaching and learning at the higher education level, emphasizing research in creating a body of knowledge that used the process of seeking knowledge and truth by oneself systematically encouraging learners to "be able to think, able to solve problems", which are important skills that lead to lifelong learning and encourage learners to have higher learning achievements.

Khumraksa and Rakbumrung (2022) did research on the development of research-based learning activities affecting learning gain of the science student teachers in an environment science course; the sample of the research were 55 third-year science student teachers in the Faculty of Education, Surat Thani Rajabhat University. The research instruments comprised (1) Instructional handbook and lesson plan; (2) 90-item multiple-choice test; and (3) 5-point, Likert scale satisfaction questionnaire. From the above research, the research-based learning activity development had planning, design and sequence of steps that were appropriate for the course content and the learner level through various activities and variety in class, which could make the learners more enthusiastic about the learning with the freedom to learn. There was an exchange of knowledge within and between groups that could encourage learners to learn and solve problems in practicing appropriately and resulting in higher learning progress for the learners.

Research Objectives

1. To develop the research-based learning model to promote critical thinking skills in measurement and evaluation education.

2. To study the results of using the research-based learning model to promote critical thinking skills in measurement and evaluation education.

3. To study the satisfaction of participants through the research-based learning model.

Research Conceptual Framework

The researcher synthesizes concepts and summarizes variables in studying the research-based learning model to promote critical thinking skills for educational assessment and evaluation, as shown in Figure 1.

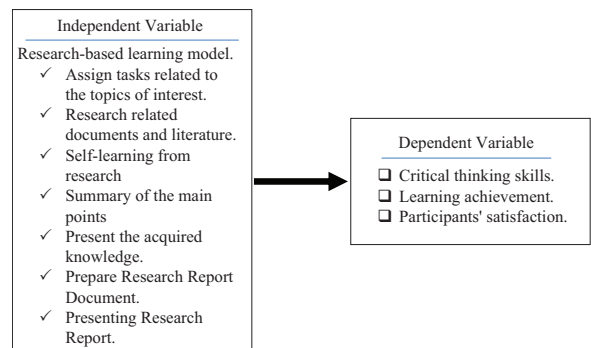


Figure 1 Conceptual framework in research

Methodology

The development of critical thinking skills using a research-based learning model in measurement and evaluation education through experimental research. The research design was the one-group pretest-posttest design. The details were as follows;

Participants

The population in this study were first-year undergraduate students at the Department of Teacher Training in Electrical Engineering Education, Faculty of Industrial Education, King Mongkut's University of Technology North Bangkok (KMUTNB), who enrolled in the educational measurement and evaluation subjects during semester 2/2022, 4 groups and 71 people. The participants used a purposive sampling method of 2 groups of 38 people, with a duration of learning 4 weeks (4 hours/week), facilitating time management in the organizing learning activities.

Data Collection

STEP 1: The development of the research-based learning model to enhance critical thinking skills in measurement and evaluation education.

1. The researcher studied the learning theory, the ability to critical thinking, and research related to the learning design for the basic concepts in creating the research-based learning model, as shown in Figure 1. The research-based learning model used for learning management allows learners to do their own research according to the steps of the 6-step process, namely, (1) Identifying tasks/issues of interest, (2) Researching relevant documents and research, (3) Self-learning from research, (4) Summarizing the main ideas, (5) Presenting knowledge obtaining; (6) Documenting the research report, and (7) Presenting the research report as shown in Figure 2:

1) Assign Step: The step is formulation of the problem topic that the learners must research by using research to be integrated with the student's prior knowledge.

2) Search Step: The step is search for knowledge by bringing different issues defined keywords to search for research topics that correspond to the desired keywords.

3) Learn Step: The step is self-learning from research where the learners bring relevant research and literature to work, study and consider the details of each work to see how interesting and consistent the issues are.

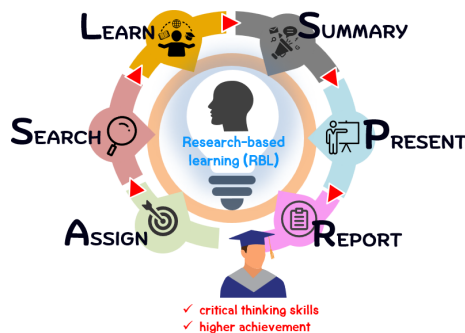


Figure 2 The research-based learning model

4) Summary Step: The step is learners had to filter the research for only the work that was relevant to the keywords, and what they want the most by bringing out a summary of the key points of each relevant research.

