The Development Of A Learning Activity Set Based On The Active Learning Concept To Enhance Creative Problem-Solving Ability On Chemical Equilibrium For Secondary 5

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Abstract

The objective of this research was to develop and evaluate a learning activity package based on the concept of Active Learning to enhance creative problem-solving abilities in Chemical Equilibrium. The study aimed to gather basic information for package development, assess its efficiency, conduct experiments, and evaluate and improve the package.

Results showed that the learning activity package should have an appropriate size, colorful illustrations to capture students' attention, self-assessment features to gauge proficiency levels, and diverse content relevant to chemical equilibrium. It was recommended to include various measurement and evaluation methods to align with actual conditions.

The researcher developed a set of learning activities using the 6Cs Model, comprising Challenge, Collection of Data, Cultivation, Creativity and Innovation, Comment, and Communication and Service. This package consisted of eight sets of activities, each encompassing specific components such as activity name, introduction, instructions for teachers and students, learning content and objectives, activity steps, knowledge and activity sheets, pre-tests, and post-tests. The package demonstrated an efficiency value of 81.67/82.54, meeting the 80/80 criterion.

Experimental implementation of the Active Learning-based package revealed increased student engagement and enjoyment during activities. Furthermore, student learning achievements in chemistry significantly improved, indicating enhanced creative problemsolving abilities after using the package. Students' psychological well-being and overall opinions toward the learning management with the package were also positively influenced.

The research successfully developed and evaluated a learning activity package based on Active Learning principles. The package

showed positive effects on student engagement, learning outcomes, problem-solving abilities, psychological well-being, and overall satisfaction.

Keywords: Learning Activity Set, Active Learning, Creative Problem Solving.

Introduction

Science plays a very important role in today's world society and in the future. Because science is relevant to everyone both in daily life and in various professions. as well as technology Various tools and products that human beings have used to facilitate life and work These are all the results of scientific knowledge mixed with creativity and other sciences. Science helps humans develop ways of thinking. both thought and reason creative thinking think analytically have important skills in searching for knowledge can solve problems can solve problems systematically as well as being able to search for information or information evaluate information

Apply computational thinking skills and knowledge in computer science, digital media, information and communication technology. to solve problems in real life creatively able to make informed decisions and have verifiable testimony Science is a culture of the modern world, which is a learning society (K – knowledge – based society). Therefore, everyone needs to be developed to know science. In order to have a deeper understanding of nature and human technology. create able to apply knowledge rationally, creatively and with morality (Ministry of Education, 2017).

The science learning group aims for learners to learn science that focuses on linking knowledge with processes. have important skills in research and knowledge creation using the process of seeking knowledge and solving a variety of problems Encourage students to participate in every step of their learning. There are various hands-on activities. suitable for the level to develop learners Everyone can learn and develop themselves to their full potential. (Ministry of Education, 2008: 92) in which science learning management It should be in response to the true value and meaning of life. Students can think, imagine, do, and experience for themselves. Build selfawareness, experiential learning. (Experiential Learning), which is considered important and close to the learning conditions of people in today's era. action and review regarded as a reasonable learning condition. These will help students to learn science. which will lead learners to achieve that goal, it is necessary to have appropriate tools and methods (Prasat Nuengchalerm, 2015: 145). Get the science you need to start your class. Teachers must make learners have a liking or

a good attitude toward science first for learners to open their minds. Open the brain to learn science content. Teachers must have knowledge of science content. teaching knowledge and contextual knowledge If the teacher has knowledge of all three aspects and able to combine these three areas of knowledge to be related to each other to make students learn and love science.

From the situation in Thailand Science Intelligence scores were below the OECD average across all assessments. According to the 2018 assessment, Thailand's science literacy average was 426, which is lower than the standard average of the Organization for Economic Cooperation and Development. (Organization for Economic Co operation and Development: OECD) has set a score of 489, and most of them are at the 2nd out of 6 scientific competency levels. Students can create explanations and draw conclusions from examining simple situations. and can interpret results from simple scientific surveys but students are unable to explain and apply scientific knowledge in diverse or complex situations. Nor can there be a connection between the explanation and the use of scientific testimony from different sources. As a reason for making decisions, students are unable to demonstrate a high level of scientific thinking and rationality. (National PISA Implementation Center, Institute for the Promotion of Science and Technology Teaching, 2021), which contradicts the aim of science learning management that focuses on students to practice thinking and doing in a systematic way. Therefore, scientific learning management needs to change the learning method. reduce the role of the instructor Let teachers plan activities for students to learn. and give students the opportunity to seek knowledge on their own the researcher therefore studied the learning management approach that emphasizes the student's focus. There are new learning theories. Several theories emerged. But the learning theory that most educators are interested in is creative learning theory. (Constructivist learning theory), whose concept is most consistent with education management in the 21st century, is that learning occurs when students create their own knowledge from existing knowledge or from Newly acquired knowledge Therefore, the 21st century classroom must allow students to do it themselves. Create knowledge from their own understanding and participate in learning more (Active learning), which is a learning model that arises from this concept in many forms, such as cooperative learning. Problem based learning, Creativity Based Learning, Inquiry based Learning, etc. Problem based Learning (PBL) is a learning model that arises from the concepts of creative learning theory. (Constructivism) by allowing students to create new knowledge. from using problems that arise in the real world as a learning context to enable students to develop skills in critical thinking and problem solving.

Problem-based learning is therefore the result of a work process that relies mainly on understanding and solving problems. It is one of the best teaching methods that can be used to improve the quality of student learning. Because it is in line with the educational management guidelines according to the National Education Act 1999, that is, it makes students develop skills in thinking, analyzing, problem-solving and creative thinking. There is also an opportunity to seek knowledge by oneself from learning resources. both inside and outside educational institutions (Phatravadi Makmee, 2011: 9). In everyday life Each person's problem-solving thinking is valuable. Especially in solving problems by that group or faculty. Found that it is more valuable than individual problem-solving thinking. and working with others in the group can also be used to develop problem-solving skills of each individual when faced with their own problems A person's problem-solving thinking is fundamentally more developed with age. in organizing the problem-solving process to achieve the desired destination Able to live according to the purpose and destination correctly This is in line with the skills of the 21st century (Phongsathorn Mahawichit, 2015) stating that education should focus on 3 important skills for students: 1) learning and innovation skills. It focuses on developing the ability to think critically and solve problems, communicate, and create cooperation. Creativity and innovation 2) life and occupational skills Focus on having the ability to be flexible and adaptable. have life goals and initiatives understand society and accept cultural differences; and 3) information and technology skills, focusing on having the ability to access information and various media. appropriately When considered, it was found that the basic and important skills were thinking skills, especially creative problem-solving. Because it is a collaboration of creative ideas. and critical thinking (Siriporn Kaew-On, 2015) to come up with a variety of innovative solutions. There is a step-by-step process that is flexible. It is a problem-solving process that uses creative thinking skills along with rational thinking. Use existing facts to solve problems. To find alternatives and lead to the creation of ideas to solve a variety of problems.

