Teaching Method for Active Learning Using Thinking and Practical Skills

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Abstract

The objectives of this paper were to 1) study and analyze active learning instructional management and 2) summarize the results of the application of teaching and learning techniques using active learning. The population was 342 instructors. The research tool was a questionnaire on instructional management. The data was analyzed with frequency, percentage, and content analysis. The research findings revealed that 1) active learning instructional management was divided into four groups as follows: 1.1) focus on developing individual thinking skills, 1.2) focus on developing individual practical skills, 1.3) focus on developing group thinking skills, and 1.4) focus on the development of group practical skills. 2) The results of active learning instructional management were as follows: 2.1) learning by doing, 2.2) project-based learning, 2.3) brainstorming and 2.4) case study and discussion. promote active learning, universities should encourage learning exchange forums, and promote cross-disciplinary teaching integration and cross-disciplinary learning techniques

Keywords: Active learning, Higher Education, Practical-based instruction, Thinking-based instruction.

1. Introduction

A learning style where the teacher is the messenger and learners are only the recipients is a one-way communication, causing the learning process to be less efficient than it should be. Therefore, teachers must adapt to becoming facilitators and keep guiding students to pursue knowledge on their own [1]. Instructional management that meets the needs of education management in the 21st century suggests that active learning can respond to the learning management in the 21st century, which needs to reduce the role of the teacher but increase the role of the learner. It is a learning management that focuses on what students do and think about what they have done to create a direct experience to interact with classmates and teachers by doing activities together, both in and out of class. Students then build knowledge from what has been done through listening, speaking, reading, writing, discussion, and reflection to make sense of what has been learned. Active learning consists of five steps of instruction: stimulating interest, showing a challenging situation, discussing reflex thinking, constructing knowledge, and collaborative learning [2]. Active learning instruction reflects the use of materials and exchange process analysis, which promotes higher-order thinking skills, critical thinking, and hands-on experience in real-world situations and can be applicable in all fields [3]. The principle of active learning and learning outcomes, where learning outcomes are positively significant, can include a method of measurement that is not problematic. This research is a study of engineering education in a higher education context from 66 articles by content analysis. The results illustrated that active learning can be accomplished in many

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ways. There is evidence of the use of active learning in the teaching process. The impact of using active learning is measured. According to self-reported learning outcomes and subjects related to the knowledge, they are appropriate because the evidence studied is obvious in the application of active learning [6].

Active learning using the Australasian Survey of Student Engagement [7] consists of questions about teaching during the current academic year, including working on projects with students during class, provided in-class or online presentations, asking questions or participating in class or online discussions, participating in community-based projects as part of the course, working with students outside the class, discussing ideas from readings or from those involved outside the class, and teaching students from different institutions. According to the study, the active learning teaching strategy consists of three components [4], namely, active learning classrooms, which are a set of individual activities, paired activities, and cooperatives in small groups. This all depends on class size, space, and learning activities between students. In addition, active learning strategies that have a positive impact on students' learning outcomes in undergraduate college algebra and business calculus courses in mathematics have a variety of strategies [8], including interactive presentation style, group work with discussion and feedback, volunteer presentations of solutions by groups, raising students' learning interest towards specific topics, involving students in mathematical explorations, experiments, and projects, and the continuous motivation and engagement of students. The findings showed that using these strategies had a positive effect on both student passing rates and the average results of the sections. Center for Excellence in Learning and Teaching, [9] presented 226 active learning teaching techniques, which are: 1) lecture, 2) small class size lecture, 3) student action: individual, 4) student action: pair, 5) student action: groups, 6) second chance testing, 7) YouTube, 8) mobile and tablet devices, 9) audience response tools, 10) creating groups, 11) icebreakers, 12) games, 13) interaction through homework, 14) student questions, 15) role play, 16) student presentations, 17) brainstorming, and 18) online interaction. In addition, [10] explored undergraduates' perceptions of the use of active

learning techniques in science lectures. According to the written comments from over 250 students, they provided rationale for why students may believe that active learning techniques can improve or hinder their learning and experience. Students in their fourth year and fifth year were more likely to believe that active learning approaches used in class were a waste of lecture time, whereas third-year students considered that these techniques were helpful in enhancing their understanding and interactions with teachers and peers. Additionally, students offered recommendations for the efficient use of active learning techniques in lectures.