5) Present Step: The step is learners bring the main points of each research collected to make a media presentation to present the research on the issues that the learners have been assigned.

6) Report Step: The step is students made the research information presented in step 5 (present) to create a document to summarize the research that was researched.

2. The construction research instruments in this research consist of 5 parts: (1) The research-based learning lesson plan; (2) The learning management evaluation form; (3) The student satisfaction assessment form; (4) Pre-test and post-test; and (5) the Analytical thinking skill assessment form learning design for basic concepts in creating a research-based learning management model.

STEP 2: Experimenting with the research-based learning model to enhance critical thinking skills in measurement and evaluation education. The experimental research design was the one-group pretest-posttest design. The researcher tryout was with the research-based learning model with 38 participants in first-year bachelor's degree in Electrical Engineering and Education, Department of Teacher Training in Electrical Engineering, Faculty of Technical Education at King Mongkut's University of Technology North Bangkok (KMUTNB) in the educational measurement and evaluation subject as shown in Figure 3.

In organizing teaching and learning activities, the instruments used in the teaching and learning process were the lesson plan (The research-based lesson plan, pre-test, and post-test, the participant's satisfaction questionnaire, and the critical thinking skill assessment form). The research tool was evaluated for suitability by 7 experts, with the suitability value at a high level (The mean value must be higher than 3.50), which could be used for teaching and learning, the *SD* value was not more than 1.00, indicating that the experts have

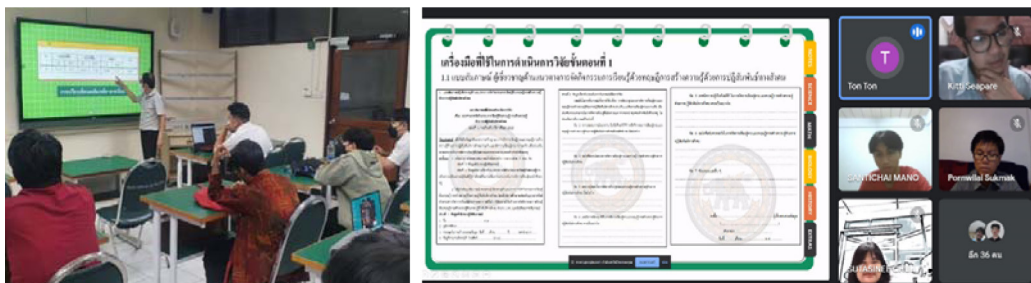


Figure 3 Experimenting with a research-based learning model

opinions in the same direction where the procedure for an experiment is as follows (1) Before the trial step: The researcher prepares the teaching and readiness of the learners; the participant takes the pre-test before studying that tests basic knowledge and collects scores to compare learning after studying, the instruments: The research-based lesson plan, and the pre-test; (2) Experimental step: The researcher organizes the research-based learning activities according to the 4 topics which were used in semester 2/2022 (March-April), duration of learning 4 weeks (4 hours/week). At the end of teaching activities, students took an achievement test. The instruments were the research-based lesson plan, pre-test, and critical thinking skill assessment form, which is the rubrics score form. The student with a mean score of more than 12 shows that the participant has critical thinking skills, and that the participant has passed the criteria of 75 percent of all students. Analyze statistical data using frequency, mean, and percentage; and (3) After the trial step: assess participant satisfaction, where the researcher compares before and after learning achievements, results of measuring analytical thinking skill, analysis of participant satisfaction, then conclusion and discussion; the instruments: The research-based lesson plan, post-test, and participant satisfaction questionnaires; this research used a one-group pretest-posttest design, which had the test after studying compared to before studying. Analyze statistical data using frequency, percentage, mean, *SD*., and compare differences between before and after the study using the *t*-test (*t*-test for dependent samples). Assessment of participant satisfaction with teaching and learning process through analysis of statistical data using Mean, *SD*; the participants were satisfied with the teaching and learning arrangement at a level of high or equal to 3.50. The *SD* value was not more than 1.00, indicating that the experts have opinions in the same direction.