From the importance of learning management that aims to develop the ability to think and solve problems This is in line with learning management in the 21st century, that is, the aim of learning. Emphasis on the development of thinking skills in all forms. Causing teachers to adjust the method of learning management to be consistent with the goals Learning management based on the concept of Active Learning is another approach. That will encourage students to interact and participate in learning. Students can apply their understanding and be able to analyze, synthesize, evaluate, or create things. and develop themselves to their full potential Including

organizing learning experiences for students to have the opportunity to participate in discussions to have the opportunity to practice communication skills. thinking skills as a result, learning outcomes can be increased. Learning management based on the concept of Active Learning is also a method of learning management that emphasizes on students being the ones who understand. self-study and jointly discuss, present, summarize the concept with classmates. by using the learning style to exchange ideas Cooperative learning and case study learning in order to promote the ability to learn and stimulate to enable students to be knowledgeable, enthusiastic, to think, to be able to analyze and synthesize rationally. It enables students to do a variety of activities according to their interests and potential. affecting the efficiency of self-development of students (Jiraporn Yakin, 2015: 2) and most importantly, learning management according to the concept of Active Learning can also be created to happen both inside and outside the classroom, and can be used with learners of all levels both individual learning small group learning large group learning Make students dare to think, dare to make decisions, solve problems, think carefully. Reasonable and critical in thinking be creative Have the ability to think analytically on the data to create various works appropriately as well as being able to express ideas Demonstrate leadership and followers clearly and have reasons that are beneficial to daily life. Therefore, teachers should recognize the importance of training learners who know how to think and solve problems with the right methods and create Problem-solving skills can be applied to dealing with a variety of personal problems, whether it is stress. Anxiety issues, anger issues Problems with selfcontrol and displaying appropriate behavior as well as social adaptation (Suwit Munkham, 2004: 16).

Therefore, participatory learning management methods Active learning management or sometimes called active learning management. Which is considered to have the same meaning. Active learning is an effective form that is very popular because it is a way to train learners to think processes, learning management processes in which learners must act and use their thinking processes. about what has been done (Bonwell & Eison, 1991). It organizes learning activities under two basic assumptions: 1) learning is a natural endeavor of human beings and 2) the individual has a way of learning. know (Meyers & Jones, 1993). As for the advantages of Active Leaning, teachers use one or more different learning methods in one learning session. which is a teaching method that allows learners to participate by the instructor to direct and facilitate as a result, learners want to learn and seek additional knowledge by themselves. In addition, Active Leaning learning management can also make students can solve problems creatively.

As part of developing skills in the 21st century, Feungladda Chitjak (2015) has studied the use of a problem-based learning activity set on chemical reactions. on academic achievement and creative problem solving of Secondary 6 students. The correlation coefficient between learning achievement and creative problem solving of students had a moderate positive correlation with statistical significance at the .05 level and scores of learning achievement and creative problem solving. The post-test of the experimental group students was higher than the control group at statistical significance at the .05 level.

Set of learning activities It is a form of educational innovation that focuses on organizing activities for learners to study and research on their own according to their abilities and interests. Everyone can use their ideas to the fullest. taking into account individual differences Helps learners become independent can be used to organize selflearning activities Learners can carry out learning activities from the instructions that appear in the learning activity pack in sequence on their own. And the learning activity package had a positive effect on science teaching. which enables students to search for knowledge and answers to problems by themselves know how to think critically and seek knowledge to connect ideas to solving problems and decision making (Suwit Moonkham and Orathai Moonkham, 2007: 57-58). It is also a communication tool between teachers and students. Able to convey concrete and abstract content Helps to encourage learners to change their own learning behavior.

According to the objectives set for efficiency in which the teacher considers the students as important Encourage students to participate in the practice of that activity without being bored or discouraged in learning. It also helps practice working with others.

To train students to live happily in society (Kanjana Kiatprawat, 1999: 180). Using activity packs according to different teaching styles Contributes to the development of creative problem-solving abilities. The researcher is therefore interested in developing a set of learning activities on chemical equilibrium to promote creative problem-solving abilities. By synthesizing the teaching and learning process according to the concept of Active Learning, Problem based Learning, Creativity Based Learning, and Inquiry based Learning. To develop a set of learning activities based on the concept of Active Learning leading to the teaching and learning process to promote the ability to solve problems creatively.

From study make the researcher interested developed a set of learning activities based on the concept of Active Learning to promote the ability to creatively solve problems on chemical equilibrium for Secondary 5 students by applying the learning process based on the Active Learning concept as a strategy for teaching and learning activities. Emphasis is placed on real practice for learners, resulting in real learning and creative problem-solving processes. and can be applied in daily life as well. The results of this research will be a guideline for teachers and educators to develop learning management for science and other subjects in the future.

Objectives of the research

1. To study basic information in developing a learning activity package based on the concept of Active Learning to promote creative problem-solving abilities on chemical balance for Secondary 5 students.

2. To develop and find the efficiency of a set of learning activities based on the concept of Active Learning to promote the ability to creatively solve problems on chemical balance for Secondary 5 students to be effective according to the 80/80 criterion.

3. To try out a set of learning activities based on the concept of Active Learning to promote creative problem-solving abilities on chemical balance for Secondary 5 students.

4. To evaluate and improve a set of learning activities based on the concept of Active Learning to promote creative problemsolving abilities. For students in Grade 5, the steps are as follows.

Is Comparison of the learning achievements of the additional chemistry subject W3022 on chemical balance before and after the learning management by using the learning activity package based on the concept of Active Learning to promote the ability to creatively solve problems on chemical balance. Compare the ability to solve problems creatively before and after learning activities by using a learning activity package based on the concept of Active Learning to promote creative problem-solving abilities on chemical balance. received learning management after using the learning activity package based on the concept of Active Learning to promote creative problem-solving abilities on chemical balance. received learning management after using the learning activity package based on the concept of Active Learning to promote creative problem-solving ability on chemical balance. And toward learning management by using a learning activity package based on the concept of Active problem-solving abilities on chemical balance.

Research hypothesis

1. A set of learning activities based on the concept of Active Learning to promote the ability to creatively solve problems on chemical balance for Secondary 5 students that were created with efficiency according to the 80/80 criterion.

2. Learning achievement in additional chemistry subject W30222 on chemical equilibrium of Secondary 5 students after learning with a set of learning activities based on the concept of

Active Learning to promote creative problem-solving abilities. were significantly higher than before learning at the .05 level.