The researchers use a survey for active learning instructional management in higher education by collecting data from lecturers, including the application of teaching techniques in the classroom for various disciplines to answer the survey. These are guidelines for teaching and learning that are suitable for the courses and students at an undergraduate and graduate level.

The objectives of this research were to 1) study and analyze active learning instructional management that emphasizes thinking and practicality and 2) summarize the results of the application of teaching and learning techniques using active learning by instructors.

2. Methods and Materials

2.1 Research methodology

The research design used in this study was a survey research.

The population was used by 342 Sripatum University instructors from 12 faculties, 3 colleges, and 1 institute. The number of study participants of 323 (94.44%) responded to the survey.

The research instrument used a questionnaire consisting of three parts: 1) general information, 2) active learning teaching techniques, which were 2.1) thinking instruction techniques (individual), 2.2) practical instruction techniques (individual), 2.3) thinking instruction techniques (group), and practical instruction techniques (group), and 3) open-ended questions about applying active learning teaching techniques. The

questionnaire was evaluated by three experts, and the Index of Item-Objective Congruence was higher than 0.5 [11]. The instructors can reply to choose more than one active teaching method.

2.2 Data collection

The researcher conducted an online questionnaire through the university system and instructors who taught in the academic year 2022 to answer the questionnaire, and open-ended questions as well for the application of active learning teaching techniques in their classroom for each major.

2.3 Data analysis

The data was analyzed with basic statistics, frequency, percentage, and content analysis.

3. Results

The research results consisted of two parts that reflected the following study objectives:

1) Study and analyze active learning instructional management that emphasizes thinking and practicality and 2) summarize the results of the application of teaching and learning techniques using active learning.

Part 1 summarizes the results of the analysis of active learning instructional management, focusing on thinking and practicality, which consisted of the presentation of the information on the affiliation of instructors who responded to the questionnaire. The results of active learning instructional management focusing on thinking and practicality for both individuals and groups are as follows:
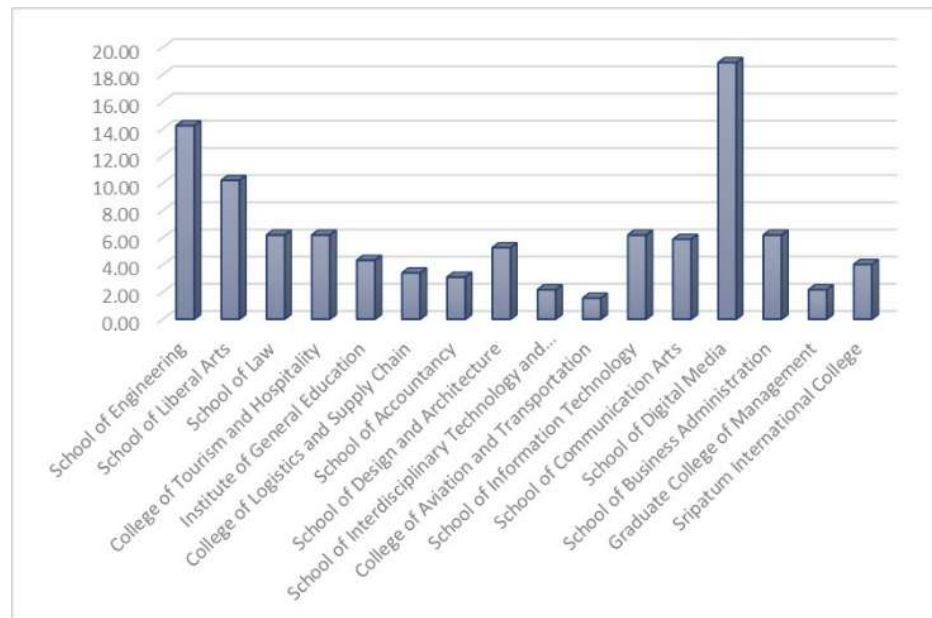
Fig. 1 Percentage of Instructors Who Responded to the Questionnaire Classified by at the Faculty Level