Instrument

The study of the research-based learning model to promote critical thinking skills. The researcher created and developed the instrument used for research, as shown in Figure 4.

The instruments were as follows:

1. The research-based lesson plan presents elements of the research-based learning management, including: (1) the principles of critical thinking; (2) the details of the study style; (3) the research-based learning process; (4) the content in Measurement and Evaluation Subject; (5) the characteristics of teaching and learning activities; (6) teacher roles and learner roles; (7) tools and media; (8) details of measurement and evaluation was based on learning objectives.

2. The learning management evaluation form, which consisted of checklist, 5-point rating scale and open-ended questions.

3. Pre-test and post-test 80-item multiple choice; the content was divided into 4 units: (1) Measurement and evaluation tools, (2) achievement test, (3) basic statistics in measurement and evaluation, and (4) finding the exam quality. The questions and behavioral objectives passed the content validity from 7 experts and found that the IOC (Item Objective Congruence) value range was from 0.50–1.00 (with a value of 0.50 and above, considered consistent within the acceptable criteria).

4. The participant satisfaction questionnaires, which were a 5-point rating scale, topics for the assessment include the atmosphere in learning, learning activities, instructional media, measurement and evaluation.

Figure 4 The instruments for research

5. Critical thinking skill assessment form that was an authentic assessment. Teachers perform assessments during each step of the learning activities. This was an assessment of each aspect, including problem-solving skills. Assumption skills Summarizing skills and evaluation skills at the end of the learning process. The results obtained from this assessment were analyzed using statistical values, namely, mean and standard deviation.

Data Analysis

The researcher compared results of the pre-post learning achievement tests and results of the participant satisfaction with the research-based learning management to promote critical thinking skills. The statistical data analysis by descriptive statistics such as mean, standard deviation and inference statistics via using *t*-test.

Results

The study of the research-based learning model to promote critical thinking skills in measurement and evaluation education had designed teaching and learning activities based on the research-based learning process and established quality instruments. After that, it was used to try with a participant, analyze data, and conclude the results of the research. The results of the research include:

1. Details of the results of the quality of the research-based learning model by seven experts with more than 11 years of teaching experience are shown in Table 1, which found that the standards with the highest average of feedback were learning process ($M = 4.39$, $SD = 0.15$).

2. Details of the results of the quality instrument by the seven experts with more than 11 years of teaching experience are shown in Table 2, which found that the standards with the highest average of feedback were learning process ($M = 4.34$, $SD = 0.40$), and the standards with

the lowest average of feedback were instructional media standards ($M = 4.14$, $SD = 0.47$). Moreover, the item with the highest average was the learning model, which had a student-centred process ($M = 4.57$, $SD = 0.53$), and the item with the lowest average was the management of the learning activities which had a clear sequence of steps and continuous relationship ($M = 3.86$, $SD = 0.69$). Moreover, the experts suggested that in organizing learning activities, learners should have the appropriate research skills related to evaluation, thus the reducing time spent on teaching and learning activities was clear so that the work was consistent with the content.

3. The results of pre-post learning achievement

The experimental research design was a one-group pretest-posttest design, comparing participants' learning achievements, beginning with pre-tests by 38 participants, operating the learning process according to the developed lesson plan for all units, and then letting the students answer the 80 questions to measure the learning achievement. The data for learning progress was collected and analyzed using the educational statistics of the *t*-test. The analyzed results are shown in Table 3.

From Table 3, it was found that the Mean of the participants' pre-test and post-test scores were 28.92 and 56.00 respectively, and when comparing the pre-test and post-test scores, it was found that the participants' post-test scores were significantly higher than before at the .05 level.

4. The assessment results of the critical thinking skills.

The measurement of the research skills of the 38 first-year students who learn using the research. The measurement was performed by using the critical thinking skills assessment system, which consisted of 4 skills, namely, determination of the goal and problem skills, determination of the hypothesis skills, conclusion skills, and evaluation skills. The researcher observed the performance according to the activity sheet of the participants. Then, the participant's critical thinking skills were assessed during the participants' activities as shown in Table 4.