3. Creative problem-solving abilities of Secondary 5 students after school with a learning activity package based on the concept of Active Learning to promote creative problem-solving abilities is higher than before Statistically significant at the .05 level.

4. Science mind of Secondary 5 students after school with a learning activity package based on the concept of Active Learning to promote creative problem-solving abilities. were significantly higher than before learning at the .05 level.

5. Satisfaction of Secondary 5 students after using the learning activity package based on Active Learning concept was at the highest level.

Method of Research

This research is research and development, the researcher has carried out the following.

Scope of research

1. Population: Secondary 5 students studying in the first semester of the academic year 2022, totaling 379 people at Sakolrajwittiyanukul School Mueang Sakon Nakhon District Sakon Nakhon Province Sakon Nakhon Secondary Education Service Area Office.

2. Sample group: Thirty students in Grade 5/15 are studying in the first semester of the academic year 2022 at Sakolrajwittiyanukul School. Mueang Sakon Nakhon District Sakon Nakhon Province Sakon Nakhon Secondary Education Service Area Office Which is obtained by simple random (Sample Random Sampling) by drawing lots. Classroom was used as a unit of randomization.

3. The variables; consisted of: 1) The independent variable was learning management with a set of learning activities based on the concept of Active Learning to promote creative problem-solving abilities on chemical balance. 2) The Dependent variables were: Achievement in additional chemistry subject on chemical balance, Creative problem-solving ability, Scientific mind, Satisfaction of students learning with the learning activity package.

4. Duration The experimental teaching period is used in the first semester of the academic year 2022. The total experimental time is 8 weeks, 3 hours each, totaling 24 hours.

5. Research Content Science learning content Additional Chemistry The learning unit on chemical equilibrium, subject code W30222, of Secondary 5 in the academic year 2022 of the first semester, Sakolrajwittiyanukul School.

6. Research Methodology The researcher conducted the experiment using the research plan One – Group Pretest Posttest Design (Mariam Ninphan, 2012: 143).

7. Tools and tool quality inspection

1) A set of learning activities based on the concept of Active Learning to promote the ability to creatively solve problems on chemical balance for Secondary 5 students. Efficiency of Process (E₁) from the post-learning score of the learning activity package. And the Efficiency of Product (E₂) from the learning achievement scale. The consistency index was 4.60 and the standard deviation (S.D.) was 0.09. Individual tryouts were performed on grade 5 students at Sakolrajwittiyanukul School. 3 groups of non-sample 9 people got efficiency 84.03/82.22. Small Group Tryout was performed on Secondary 5/2 students at Sakolrajwittiyanukul School. 5 groups were 84.08/82.67 efficiency. Field tryout was conducted with Secondary 5/1 students at Sakolrajwittiyanukul School. non-sample and have never studied in this content before, for 40 students, the efficiency was 84.06/82.06. It was found that the learning activity set had flaws in typography which the researcher has already improved before taking it to the next step of the experiment.

2) Learning management plans, 8 learning plans The duration of the activity is 24 hours. The results of the quality assessment by experts. The consistency index of the learning management plan was 4.68, and the standard deviation (S.D.) was 0.05. There was a change in the duration of the experimental activities because some learning management plans took a long time and adjusted the measurement and evaluation tools. in accordance with the measurement method.

3) Additional Chemistry Achievement Test, W 30222 on Chemical Equilibrium, is a multiple-choice test with 4 options, 40 items, used to measure learning achievement. before and after using the activity pack It was found that the consistency index was 4.63, the standard deviation (S.D.) was 0.18, the difficulty (p) was between 0.25 - 0.70, the discriminant power (r) was between 0.32 - 0.77, and the confidence of the model was 0.32 - 0.77. test Using the Kuder-Richardson formula, KR-20 is 0.95.

4) Questionnaire for measuring the ability to solve problems creatively of students for their ability to solve problems creatively The researcher has studied Forms of learning activities to develop creative problem-solving abilities. From the study of documents and research by Aree Phanmanee (1994), Sunatcha Suphathamwit (2013), Kanyarat Kojorn (2012) and Sittichai Chompoophat (2011) can be synthesized into a model of learning activities for development. The ability to solve problems creatively through 5 steps: problem identification Problem analysis Creating guidelines for solving problems Planning and solving the problem and inspection stage and

present a solution to the problem. Then used to create a subjective test of 20 items used to measure the ability to solve problems creatively. before and after using the activity pack It was found that the consistency index was 4.72, the standard deviation (S.D.) was 0.16, the difficulty (p) was between 0.34 - 0.61, the discriminant power (r) was between 0.42 - 0.77, and the confidence was determined by the method. Finding the alpha coefficient

(α - Coefficient) of the Cronbach's test (Cronbach) was the coefficient of confidence equal to 0.98 and the analysis of the correlation coefficient between item scores and total scores (Item - Total Correlation) questions. The selected subjects had a classification power ranging from 0.82 – 0.94.

5) Mental Science Assessment To compare the students' scientific mind before and after using the learning activity package based on the concept of Active Learning. The researcher studied the characteristics of the scientific mind of Collete (1973: 187) and Victor (1980: 17), which were consistent with the Institute for the Promotion of Teaching Science. and technology (2012: 147 – 151) were used to create a common assessment of people with scientific attitudes of the world, Laohaphaiboon (1999), by assessing all 5 aspects of the scientific mind, consisting of 1) curiosity 2) reasonableness. 3) Commitment effort 4) Responsibility 5) Cooperation Create 20 questions of the psychological assessment questionnaire, which is a rating scale with 5 levels of options. The quality assessment of the psychological assessment questionnaire has a consistency index of 4.67 and a standard deviation (S.D.) of 0.21. Confidence by using alpha coefficient (α -Coefficient) of Cronbach's test (Cronbach) was the coefficient of confidence equal to 0.86 and the analysis of the correlation coefficient between item scores and total scores (Item - Total Correlation) The selected questions have a classification power of each item ranging from 0.30 -0.70.

6) Student Satisfaction Questionnaire on Learning with Learning Activities In order to inquire about student satisfaction after using the learning activity package under the concept of Active Learning, the researcher created a student satisfaction questionnaire divided into 3 aspects: content, 5 items, learning activities, 5 items, and benefits. Received 5 items, totaling 15 items, with a 5-level rating scale. Content Validity was checked and the suitability of the satisfaction questionnaire was assessed. It was found that the consistency index was 4.71 and the standard deviation (S.D.) was 0.43. Confidence was 0.87 and the analysis of the correlation coefficient between item scores and total scores (Item - Total Correlation) The selected questions had a discriminant power of each item ranging from 0.44 - 0.69.