Fig. 1. Sripatum University consisted of 16 at the faculty level or equivalent, with a total of 342 full-time instructors (information from the Human Resources Department on 6 September 2022). The data were collected, which represented 94.44% of all instructors. Most of three instructors who answered the questionnaire were from the School of Digital Media, Engineering, and Liberal Arts, respectively.

The university operated in teaching and learning to develop graduates to achieve knowledge according to the curriculum goals that focused on learning outcomes. The presented here below is a summary of demographic information regarding study participants and their respective faculties with which they are affiliated. Also included in the summary are the study results regarding the utilization of active learning instructional management strategies/approaches applied by the participants in their respective classrooms with greater emphasis placed on thinking and practical skills as follows:

Table 1 The Results of Active Learning Instruction Focus on Developing Individually Thinking Skills

Teaching techniques	No. of respondents	Percentages
Questioning method	212	19.92
Thinking based learning	191	17.95
Self-learning	181	17.01
Reactions to videos	145	13.63
Student's reflection	91	8.55
Student-led review sessions	89	8.36
Brain-based learning	57	5.36
Flipped classroom	39	3.67
Keeping journals or logs	34	3.20
Other ways of individual thinking skills	24	2.26
Constructivism	1	0.09
Total	1,040	100.00

Table 1. The results of the study on the 10 active learning teaching and learning techniques employed by the study participants in their respective classrooms to develop students' individual thinking skills. Three were among the top commonly used techniques: questioning method, thinking-based learning, and self-learning, which represented 19.92%, 17.95%, and 17.01%. of the participants, respectively. Also, the three least utilized active learning teaching and learning techniques were flipped classroom, keeping journals or logs, and constructivism, which represented 3.67%, 3.20%, and 0.09% of the participants, respectively.

Table 2 The Results of Active Learning Instruction Focus on Developing Individually Practical Skills

Teaching techniques	No. of respondents	Percentages
Learning by doing	256	24.50
Independent study	171	16.36
Work-based learning	140	13.40
Technology-based	137	13.11
Discovery method/inquiry-based	114	10.91
Concept mapping	84	8.04
Research-based	52	4.98
Scientific method	42	4.02
Students generated exam questions	36	3.44
Learning management focused on other practices	13	1.24
Total	1,045	100.00

Table 2. The results' study of nine concepts and theories about active learning teaching and learning techniques focused on developing individual practical skills and found that most instructors applied these top three used instructional management techniques: learning by doing, independent study, and work- based learning, which represented 24.50%, 16.36%, and 13.40%. In addition, the three least utilized research- based, scientific methods, student- generated exam questions, and learning management that focused on other practices.

Table 3 The Results of Active Learning Instruction Focus on Developing Group Thinking Skills

Teaching techniques	No. of respondents	Percentages
Case studies	196	21.78
Think-pair-share	174	19.33
Brainstorming	136	15.11
Demonstration method	129	14.33
Integration instruction	108	12.00
Coaching	105	11.67
Multiple intelligence	25	2.78
Student debates	19	2.11
Learning management emphasized other ways of thinking	8	0.89
Total	900	100.00

Table 3. The study finding of eight concepts and theories about active learning teaching and learning techniques focused on developing group thinking skills and found that most instructors applied these top three used instructional management techniques: analyze case studies, think- pair- share, and brainstorming, which represented 21. 78% , 19. 33% , and 15. 11% . Also, the three least utilized multiple intelligences, student debate and learning management, emphasized other ways of thinking, respectively.