Table 1 Results of the research-based learning model

The topic in evaluation	(N = 7)	
	Mean	SD
1. The activities correspond to the learning style.	4.14	0.69
2. The specified activities could be performed and specified time.	4.14	0.69
3. Activities which encourage students to be creative	4.29	0.49
4. Encourage learners to be able to study by themselves.	4.29	0.49
5. Students had interactions/activities together.	4.57	0.53
6. The learning process could be linked to the content and level of the learner.	4.43	0.53
7. Measurement and evaluation were consistent with learning styles.	4.57	0.53
8. Measurement and evaluation of learning outcomes could be used to measure learning outcomes go to work.	4.43	0.53
9. Evaluation criteria were clear and appropriate.	4.29	0.49
10. Methods for measuring and evaluating learning outcomes	4.71	0.49
Total Mean	4.39	0.15

Table 2 Results of the quality of the instrument

		(N = 7)	
The topic in evaluation		Mean	SD
1. Learning process		4.34	0.40
1.1 The learning model had a student-centered process.		4.57	0.53
1.2 The learning model steps were related.		4.29	0.76
1.3 The teaching activities were appropriate.		4.43	0.53
1.4 The learning model encouraged learners for critical thinking skills.		4.14	0.38
1.5 The learning model could be applied for teaching and learning.		4.29	0.49
2. Learning activity management		4.17	0.55
2.1 The management of learning activities had a clear sequence of steps and continuous relationship.		3.86	0.69
2.2 The management learning activities had a clear process.		4.14	0.49
2.3 The management of learning activities encouraged learners to learn by using research-based learning.		4.29	0.49
2.4 Learning activities encouraged participants to practice planning for practice in field.		4.29	0.49
2.5 Learning activities encouraged participants to learn from the research process.		4.29	0.49
3. Instructional media		4.14	0.47
3.1 Learners searched for knowledge by themselves independently.		4.29	0.76
3.2 Instructional media were appropriate and consistent with learning management.		4.14	0.38
3.3 Instructional media helped encourage participants to learn by themselves.		4.00	0.58
3.4 Instructional media promoted success in learning and teaching management.		4.29	0.76
3.5 Instructional media supported and encouraged participants to have a good attitude in learning.		4.00	0.58
4. Measurement and evaluation		4.31	0.47
4.1 Measurement and evaluation were consistent with learning activity.		4.29	0.76
4.2 Measurement and evaluation tools were appropriate.		4.43	0.49
4.3 Measurement methods were diverse and used to assess learning outcomes.		4.43	0.53
4.4 Measurement methods could be used for data collection according to authentic learning.		4.14	0.53
4.5 Measurement and evaluation assessed knowledge, skills and attitudes.		4.31	0.69
Total Mean		4.24	0.41

Table 3 The compared results of the pre-post learning achievement tests

(N = 38)						
Achievement score	Full score	Mean	SD	t	df	p
Pre-Test	80	28.92	5.46	26.64	37	.0000*
Post-Test	80	56.00	4.96			

Note: * $p < .05$, one-tailed.

Table 4 Critical thinking skill scores of the participants

						(N = 38)
Critical thinking skill score					Passing score 75% (12 score)	
<i>N</i>	full score	mean	<i>SD</i>	percentage	Amount	percentage
38	16	12.79	2.11	85.27	29	76.32

From Table 4, it was found that the 38 students had an average critical thinking skill score of 12.79, representing 85.27 percent of the full score. 29 participants passed the criteria of 75 percent or more, representing 76.32 percent with basic skills assessment results for critical thinking as shown in Table 5. When considering each aspect of the components of the critical thinking process, it was found that Determination of the goal and problem skill

had a mean of 3.37 ($SD = 0.67$), and Determination of the hypothesis skill had an average of 3.34 ($SD = 0.67$). In conclusion, the skill had a mean of 3.18 ($SD = 0.77$), and the evaluation skill had a mean of 2.89 ($SD = 0.65$). The determination of the goal and problem skill, determination of the hypothesis skill, and conclusion skill of the participants were at a good level, but the evaluation skills were at a fair level.

Table 5 Critical thinking skill scores of the participants

					(N = 38)	
Critical thinking skill	Determination of the goal and problem skill	Determination of the hypothesis skill	Conclusion skill	Evaluation skill		
mean	3.37	3.34	3.18	2.89		
SD	0.67	0.67	0.77	0.65		

9 participants did not meet the criteria, constituting 23.68 percent, due to the steps and processes of teaching and learning requiring increased duration and learning resources. Facilitating participants' adaptation to the higher-order thinking process requires a lot of cognitive processes, such as critical thinking skills. Participants shifted from memorization to higher-order thinking skills. However, learners have been slow to adapt, thus hindering their ability to develop themselves as intended.