8. Methods of research and data collection

The researcher applied the learning activity package based on the concept of Active Learning to experiment with students in Grade 5/15 at Sakolrajwittiyanukul School. Mueang Sakon Nakhon District Sakon Nakhon Province Sakon Nakhon Secondary Educational Service Area Office, semester 1, academic year 2022, totaling 30 people, with a 4-step development process: which consists of the following 4 research phases (Mariam Ninphan, 2012: 230 – 254) as follows:

Step 1) Research: study the needs and basic information about the development of the activity set. A study and analysis of the Basic Education Core Principle B.E. science learning group about purpose course structure standards and indicators according to the curriculum, studying concepts and theories about the development of activity packages theory of learning based on Active Learning concept; self-knowledge creation theory; (Constructivism), Active Learning concept, Piaget's theory of intellectual development Ganye's Theory of Intellectual Development, Brunner's Theory of Intellectual Development, and Theory of Motivation. Concepts of learning management using problem-based learning (Problem based learning), Inquiry based learning, Creativity based learning, Ability to solve problems creatively. Study the content requirements of the set of activities. From students in Grade 5, Sakolrajwittiyanukul School Mueang Sakon Nakhon District Sakon Nakhon Province, 379 people studied documents, questionnaires, and interviews about the development of the activity set. From those involved, including experts, science teachers in the field of chemistry. and students to use the information to develop a set of learning activities based on the concept of Active Learning to promote creative problem-solving abilities.

Step 2) Development: The development and efficiency of a set of learning activities based on the concept of Active Learning to promote the ability to creatively solve problems on chemical balance for Grade 5 students. Basic information was studied to develop a set of learning activities according to the concept of Active Learning, which consisted of 3 steps as follows: 1) Developing a set of activities and a learning management plan. Set learning standards, indicators as a guideline for developing a set of learning activities based on the concept of Active Learning, sorting content before – after, sequencing the steps of learning activities. 2) Checking the quality and finding the efficiency of the set. Learning activities based on the concept of Active Learning, created, and developed, examine the appropriateness, consistency and relationships. before applying the

activity set and finding the effectiveness of the learning activity set according to the concept of Active Learning by applying the activity set to E1/E2 quality as follows: 1) Small group tryout efficiency 2) Field performance Tryout) 3) The improvement of the learning activity set based on the concept of Active Learning brings the results obtained from the performance of the activity set. Consult with experts for advice as information to improve and develop a set of learning activities based on the concept of Active Learning to be more complete than before using it.

Step 3) Research: An experimental use of learning activity packages based on the concept of Active Learning to promote creative problem-solving abilities on chemical balance for Secondary 5 students. The pre-learning test on chemical balance for Secondary 5 was tested before using the learning management activity pack and conducting the experimental use of the activity set. by teaching According to the learning management plan set out with students in Grade 5 at Sakolrajwittayanukul School. Mueang Sakon Nakhon District Sakon Nakhon Province who is an experimental group It takes 24 hours to teach.

Step 4) Development Evaluating and improving a set of learning activities based on the concept of Active Learning to promote creative problem-solving abilities on chemical balance for Secondary 5 students. Complete the revised academic achievement test. to test with Secondary 5 students at Sakolrajwittayanukul School Mueang Sakon Nakhon District Sakon Nakhon Province which is a sample of 30 people and takes the score obtained from the pre - and post - tests were used to compare the differences by means, standard deviation (S.D.) and t-test (t – test Dependent).

Research results

1. The results of the study of basic information and the need to develop a set of learning activities based on the concept of Active Learning to promote creative problem-solving abilities. For Secondary 5 students, the results of the analysis showed that the learning activity set Suitable for students should have a font that is not too small. There are beautiful colorful illustrations. To attract students' attention, insert knowledge beyond what they have learned. can check their own skill level The set of activities will therefore be able to maximize the benefit of the learners.

As for the learning media, the learning materials used in learning management using the learning activity package should be diverse and suitable for the content. And in the measurement and evaluation aspect, there should be a variety of measurement and evaluation. Assessment according to actual conditions and content about chemical equilibrium It is the content that is suitable for creating a set of learning activities. Provide students with a 24-hour course on chemical equilibrium, consisting of the following contents: (1) basic knowledge about the change of substances (2) equilibrium

(3) equilibrium constant (4) benefits and calculations of constants at equilibrium, (5) change in concentration and equilibrium, (6) change in pressure and equilibrium, (7) change in temperature and equilibrium, and (8) Le Chaterie's principle. and balance in living things the components of the activity set consisted of 1) name of the activity, 2) introduction, 3) instructions for teachers, 4) instructions for students, 5) content and learning objectives, 6) activity steps, 7) knowledge sheets/ Activity sheet 8) Pre-test 9) Post-test.

It was found that the content on 24-hour chemical equilibrium consisted of the following contents: (1) Basic knowledge about changes in substances (2) Equilibrium (3) Equilibrium constant

(4) Benefits and calculation of equilibrium constant (5) change in concentration and equilibrium, (6) change in pressure and equilibrium, (7) change in temperature and equilibrium, and (8) Le Chaterie's principle. and balance in living things the components of the activity set consisted of 1) name of the activity, 2) introduction,
3) instructions for teachers, 4) instructions for students, 5) content and learning objectives, 6) activity steps, 7) knowledge sheets/ Activity sheet 8) Pre-test 9) Post-test

2. The results of the development and efficacy of the learning activity set based on the concept of Active Learning to promote the ability to creatively solve problems on chemical balance for Secondary 5 students found that the learning activity set based on the Active Learning concept that Created a total of 8 learning activity sets. There is a 6Cs Model learning management process consisting of 1) Challenging activities (Challenge: C) 2) Aiming towards collecting data (Collection of data: C) 3) Cultivation: C) 4) Continuing create works (Creativity and Innovation: C), 5) reflect (Comment: C), and 6) feed results back to society. (Communication and Service: C), which uses the learning activity set based on the concept of Active Learning to find the efficiency of the single group learning activity set (Individual Tryout) with efficiency 84.03/82.22. Find the efficiency of a small group (Small Group Tryout). Efficiency 84.08/82.67 and field tryout efficiencies (Field tryout) 84.06/80.06 which according to the criteria 80/80 defined.

3. The results of the experimental use of a learning activity package based on the concept of Active Learning to promote creative problem-solving abilities. For 30 students in Grade 5/15 in the first

semester of the academic year 2022 at Sakolrajwittiyanukul School Duration of the experiment, 24 hours, 8 learning management plans for the experiment, the researcher conducted self-teaching activities for each learning plan. There are steps for implementing all 8 sets of learning activities that have a 6Cs MODEL learning management process when students practice regularly. Always be interested in learning and practicing creative problem-solving processes. Therefore, the level of creative problem-solving ability of the students is higher. Complete answer to questions When testing the learning activity package based on the concept of Active Learning, the efficiency was 81.67/82.54, higher than the specified criteria. This shows that it is consistent with hypothesis 1.