Table 4 The Results of Active Learning Instruction Focus on Developing Group Practical Skills

Teaching techniques	No. of respondents	Percentages
Project-based learning	181	16.35
Activity-based learning	149	13.46
Collaborative learning group	125	11.29
Discussion group	106	9.58
Problem-based learning	104	9.39
Committee work method	97	8.76
Experiential learning	93	8.40
Simulation	68	6.14
Role playing	58	5.24
Games-based learning	54	4.88
5E model	22	1.99
Scaffolding	14	1.26
Community-based learning	11	0.99
Learning management focuses on other practices	9	0.81

Teaching techniques	No. of respondents	Percentages
STEM education	7	0.63
Jigsaw	6	0.54
CIPPA model	3	0.27
Total	1,107	100.00

Table 4. describes the study's findings of 16 concepts and theories about active learning teaching and learning techniques focused on developing group practical skills and discovered that most instructors applied these three as the top instructional management techniques: project-based learning, activity-based learning, and collaborative learning groups, which represented 16.35%, 13.46%, and 11.29%. These were followed by discussion groups, problem-based learning, committee work methods, experiential learning, simulation, role-playing, and games-based learning with 4.88%–9.58%, respectively.

Part 2: Summarize the results of the application of teaching and learning techniques using active learning.

The results regarding the application of teaching and learning techniques using active learning: the study participants reported to have applied 15 different approaches, which are delineated here below in greater detail.

1) Learning by doing: This type of instruction is a university policy. The students will have the opportunity to learn from planning, designing, and practicing in real settings, for example, in a tourist guide subject. Students will get to work organizing trips and being an actual tour guide. In the flower arrangement subject, a flower arrangement demonstration was provided for students to give them practice. Moreover, the information technology subject assigned students to use the AI chatbot and to try it out in real situations with clearly defined results. Practical instruction can be applied both in the laboratory and in a real setting. This may start with a study tour or learning from people with real experience, and then the knowledge is taken to the workshop. In addition, a task or project may be assigned to provide students with the opportunity to analyze, exchange their ideas with the team, design, and present their progress to receive suggestions to improve their task or project. However, there must be a clear set of criteria. This represented 20.00% (47 responses).

2) Project-based learning can be applied in many disciplines and combined with other teaching techniques such as project-based and group discussion, where the instructor performs as a facilitator giving advice during activities.

Project-based learning was used for creating a final task to measure learning outcomes by involving various subjects in a major. For example, the Acting and Film Shooting subjects in the School of Communication Arts assigned a final project to their senior students by asking them to perform and film with an emphasis on real practice. There were different ways of measuring their learning outcome from their participation. In addition, they must present their work progress and receive suggestions from external specialists during the project, which includes developing project design by assigning fieldwork to collect data, analyzing and synthesizing information, and then summarizing the concept with a coach until it can be developed into a project. An example was of designing character concept art using imagination on the anatomy of muscles of animals to communicate the ideas of character characteristics that the learners planned. This was designed as the final project to summarize the knowledge learned in the past semester. Additionally, using difficulties encountered from the establishment to create a project such as in the hotel business development planning, which offered students the opportunity to visit the area to study problems from the workplace and apply the hotel knowledge learned to solve problems. Their project was then evaluated by instructors and specialists. Another example was in technology, which assigned students to find a pain point and use it to design a solution with Internet of Things (IoT) technology. This included steps of creating a project using design thinking, brainstorming to solve problems, and

developing projects with an emphasis on teamwork and self-experience.

Additionally, students work on a project with detailed steps by learning the theory together with an analysis of the problem, doing exercises, and experimenting with practice until they understand the whole picture and are divided into groups to develop work pieces. For example, Business Administration provided international business plan writing, or Engineering provided steel bridge design for students to build a wall and test its strength, then calculate those designs. This accounted for 13.19% (31 responses).