5. The results of the participant's satisfaction

The assessment of the satisfaction of the participants who passed through the research-based learning model was applied to a sample of 38 participants, as shown in Table 6, which found that the topic with the highest average of feedback was the learning atmosphere. ($M = 4.44$, $SD = 0.31$). The topics with the lowest average of feedback were measurement and evaluation standards ($M = 4.18$, $SD = 0.35$). Moreover, it was found the item with the highest average showed the participants the opportunity to do the activities independently ($M = 4.58$, $SD = 0.50$). The item with the lowest average was the measurement, and the evaluation assessed knowledge, abilities, skills, and attitudes. ($M = 4.00$, $SD = 0.52$).

Discussion

From the study of academic achievement and critical thinking skills of 38 first-year students enrolled in the academic measurement and evaluation subject in semester 2/2022 with the research-based learning teaching method, discussion of the results is as follows.

Learning Achievement

Learning Achievement of the 38 student participants when comparing pre-test and post-test found that the participant's post-test score was significantly higher than the pre-test at the .05 level because the research-based learning management encouraged the participants to learn in the content of measurement and evaluation appropriately, the participants to determine problem, research, and collect on their own from various learning resources to arrive at the answer, synthesize knowledge from research and literature, summarize the main points, presentation of knowledge, preparation of documents. The learners work by themselves from activities in a step-by-step manner, encouraging learners to have lifelong learning. In addition, students were involved in learning. There were discussions to create an atmosphere that promoted learning that

Table 6 Results of the participants' satisfaction

The topic in evaluation	(N = 38)	
	Mean	SD
1. Learning atmosphere.	4.44	0.31
1.1 Give participants the opportunity to participate in activities.	4.53	0.51
1.2 Participants were responsible for themselves and the group.	4.29	0.61
1.3 Participants were enthusiastic in learning.	4.42	0.50
1.4 Give students the opportunity to do activities independently.	4.58	0.50
1.5 Encourage participants to critical thinking skills.	4.39	0.50
2. Learning activity management	4.31	0.38
2.1 The management of learning activities had a clear sequence of steps and continuous relationship.	4.16	0.79
2.2 The management learning activities had a clear process.	4.21	0.66
2.3 The management of learning activities encourages learners to learn by using research-based learning.	4.42	0.50
2.4 Learning activities encourage participants to practice planning for practice in field.	4.39	0.50
2.5 Learning activities encourage participants to learn from the research process.	4.34	0.48
3. Instructional media	4.21	0.32
3.1 Learners searched for knowledge by themselves independently.	4.42	0.64
3.2 Instructional media were appropriate and consistent with learning management.	4.16	0.64
3.3 Instructional media helped encourage participants to learn by themselves.	4.16	0.49
3.4 Instructional media promoted success in learning and teaching management.	4.21	0.47
3.5 Instructional media supported and encouraged participants to have a good attitude in learning.	4.13	0.47
4. Measurement and evaluation	4.18	0.35
4.1 Measurement and evaluation were consistent with learning activity.	4.32	0.62
4.2 Measurement and evaluation tools were appropriate.	4.03	0.64
4.3 Measurement methods were diverse and used to assess learning outcomes.	4.42	0.50
4.4 Measurement methods could be used for data collection according to authentic learning.	4.16	0.49
4.5 Measurement and evaluation assessed knowledge, abilities and attitudes.	4.00	0.52
Total Mean	4.29	0.19

emphasized higher thinking processes. This was consistent with the research by Numtip (Trakulmaykee, 2020), a study on learning outcomes of research-based learning on the content of knowledge management in organization which found that students' post-learning achievement was higher than before at the statistical significance level of .05 due to research-based teaching and learning management. Such helps to increase learning achievement because the research process could enable learners to gain knowledge and understand the topics studied, creating skills in seeking knowledge and learning the theory of concepts meaningful principles and findings because this type of learning management has allowed students to study related research and creating questions that encourage students to think critically and creatively in a systematic way.