4. Assessment and improvement of the learning activities set based on the concept of Active Learning to promote creative problem-solving abilities. For students in grade 4, the steps are as follows: 1) Comparison of learning achievements in additional chemistry courses on chemical balance of students before and after learning. using the learning activity set based on the Active Learning concept was significantly different at the .05 level, after using the learning activity set based on the Active Learning concept was higher than before using the activity set which accepts research hypothesis number 2. 2) The comparison of creative problem solving abilities of Secondary 5 students before and after learning management was found to be significantly different at the .05 level. creative problem solving After the learning activities were higher than before the learning activities. which accepts the third research hypothesis. 3) Comparative results of scientific psychology Before and after the learning management found that there was a statistically significant difference at the .05 level by scientific psychology. after learning activities higher than before the learning activities which accepts research hypothesis No. 4.

5. The results of the study on the satisfaction of Secondary 5 students toward learning management with a learning activity package based on the concept of Active Learning after learning management found that the overall satisfaction was at the highest level. which accepts hypothesis 5.

Discussion

From the research study, the development of a learning activity package based on the concept of Active Learning to promote the ability to creatively solve problems on chemical balance for Secondary 5 students, the researcher can bring the results to discussion as follows.

1. The results of the study were to find basic information to develop a learning activity set based on the concept of Active Learning to promote creative problem-solving abilities on chemical balance for Secondary 5 students developed. Know that there is a consistency index at the most appropriate level. This is due to the development of a set of learning activities. There was a comprehensive analysis of basic information, concepts, theories related to science learning management, including basic information about the basic education core curriculum, B.E. 2551, science learning subject group. (Ministry of Education 2008: 3 - 5) and from the synthesis of the concept of learning theory about creating and developing a set of learning activities based on the concept of Active Learning, which is consistent with Piaget's theory of creating selfknowledge (Piaget) (Thitna Khaemanee, 2015), which is of the opinion that each person develops intelligence according to the order of learning of children according to intellectual development. which will develop according to different ages hierarchical Development is a natural thing. It also corresponds with Vygotsky (Vygotsky. 1978) who believes that learner learning is a cognitive process. or brain processes that occur with individual learners Learners are enthusiastic self-creators of knowledge. from the environment and experiences around him rather than being a recipient of knowledge It is also in line with the theoretical concept of creating a set of learning activities of Chaiyong Promwong (2002: 123), and has a concept that is consistent with Saowanee Sikkhabundit (1995: 292-293) and Boonkuer. Kuanhavej (2002: 92-94) is to create a set of learning activities that must take into account the principles and theories of individual differences in response to the needs of the learners. and interaction between teachers and student's learner and environment based on multimedia theory group process and learning theory It is the basic idea to create a set of learning activities that truly respond to the needs of the learners and can effectively develop the learners.

2. The results of the development and efficiency of the learning activity package based on the concept of Active Learning to promote creative problem-solving abilities. To be effective according to the 80/80 criterion, it was found that the results of developing and determining the efficiency of the learning activity set in a single group (Individual Tryout) were effective 84.03/82.22, and the effectiveness of small group tryout was 84.08/82.67. and find field performance (Field tryout) 84.06/80.06, which is based on the 80/80 criterion that is defined because in creating a set of learning activities, a systematic, step-by-step system was prepared. A study of the concepts of the theory of creating a set of learning activities. Based on interviews

with experts in creating learning activity packs. and from interviews with teachers in science learning subjects in chemistry the questionnaire responses of the students found that the components of the learning activity set that students want quality and suitable for students This is consistent with the concept of Thitana Khaemmanee (2000: 10-12), which has defined the components of the learning activity set that are consistent with the research of Panida lamnoon (2010). complete set of activities Created through a systematic and efficient process. Therefore, students are interested and perform activities by themselves. encourage students to want to learn and encourage students to learn After doing the activities by myself This is in line with the idea of Chaiyong Phromwong (2008: 915-916) who said that to find the efficiency of the activity set. It is a process of quality checking and evaluating media or considering various aspects of value. of the media systematically whether the guality is valuable or not before being used for teaching and learning the researcher has brought to improve the language content. correct according to the instructions This is in accordance with the concept of Chaiyong Phromwong (2545: 494), the performance testing will ensure that manufacturers. The content contained in the activity kit is appropriate and easy to understand. which will help manufacturers have higher proficiency This saves labor, time, and money in prototype preparation. And the set of activities also helps learners change their behavior as intended. and encourage students to practice self-learning activities This is in line with the concept of Boonkua Kuanhawet (2002: 110) who discussed the benefits of the learning activity package that learners learn according to their aptitudes, interests, and time and opportunities that are suitable for each person. Give learners the opportunity to express their opinions and practice decision making. Seeking self-education and being responsible for oneself and society Helps many learners get to know each other's concepts effectively. Help train learners to respect other people's thoughts in line with the concept of Suthon Sinthaphanon (2008: 21-22) has mentioned the benefits of the activity set as follows. Learners have used their ability to study knowledge in selfteaching as a skill practice in seeking knowledge. Doing learning skill exercises and the thinking skill model at the end of the activity set, enabling learners to think and solve problems. Make learners learn to practice themselves to follow the rules. Learners know how to work with others. Listening to each other's opinions is an exercise of democracy. which is an important basis of coexistence in a democratic society The use of activity packs can be studied outside of school hours depending on the teacher's design, conducive to selfstudy.

3. The experimental results of the learning activity package under the concept of Active Learning for Secondary 5 students when testing the learning activity package under the Active Learning concept, the efficiency was 81.67/82.54 higher than the specified criteria. It was consistent with Hypothesis 1. It was also found that the students were interested and determined to perform the activities according to the objectives of the learning activity set in each subject well. In addition, the students were able to learn the chemical content on chemical equilibrium with Interest, enthusiasm in seeking knowledge and interest in doing activities by oneself Enjoy learning and gaining knowledge along with studying after the experimental set of learning activities was completed This may be because a set of learning activities based on the concept of Active Learning allows students to acquire knowledge. and take action Make students interested, eager to pursue knowledge, have fun in learning to practice experimental activities. This is in line with the idea of Thitana Khaemanee (2015: 90), stating that learning requires students to do it. search for self-knowledge Until discovering knowledge and knowing what he found Learn to analyze until you really know that deep down. So, what is that? How important is it? And study and research in depth until enlightenment, which is consistent with the research of Feungladda Chitjak (2014: 117 – 126) found that the results of using the problem-based learning activity set on chemical reactions on results Achievement and creative problem solving of Secondary 6 students. The science activity set allows students to learn in a sequence of steps. by following the given instructions, it is an opportunity for learners to study and find answers on their own and to truly participate in the activities. Help students practice scientific practical skills. To be a guide to thinking, doing, and solving problems.