3) Brainstorming focuses on self-learning, with instructors stimulating learning through activities and various teaching materials with other teaching techniques, including role play or demonstration. In this regard, brainstorming was a teaching technique that allowed students to work as a team, learn together, brainstorm ideas, collect information, and investigate more information to expose ways to develop or solve problems. For example, solving problems for community entrepreneurs, designing a project to transfer wisdom to the elderly, developing technological measurement tools for the industrial sector in cooperative education, giving logistics regulations presentations, analyzing legal issues for the prosecution and defense, and analyzing natural building structures, including the design of co-working space, can lead to the development of specific projects. This represented 10.21% (24 responses).

4) Case study and discussion was an analysis of case studies and organized group discussions in which students participated in critiques and presentations to find solutions. The case studies used must be relevant to the subject content. Students analyzed what was researched together and then presented it in class. Then they discussed and exchanged ideas between themselves and instructors by comparing existing experiences with new experiences that have been researched. It could be applied in a variety of ways in teaching, including conducting international business practice in group activities, conducting comparative studies on educational management in each country, creative and design thinking, lawsuit analysis, and comparing international law, etc. In addition,

case studies that have been learned in class could also be used to organize debates to illustrate different points of view. Combined integrated learning between content and different disciplines could be done as well. This represented 9.36% (22 responses).

5) Thinking and design thinking encouraged students to think by listening to expert speakers in the industry. Problems determined by entrepreneurs, including simulations, allowed the students to organize the thinking process as a group or in pairs. The thinking pair shared techniques and exchanged their ideas and designed thinking systematically, with a plan to create a simulation model from the knowledge learned. This could be linked to research leading to practice, including business planning with a business model canvas, the application of theory to solve rail system problems, the design and selection of machine parts with available materials in the market applying theoretical calculations, and simulation with engineering software packages with a thinking process and problem solving. This accounted for 7.23%. (17 responses)

6) The demonstration method was an illustration by the teacher to give an example and allow students to watch a video using the simulation and organize real practice, such as a demonstration of how to make duets according to hotel standards, a demonstration of mechanical solutions, a demonstration of how to arrange flowers in various ways, or a demonstration of the use of an AI chatbot. Students could test the method out with clear criteria for evaluating results. This represented 5.96% (14 responses).

7) Simulation was the creation of a simulated situation to practice analyzing the cause and solution or assigning problems that were related to the assignment to practice analytical thinking and design in combination with other teaching techniques such as brainstorming, collaborative learning, and discussion groups. For example, creating a conversational situation from teaching material, speaking English or Chinese, and using vocabulary in aviation business by dividing the students into groups according to their proficiency to help each other. Other examples include defining a situation that causes a defect, such as an engine breakdown, to analyze and repair, piloting self-introduction to go to a

company meeting, and designing new furniture from work samples. This represented 4.68% (11 responses).

8) Questioning methods could be used in conjunction with other techniques such as discussion, case studies, and collaborative learning by using questions as a tool that allowed students to find answers and to always participate in their learning. It also promoted the exchange of ideas between the group and the instructor, including encouraging the use of analytical thinking and finding ways to solve problems. For example, students gave instances of problems that arise in companies both nationally and internationally, then used provocative questions to work together to find a solution or present examples of products focusing on being customer-centric and ask questions of how to proceed. This represented 4.68% (11 responses).

9) Game-based learning was to create a learning atmosphere by having students solve problems through games and using gamification to stimulate teaching and learning environments, such as the design of works from the knowledge of art history in different eras, creating scenes in Minecraft, and including the design of board games, tarot cards, and art toys. Moreover, in logistics, a Lean game or a Beer game was used, etc. Learning through games encouraged students to work together, peer to peer, and exchange knowledge with each other. This accounted for 4.26% (10 responses).

10) Inquiry-based learning was an assignment for students to study and research by themselves or in groups, including study and research on concepts, theories, and research from documents, databases, or videos related to the content in the lesson. For example, study and research on legal cases, concept art, or performances from field trips to discuss and present what was studied along with answering questions. This represented 4.26% (10 responses).