Critical Thinking Skills

From the results of the skill assessment, it was found that participants' critical thinking skills, with an average of 12.79 think, were 85.27 percent of the full score. There were 29 participants who received a passing score of 75 percent, representing 76.32 percent of all students. When considering each aspect of the critical thinking process, it was found that the determination of the goal and problem skill had a mean of 3.37 ($SD = 0.67$), and the determination of the hypothesis skill had a mean of 3.34 ($SD = 0.67$), the conclusion skills had a mean of 3.18 ($SD = 0.77$) and the evaluation skill had a mean of 2.89 ($SD = 0.65$), which could show that the determination of the goal and problem skill, the determination of the hypothesis skill, and the conclusion skills of the participant were at a good level, but the evaluation skill, which was the decision to draw reasonable conclusions from the subjects' different studies, was at a fair level because evaluation skills are high-level skills that require learning experience and basic knowledge in all related fields, both academic knowledge, measurement and evaluation of education including academic research in education. It was a skill that most learners needed quite a lot of time in order to gather all the information to synthesize and make decisions in choosing reasonable conclusions well enough. Overall, the results of the research are consistent.

Participant's Satisfaction

According to the results of the assessment of participant's satisfaction with the teaching and the learning management using the developed research-based learning model, it was found that the participants' satisfaction was at a high level because the teaching and learning process promote participants search for knowledge

independently, opportunities were given for participants to do activities by themselves where the property of the activities was consistent with the actual application of the content, exchange knowledge with instructor who is responsible for providing appropriate suggestions. This was consistent with the research by Songphop and Kanchana (Khunmathurot & Witchayapakorn, 2021), who studied student's satisfaction with research-based learning management in the course of literature theory and teaching Thai literature. They found that the learners were satisfied with the research-based teaching and learning management at the highest level because the learning management process encouraged the learners to think and search answers continually, whereby learners create a new explicit knowledge. In addition, learners are enthusiastic all the time in the teaching and learning process.

Research-based learning can enhance learners' learning achievement of critical thinking skills because research-based teaching and learning management is grounded in the theories of Constructivism learning and Constructionism learning, which emphasizes enabling learners to construct new knowledge from their existing knowledge in conjunction with new discoveries. The teacher is a mentor and facilitator guiding students toward independent learning and knowledge creation. This research has methodologies and steps for learning management that help enhance the learners' learning achievements in critical thinking skills, such as assign, search, learn, summary, present, and report. In each step, learners utilize the research process to seek answers independently rather than learn from the content in books. Creating explicit knowledge on their own enables learners to remember and learn effectively, which aligns with the identity of KMUTNB: "Graduates with creativity and practicality" and develop KMUTNB learners to have the necessary skills and abilities in three aspects, including (1) Intrapersonal Domain, (2) Cognitive Domain, and (3) Interpersonal Domain (King Mongkut's University of Technology North Bangkok, 2024). Furthermore, 21st-century skills, which would be a crucial foundation in preparing students before graduating and entering society to develop the national and global community, align with Prateep's (Metakunawut, 2003) statement that knowledge is abundant and constantly emerging in teaching and learning through research-based methods. This approach to teaching encourages students to seek knowledge beyond learning from textbooks, enjoy learning, ask questions that lead to research, engage in collective brainstorming and analysis, allow students to seek knowledge on their own, create new bodies of knowledge, and foster lifelong learning.

Conclusion and Recommendation

The developed research-based learning model is appropriate and can encourage learners to have higher learning achievement. The students' post-test scores were significantly higher than the pre-test at the .05 level, and 85.27 percent of participants had appropriate critical thinking skills. In addition, learners develop design skills, data collection planning skills, search of knowledge skills step-by-step, data analysis skills rationally, summarizing skills that are consistent with actual practice, and working with others. This promotes lifelong learning for learners appropriately. From the research results, in each skill of the critical thinking process of the participant, the determination time of each activity is different. Particularly in terms of the activity period, assessment skills should allow sufficient time to allow learners to synthesize and make decisions in selecting conclusions reasonably, including various aids such as learning resources corresponding to problem situations that are important to help learners spend less time on research and study to synthesize information, including helping students to develop critical thinking processes easily.

Recommendation for Future

1. Adapt the Diversity of Learning Activities, which engages teaching and learning by applying various learning methods combined with research-based learning processes such as gaming activities, project-based learning, etc.