4. Assessment and improvement of the learning activities set based on the concept of Active Learning to promote creative problem-solving abilities. For secondary 5 students, there are 4 steps as follows:

1) The comparison of learning achievement in the additional chemistry subject on chemical balance of Matthayom Suksa 5 students by using the activity set before and after the learning management revealed that the students had additional learning achievement in the subject chemistry subject on chemical balance after the management. learning with a learning activity set was higher than before the learning management with a learning activity set with statistical significance at the .05 level, which accepted the second research hypothesis because the learning activities set developed by the researcher helped learners learn faster. and have a

variety of activities which students can search for knowledge by themselves and practiced activities in sequence with interest, resulting in enthusiasm for learning and interested in performing activities on their own This is consistent with Gardner's Theory of Multiple Intelligences (Gardner, 1983), which states that each learner has a different level of intelligence. Therefore, it shows that the learning activity set There is a process for organizing learning activities. and has a variety of teaching materials Including an experiment that the students have done by themselves, resulting in the ability to solve problems creatively. This resulted in learning achievements in the additional chemistry course on chemical equilibrium after the learning management with the learning activity set was higher than before the learning management with the learning activity set. with statistical significance at the .05 level, which is consistent with the research of Panida Jamnoon (2010) to study the effect of learning management with a science project activity package on science learning achievement and creative ability. Science of grade 1 students, which the results of the study found. The students who were taught by using the science project activity package had a statistically significantly higher post-learning achievement at the .01 level. science activity set relationship life for grade 3 students; the research results showed that A set of science activities for grade 3 students on the subject of life relations. Efficiency (E₁/E₂) was 81.48/80.37. The comparison between pre- and post-test scores showed that the post-test score was significantly higher than before at the .05 level.

2) The comparison of creative problem-solving abilities of secondary 5 students before and after learning management. By the level of the ability to solve problems creatively. after learning activities higher than before the learning activities with statistical significance at the .05 level, which accepts the 3rd research hypothesis because the learning activity set based on the concept of Active Learning on chemical equilibrium created by the researcher has a 6Cs MODEL learning process model with 6 steps. The researcher has synthesized 1) Challenging activities (Challenge: C) 2) Aiming towards collecting data (Collection of data: C) 3) Cultivation of knowledge by process (Cultivation: C), 4) Continuing the creation of works (Creativity and Innovation: C), 5) Reflecting (Comment: C), and 6) Giving results back to society. (Communication and Service: C). In addition, the form of activities in the learning activity set developed 5 creative problem-solving skills, i.e., problem identification, problem analysis, and problem solving. create a solution to the problem plan and implement solutions and reviewing and proposing solutions. in every set of learning activities Make students learn steps and creative problem-solving processes through practical activities according to

the set of activities. which consists of 8 sets of learning activities Which has content about chemical balance, allowing students to learn continuously Make students fully understand the content studied and the knowledge gained from one's own process skills is sustainable knowledge. Make students familiar with and learn creative problem-solving procedures from the activity process. Using different perspectives to solve problems Recognize the individual's ability to present ideas. Because each person will have a different perspective on seeing the problem. listening to different perspectives of the individual will help create new ideas for solving problems Encouraging students to learn on their own will create opportunities to invent diverse and innovative solutions, leading to innovation, in line with Piaget's theory of cognitive development (Piaget). Thitana Khaemmanee, 2015) stated that the Concrete Operation period at this stage starts from the age of 7-11 years, the intellectual and thinking development of children. Abstract Thinking (Formal Operational period) starts from the age of 11-15 years. At this stage, the intellectual and thinking development of children at this age is the highest point. is that children at this age will begin to think like adults Children will be able to reason beyond the available information. able to think like a scientist be able to formulate hypotheses and theories and see that reality agree with critical perception and it is in line with the research of Zetinkaya (Cetinkaya, 2014) who studied the effect of creative problem-solving programs of students with creative abilities. It was divided into 2 groups, namely the experimental group and the control group. It was found that the students in the experimental group had creative problem solving and had different scores on pre- and post-test tests.

And the research of Feungladda Chitchak (Fuangladda Chitchak, 2015) has studied the use of the problem-based learning activity set. chemical reaction the effect on learning achievement and creative problem solving of secondary 6 students with Solomon's four-group experimental model found that the scores on learning achievement and creative problem solving were After learning, the students in the experimental group were significantly higher than the control group at the .05 level. According to the documents and related research, the students' creative problem-solving abilities after learning were significantly higher than before. at the .05 level, in accordance with the 3rd hypothesis.

3) Comparative results of scientific psychology Before and after the learning management found that there was a statistically significant difference at the .05 level by scientific psychology. after learning activities higher than before the learning activities which accepted research hypothesis number 4, it was found that the average score of secondary 5 students in science psychology after learning management by using the Active Learning concept activity pack was higher than before learning in all 5 aspects: curiosity, reason, effort, determination responsibility cooperation When considering the statistically significant difference at the .05 level, it was found that students had a scientific mind. after learning activities higher than before the learning activities with statistical significance at the .05 level in all aspects. This is due to the learning activity set created by the researcher and the 6Cs MODEL learning management process model synthesized by the researcher. In each level, students were encouraged to develop a scientific mind as follows: 1) Challenge: C) Students were encouraged to wonder. use stimulation attract attention and the motivation of the learners that occur with activities problem situation or any method using various forms of media Through a variety of learning techniques 2) Aiming to collect data (Collection of data: C) is a step in which the learners jointly plan operations on the information database sought or searched by the application of media, tools, materials. equipment and technology, searching for concepts related to the problem 3) instilling knowledge through processes (Cultivation: C) is a step that allows students to work together to do activities on the information database that they can find. learners will Use the scientific process. 4) Continuing the creation of works (Creativity and Innovation: C) is a step in which learners create new ideas. to be applied in practice with a goal It is knowledge creation through practice. Learners will have an understanding of cause and effect. 5) Reflection (Comment: C) is a step to analyze information and ideas. along with presenting arguments and judgments that are reasonable to support It is a review of objectives, goals, events, and results. Evaluate the work or results from the performance and 6) feed the results back to society. (Communication and Service: C) is a process that presents both work results and new techniques obtained from the operation or from the process of searching for knowledge of truth. It is a way of communicating to the use of presentation techniques. And the researcher gives students the opportunity to gain experience, experimentation, learning and scientific skills. and focusing on students to practice activities by themselves bring on responsibility and train students to express their opinions rationally, using questions, asking questions, or creating situations to help students develop a scientific attitude. Instructors use a variety of activities to practice a variety of skills and never get bored doing them. It encourages learners to be interested and learn to develop their skills and scientific mind. This is in line with Patchara Taweewong Na Ayudhya (1994: 63) who proposed a guideline for developing scientific attitudes that allow students to gain various experiences for scientific learning, emphasizing the method of learning using

scientific methods. Give students the opportunity to take responsibility for activities such as group work to practice working together, practice listening to others' opinions. and practice expressing opinions rationally Give students the opportunity to practice observation. Using questions or creating situations to help motivate students to develop the scientific mind. Teachers should prepare several activities. Encourage students to be interested in scientific progress to create initiatives as well as the Institute for the Promotion of Teaching Science and Technology.