11) Role playing was used for presentations such as the presentation of results from experiments. Furthermore, students presented role-play styles such as first aid training, resolving emergency situations on airplanes, or simulating situations that may occur on the plane by allowing students to attempt and practice in an actual location like the Air Asia Academy. Students could also practice their language communication skills, including vocabulary, sentence structures, and phrases with role play, and communicate in English and Chinese in common situations. In addition, role-playing in the tourism management career simulation for MICE and tourist guide businesses could also be done. This accounted for 4.26% (10 responses).

12) Activity-based learning was about learning through activities. The application of theories was related to the contents consisting of case studies, activities, on-site analysis such as documents, preparation for establishing and operating a business, or space simulation design for interior design, etc. Another example was organizing activities that focused on collaborative learning among students on the specified topic. This represented 3.83% (9 responses).

13) Flipped classroom was an assignment for students to study by themselves through VDOs or assigning problems or keywords to be analyzed in advance and take the pre-test via an online system. When attending class, students brought the studied information to be analyzed and exchanged among classmates, summarizing and presenting by using technology according to the learner's expertise. This represented 2.13% (5 responses).

14) Programming was used to teach mathematics, calculate engineering analysis results, discover causes and solutions to problems, summarize results, and present reports. This represented 2.13% (5 responses).

15) Mind mapping was used to summarize research, produce reports, and write journals to comment on topics that were relevant to a lesson in an English grammar course by assigning students to summarize the grammar from the lesson with a mind map and infographic accompanying the presentation. They could be assigned to work in pairs or in groups. This represented 1.70% (4 responses).

4. Discussion

The delineation of the study discussion are the followings:

1. Active learning teaching and learning techniques were divided into four categories as follows: 1) focus on developing individual thinking skills found that most instructors applied questioning methods, thinking-based and self-learning, respectively, 2) focus on developing individual practical

skills found that most instructors applied learning by doing, independent study, and work-based learning, respectively, 3) focus on developing group thinking skills found that most instructors applied analyses case studies, think-pair-share and brainstorming, respectively, 4) focus on developing group practical skills discovered that most instructors applied project-based learning, activity-based learning, and collaborative learning groups. The results were consistent with the research of [2] that found active learning as a learning management that could respond well to learning in the 21st century. This reduced the role of the teacher but increased the role of students. It emphasized the students to act and think about what they have done to create a direct experience for them by interacting with peers and teachers and by attending activities together both in and outside of class. Later, they built knowledge through listening, speaking, reading, writing, discussion, and reflection to make sense of what they have learned. Active learning consisted of five steps of instruction: stimulating interest, showing a challenging situation, discussing reflex thinking, constructing knowledge, and collaborating learning. In addition, [6] studied the principles of active learning and learning outcomes where learning outcomes were positively significant; however, the method of measurement was not a problem. This research was a study of engineering education in a higher education context from 66 articles by content analysis. The results illustrated that active learning can be accomplished in many ways. There was evidence of the use of active learning in the teaching process. The impact of using active learning was measured. According to the self-reports of learning outcomes and subjects related to the knowledge, all were appropriate because the evidence studied was obvious in the application of active learning.

2. The results of teaching and learning using active learning of instructors in order of frequency were as follows: 1) Learning by doing, 2) Project-based learning, 3) Brainstorming, 4) Case study and discussion, 5) Thinking and design thinking, 6) Demonstration method, 7) Simulation, 8) Questioning method, 9) Game-based learning, 10) Inquiry-based learning, 11) Role playing, 12) Activity-based learning, 13) Flipped classroom, 14) Programming and 15) Mind

mapping. These were in line with the Center for Excellence in Learning and Teaching, [9] which proposed 226 active learning teaching techniques that were divided into 1) Lecture, 2) Small class size lecture, 3) Student action: individual, 4) Student action: pair, 5) Student action: groups, 6) Second chance testing, 7) YouTube, 8) Mobile and tablet devices, 9) Audience respond tools, 10) Creating groups, 11) Icebreakers, 12) Game, 13) Interaction through homework, 14) Student questions, 15) Role play, 16) Student presentations, 17) Brainstorming and 18) Online interaction.