2. The management of teaching and learning using research-based learning can be applied to other subjects and should be studied with variables that emphasize analytical thinking skills, problem-solving skills, and other skills relevant to the research-based learning model.

Conflict of Interest

The authors declare that there is no conflict of interest.

Acknowledgements

This research was funded by the Faculty of Technical Education, King Mongkut's University of Technology North Bangkok (KMUTNB) Contract FTE-2565-07.

References

- Boonchit, Y. (2022). A research-based learning model for enhancing critical thinking skills of student enrolling in educational quality assurance course. *Journal of Graduate Studies Valaya Alongkorn Rajabhat University*, 16(2), 81–95. <https://so02.tci-thaijo.org/index.php/JournalGradVRU/article/view/246020>
- The Office of National Education Commission. (1999). *National Education Act, B.E.2545*. Seven Printing Group Co., Ltd.
- Inyaya, Y., & Thongyod, W. (2018). Student-centered learning management and portfolio-based authentic assessment in the Thai language for elementary teachers 2 course. *Journal of graduate Research*, 9(1), 25–38. <https://so02.tci-thaijo.org/index.php/banditvijai/article/view/99510/98141>
- Khumraksa, B., & Rakbumrung, P. (2022). The development of research-based learning activities affecting learning gain of science student teachers in an environment science source. *Journal of Education, Prince of Songkla University, Pattani Campus*, 33(2), 30–46. <https://so02.tci-thaijo.org/index.php/edupsu/article/view/247096>
- Khunmathurot, S., & Wichayapakorn, K. (2021). Student's satisfaction with research-based learning management in the course of literature theory and teaching Thai literature. *Liberal Arts Review*, 16(2), 159–170. <https://so04.tci-thaijo.org/index.php/larhcu/article/view/242749>
- King Mongkut's University of Technology North Bangkok. (2024, April 4). *The desired characteristics of the graduates*. https://acdserv.kmutnb.ac.th/wp-content/uploads/2019/07/bundit_kmutnb.pdf
- Metakunawut, P. (2003). *Teaching using the research process* (3rd ed.). Chulalongkorn University.
- Nillapun, M. (2015). *Research Methodology in Education* (8th ed.). Research and Educational Development Center, Faculty of Education, Silpakorn University.
- Phakhaphamongkholchai, W., & Sirisamphan, O. (2018). The development of critical thinking skills using research-based learning of Matthayomsuksa 5 students. *Silpakorn Education Research Journal*, 10(2), 241–254. <https://so05.tci-thaijo.org/index.php/sueduresearchjournal/article/view/86252>
- Srikoon, S., Bunterm, T., Nethanomsak, T., & Ngang Tang, K. (2018). Effect of 5P model on academic achievement, creative thinking, and research characteristics. *Kasetsart Journal of Social Sciences*, 39(3), 488–495. <https://so04.tci-thaijo.org/index.php/kjss/article/view/242573>
- Suwanno, P., & Sintana, S. (2018). The study of learning achievement and research skills of the fourth year students at Yala Rajabhat University with a learning and teaching focused on research-based learning. *Journal of Yala Rajabhat University*, 13(1), 161–170. https://so04.tci-thaijo.org/index.php/yr_u_human/article/view/157512
- Timroon, S., & Linjalern, A. (2021). Linjalern. The development of research based learning in unit "life in the environment" to promote critical thinking skills of grade 10 students. *Journal of Faculty of Education Pibulsongkram Rajabhat University*, 2(2), 240–252. <https://so02.tci-thaijo.org/index.php/edupsru/article/view/248185>
- To-im, J., & Waichalad, U. (2020). The study of learning achievement of student-centered learning approach: Principle of environmental informatics course. *Silpakorn University Journal*, 40(2), 115–131. <https://so05.tci-thaijo.org/index.php/sujthai/article/view/131210/164332>
- Trakulmaykee, N. (2020). Learning outcomes of research-based learning on content of knowledge management in organization. *Journal of Education Naresuan University*, 22(4), 129–138. https://so06.tci-thaijo.org/index.php/edujournal_nu/article/view/114364
- Wichadee, S. (2011). Education in the new paradigm: Research-based learning. *Executive Journal*, 31(3), 26–30. https://www.bu.ac.th/knowledgecenter/executive_journal/july_sep_11/index.html