Ministry of Education (2003) said that the development of scientific attitudes gives students the opportunity to fully practice their learning experiences. It emphasizes an experimental learning approach that provides students with the opportunity to apply scientific process skills that will help develop scientific attitudes over time. And in accordance with the research of Suwathida Lansa (2015), a set of learning activities was developed using the process of seeking knowledge to promote analytical thinking and scientific mind abilities for grade 4 students. The characteristics of psychological science after using the learning activity set were higher than before using the learning activity set, which was at a high level.

4) The results of the study revealed the satisfaction of secondary 5 students towards learning management with a learning activity package based on the concept of Active Learning to promote creative problem-solving abilities. After learning management using the activity set, it was found that the overall satisfaction of the students was at the highest level. Which accepted Hypothesis 5 and asked the students to write about their satisfaction with learning activities with the learning activity package. After the end of the learning activities with the learning activity set, it was found that the students liked the learning activities with the learning activity set on chemical balance and wanted them to organize learning activities with the learning activity set again. And should be organized with a set of learning activities in other subjects as well because students have done the activities by themselves. Make learning fun as well This may be because Organizing learning activities with a set of learning activities is a teaching management that provide students with selfstudy Students therefore feel independent in learning. Able to perform activities in steps according to their abilities achieve learning objectives Satisfaction was at the highest level. This is because the teachers have designed a variety of teaching and learning activities that are suitable for the content. enabling students to practice various activities both as a group and as an individual make fun not bored Interested in learning and doing activities together. When students succeed in self-study thus causing satisfaction This is in line with Maslow's theory of motivation (Kawee Siripokaphirom, 1999: 7),

which states that human beings always have needs. When a need is satisfied or satisfied, another need arises. Our needs may be redundant. One need is not exhausted, one need may arise. then there will be other needs to replace needs that have been met Then it will no longer be an incentive. But unfulfilled needs become incentives instead of basic human needs. Again, it is consistent with Brunner (Brunner, 1963: 1-54), which has the idea that Human learning chooses to perceive interests and learning is a process of self-discovery. starting from learning from action learning from thought and learning symbols and abstraction then cause action It is also consistent with Tisana Khaemanee (2015: 90) who said that learning from doing will lead to learning the most.

Good learning comes from self-discovery. Resulting in the satisfaction of the learners must be caused by the feeling that the learners received as expected. It is a good feeling, liking, and valuing the learners towards learning management. as a result of learning management, teachers, readiness, and atmosphere of learning management Including the practice of learners the activities were successful according to the needs of the learners (Sudarat Alee, 2015: 48), in line with the research results of Rasita Raksakul (2014) studying the effects of integrated teaching and learning. Using Active Learning to study satisfaction in teaching and learning management. It was found that the learners who received such activities were satisfied at a high level. And in accordance with the research of Thanasit Kantha (2008), a study of active learning teaching and learning to develop morality and ethics of Nakhon Sawan Rajabhat University students. To study the student's learning satisfaction. It was found that the satisfaction was at a very satisfied level. And in line with the research of Atchara Phet-on (2010) has studied the development of a science activity package on the diversity of plants and animals. that promotes academic achievement for grade 5 students, which the research found Science activity set on the diversity of plants and animals as a result, the Prathomsuksa 5 students were satisfied with the use of the science activity package on the diversity of plants and animals. at a high level.

Suggestion

From development of a set of learning activities based on the concept of Active Learning on chemical balance for secondary 5 students, the researcher has summarized the concepts and recommendations on the following issues: a suggestion for the use of a learning activity package based on the concept of Active Learning to promote creative problem-solving abilities; on chemical equilibrium for use and recommendations for research The details are as follows.

Suggestions for applying research results:

1. From the research results, it was found that the average score after learning with the learning activity package under the concept of Active Learning was higher than before learning. Shows that students have improved in learning more. Therefore, teachers should bring set of learning activities used in chemistry learning activities for students in grade 5.

2. According to the research results, it was found that secondary 5 students had the ability to solve problems creatively. Before and After learning activities with a set of learning activities of students are different. The statistical significance was at the .05 level in all aspects. Therefore, teachers should continue to promote creative problem-solving abilities for students. To encourage students to develop the ability to solve problems creatively. Continually.

3. According to the research results, it was found that the mental science characteristics of grade 5 students were the least in terms of effort and commitment. Therefore, teachers should add a variety of activities. keep students motivated It will make a determination to devote both body and mind to learning and getting to the essence of that. and cause a real scientific mind.

Recommendations for further research

The development of a set of learning activities based on the concept of Active Learning on chemical balance for secondary 5 students is one way to support learning management that emphasizes According to the reform of the learning management process, there should be additional studies and research in the development of a learning activity set, as follows:

1. The learning outcomes from the science activity package should be studied with other variables such as scientific practical skills, group working behavior and scientific creativity.

2. The learning outcomes of other science process skills should be studied at the integrated stage. to develop advanced science process skills.

References

Ministry of Education. (2017). Indicators and core learning content. science learning group (Revised edition 2017). First edition. Bangkok: Agricultural Cooperative Community of Thailand.

Ministry of Education. (2008). Basic Education Curriculum 2008.

Bangkok: Teachers Council Ladprao Printing House.

Kawee Siripokha Phirom (1999). Satisfaction with the work of teachers at Thepsatri Rajabhat Institute. Lop Buri:Thepsatri Rajabhat Institute. Kanjana honor history. (1999). General teaching methods and teaching skills. Bangkok: Wattana Panich.