5. Conclusions

The following are the conclusions:
Active learning teaching and learning techniques were divided into four categories as follows: 1) focus on developing individual thinking skills found that most instructors applied questioning method, thinking-based and self-learning, respectively, 2) focus on developing individual practical skills found that most instructors applied learning by doing, independent study, and work-based learning, respectively, 3) focus on developing group thinking skills found that most instructors applied analyses case studies, think-pair-share, and brainstorming, respectively and 4) focus on developing group practical skills discovered that most instructors applied project-based learning, activity-based learning, and collaborative learning groups, respectively. Using active learning of instructors in order of frequency were as follows: 1) Learning by doing, 2) Project-based learning, 3) Brainstorming, 4) Case study and discussion, 5) Thinking and design thinking, 6) Demonstration method, 7) Simulation, 8) Questioning method, 9) Game-based learning, 10) Inquiry-based learning, 11) Role playing, 12) Activity-based learning, 13) Flipped classroom, 14) Programming, and 15) Mind mapping.

6. Recommendations

The information in the Recommendation section is expertly presented.

6.1 Suggestions for applying the research results

1. Teachers should consider selecting appropriate active learning teaching techniques to apply in their responsible subjects. Moreover, there should be a variety of teaching techniques consistent with learners and an emphasis on students' learning and cooperation in the teaching design.

2. Faculty administrators should encourage teachers to continuously develop teaching and learning techniques through active learning and welcome students' suggestions to improve their teaching efficiency.

3. University administrators should support learning exchange forums to disseminate active learning teaching and learning strategies between disciplines, as well as promote cross-disciplinary teaching integration.

6.2 Suggestions for future study

1. Recommendations and guidelines for teaching and learning through active learning that focus on stakeholders should be studied, the design should be collaborated on, and the teaching plan should be systematically created.

2. An analysis of the causes of problems that affect students in learning due to teaching and learning management of instructors should be done to plan for developing and solving problems sustainably.

7. References

[1] K. Chatkaew, & S. Pymsa-ard, Active learning management in the Thailand 4.0 era of lower secondary school teachers, Humanities and Social Sciences Journal Ratchaphruek University 7(1) (2021) 136–151. [in Thai].

[2] K. Phoyen, Active learning: Learning satisfy education in 21st century, Journal of Education Silpakorn University 19(1) (2021) 11–28. [in Thai].

[3] A.J. Rissanen, Active and peer learning in STEM education strategy, Science Education International 25(1) (2014) 1–7.

[4] Z. Zayapragassarazan, & S.Kumar, Active learning method, NTTC Bulletin 19(1) (2012) 3–5.

[5] E. Lugosi, & G. Uribe, Active learning strategies with positive effects on students' achievements in undergraduate mathematics education, International Journal of Mathematical Education in Science and Technology 53(2) (2022) 403–424.

[6] H. Hartikainen, H. Rintala, L. Pylvas, & P. Nokelainen, The concept of active learning and the measurement of learning outcomes, A review of research in engineering higher education. Education Sciences 9(276) (2019) 1–19.

[7] R. Carr, S. Palmer, & P. Hagel, Active learning: The importance of developing a comprehensive measure, Active Learning in Higher Education 16(3) (2015) 1–14.

[8] E. Lugosi, & G. Uribe, Active learning strategies with positive effects on students' achievements in undergraduate mathematics education, International Journal of Mathematical Education in Science and Technology 53(2) (2022) 403–424.

[9] A.J. Welsh, Exploring undergraduates' perceptions of the use of active learning techniques in science lectures, Journal of College Science Teaching 42(2) (2012) 80–87.

[10] R.J. Rovinelli, & R.K. Hambleton, On the use of content specialists in the assessment of criterion-referenced test item validity, Dutch Journal of Educational Research 2 (1977) 49–60.

[11] Center for Excellence in Learning and Teaching, Iowa State University. (n.d.). 226 Active learning techniques. Available online in December 20, 2021, Available from: https://www.celt.iastate.edu/wpcontent/uploads/2017/03/CELT226activelearningtechniques.pdf .