- Kanyarat Kojorn. (2012). A learning model for creative problem solving. academic journal Education, 13(2), 20 29.
- Jiraporn Yok-in. (2015). The use of cooperative learning management methods on learning behavior.of students Using Cooperative Learning towards Students' Learning Behavior. Bangkok: Branch of Early Childhood Education, Faculty of Education, Suan Dusit University.
- Chaiyong Phromwong. (2002). Teaching documents for the
 Educational Technology Series, Units 1 5. Office of
 Educational Technology. Nonthaburi: Sukhothai Thammathirat
 Open University.
- Chaiyong Phromwong and Wassana Thaweekulsap. (2008). Teaching and learning package in the course contents Curriculum development and instructional media Unit 14. Nonthaburi.
 2nd edition.Department of Education, Nonthaburi: Sukhothai Thammathirat Open University.
- Thitana Khaemmanee. (2000). A set of instructional activities and process skills training for elementary school groups Year 6. Department of Elementary Education Faculty of Education Bangkok: Chulalongkorn University.
- Tisana Khaemanee. (2015). Science of teaching knowledge for effective learning process management. (19th edition). Bangkok: Chulalongkorn University Press.
- Thanasit Kantha. (2008). Active Learning Teaching for Moral and Ethical Development. of Nakhon Sawan Rajabhat University students who enrolled in the ideal Thai bachelor's degree course. Nakhon Sawan: Nakhon Sawan Rajabhat University.
- Boonkuer Kuanhawet. (2002). **Educational innovation.** Bangkok: Chulalongkorn University Press.
- Prasart Nuengchaloem. (2015). Science Learning Guidelines in the 21st Century. Journal of Teaching and Learning Development. Rangsit University, 9(1),136 – 154.
- Phongsatorn Mahawijit. (2015). Adjustment of learning design methods. For learners in the 21st century. Magazines Institute for the Promotion of Teaching Science and Technology.
- Patchara Taweewong Na Ayutthaya. (1994). **Compilation of subject matter and scientific method.** Nonthaburi:Sukhothai Thammathirat Open University.

- Panida lamnoon. (2010). A study of learning management results with a science project activity package.Towards science academic achievement and scientific creative ability.of students in grade 1. Master of Education thesis. Bangkok:Srinakharinwirot University.
- Puangrat Taweerat. (1997). **Research methods in behavioral and social sciences.** 7th edition. Bangkok:Bureau of Educational and Psychological Testing. Bangkok: Srinakharinwirot University.
- Feungladda Chitjak. (2015). The results of using a set of problembased learning activities on chemical reactions. on academic achievement and creative problem solving of secondary school students. Year 6 with Solomon's four-group experimental scheme. Master of Education Thesis Human Potential Research and Development Branch. Bangkok: Srinakharinwirot University.
- Patravadi Makmee. (2011). Problem-based Learning. **Eastern Asian University Academic Journal**, 1(1), 7 – 14.

Pop Laohapaiboon. (1999). **Guidelines for teaching science.** Bangkok: Thai Wattanapanich.

Mariam Ninphan. (2012). **Research Methods in Behavioral and Social Sciences.** Nakhon Pathom: Silpakorn University Printing House.

Worachat Monturat. (2010). The development of a science activity package on life relations. for students Grade 3. Independent study. Department of Educational Research and Evaluation graduate school Phitsanulok: Naresuan University.

Rasita Raksakul. (2014). **The Achievement of Integrated Teaching and Learning Using Active Learning.** Master's Degree Thesis in Industrial Education Faculty of Industrial Education and Technology.Bangkok: King Mongkut's University of Technology Thonburi.

Siriporn Kaew-on. (2015). The development of students' creative problem-solving abilities and attitudes. High school students in the special science classroom project. Behavioral Science Research Institute Bangkok: Srinakharinwirot University.

National PISA Implementation Center, Institute for the Promotion of Teaching Science and Technology. (2021). Assessment Results PISA 2018 Reading, Mathematics and Science. Bangkok:

Teaching Promotion Institute science and technology. Institute for the Promotion of Teaching Science and Technology. (2003).
Organizing subjects for learning in science groups.Basic education curriculum. Bangkok: Institute for the Promotion of Teaching Science and Technology. Institute for the Promotion of Teaching Science and Technology. (2012). **Science Evaluation.** Bangkok: SE-ED Unication.

Sukon Sinthaphanon and others. (2008). **Thinking skills development...conquer teaching.** Bangkok: Chulalongkorn University Book Center.

Sudarat Ali A. (2015). The effect of learning management based on the concept of science, technology, society, and the environment on achievement in chemistry ability to solve problems and satisfaction with learning management of secondary 6 students. Master's Degree in Science Education. Songkhla: Prince of Songkhla University.

Suwit Munkham. (2004). **Synthetic Teaching Strategies**. 2nd edition. Bangkok: Photo Printing House.

Suwit Munkham. (2007**). Thinking Teaching Strategies.** 5th printing. Bangkok: Photo printing house.

Suwathida Lansa. (2015). The development of a set of learning activities using the process of seeking knowledge to promote Critical Thinking and Scientific Mental Ability for Elementary School Students Year 4. Master of Education Thesis. Bangkok: Silpakorn University.

Sunatcha Suphathamwit, (2013) The development of a model for using learning activity packs based on learning principles Using the brain as a base to promote creative problemsolving abilities of students. Primary education.Bangkok: Chulalongkorn University

Sittichai Chompoophat. (2011). The development of instructional behavior for creative problem solving of teachers and students in schools fostering students with exceptional scientific abilities by using critical action research. Ph.D. thesis. Bangkok: Srinakharinwirot University.

Saowanee Sikkhabundit. (1995). **Terminology of educational technology**. Bangkok: Duangkamol.

Atchara Phet-on. (2010). **Development of a science activity package on Diversity of flora and fauna that promotes academic achievement for students in grade 5.** independent study Master of Education. Phitsanulok: Naresuan University.

Aree Phanmanee. (1994). Creativity. Bangkok: 1412

Bonwell, C.C.; & Eison.J. A. (1991). Active Learning: Creative Excitement in the Classroom. ASHE – ERIC Higher Education Reports No. 1. Washington, D.C.

Bruner, J. (1963). **The process of education**. New York: Alfred A. Knopf, Inc. and Random House.

Çetinkaya, Ç. (2014). The Effect of Gifted Students' Creative Problem-Solving Program on Creative Thinking. **Procedia – Social and Behavioral Sciences**, 116, 3722 – 3726. Collete,Alfred.T. (1973). Science Teaching in Secondary School. Boston: Allyn and Bacon,Inc, Good, Carter.Dictionary of education. New York McGarw – Hill book Company.

Gardner, Howard. (1983). Multiple Intelligence. **The Intheory in Practice**, 76(8),92 – 102.

Vygotsky, L.S. (1978). Mind in society:The developmental of higher psychological process. Cambridge, MA: Harvard University Press

Victor, E. (1980). Science for Elementary School. New York: Macmillan Publishing.