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Learning Management Based on Akita Approach on Multiplication and Division for Grade 3 Students

Piyaphat Thiangtrong

Faculty of Education, Mahasarakham University

79/2 Nakhon Sawan, Talad, Mueang, Maha Sarakham 44000, Thailand

Tel: 66-91-469-1693 E-mail: 63010582017@msu.ac.th

Jiraporn Chano (Corresponding author)

Faculty of Education, Mahasarakham University

79/2 Nakhon Sawan, Talad, Mueang, Maha Sarakham 44000, Thailand

Tel: 66-89-711-3395 E-mail: jiraporn.j@msu.ac.th

Bussayarat Nithideechaiwarachok

Faculty of Interdisciplinary Studies, Khon Kaen University, Thailand

Tel: 66-63-498-7853 E-mail: bussayarat@kku.ac.th

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Abstract

The Akita approach is the guideline in learning that responds to rapid changes in the 21st century. This research aimed to determine the effectiveness of learning management based on the Akita approach in accordance with the criteria efficiency of 75/75 and to explore the index of effectiveness of learning management pursuant to the Akita approach. Furthermore, to discover students' learning retention and to study the students' satisfaction with learning management based on the Akita approach. The participants were 34 primary school students in the northeast of Thailand, selected by cluster random sampling. Research instruments comprised of learning management plans, achievement tests, and a questionnaire. Statistics were used, including percentage, mean and standard deviation, and dependent samples t-test.

The results found that, firstly, learning management plans based on the Akita approach identified students' efficiency (E1/E2) at 86.46/85.29, which was higher than the specified criteria. Secondly, the index of effectiveness of the learning management plans based on the Akita approach on multiplication and division of students was equal to 0.6835 or 68.35 percent. Thirdly, for students who studied by using Akita-based learning management plans on multiplication and division topics, the post-test scores after studying and the post-test scores after they had finished studying for two weeks appeared to reveal no difference, which showed the persistence of students in learning. Lastly, students were satisfied with studying multiplication and division by Akita-based learning management plans with high overall scores and each item at the highest ($\bar{x}$ = 4.65-4.88) level.

Keywords: Akita approach, Learning management, Multiplication and division

1. Introduction

According to the vision of the basic education core curriculum A.D. 2017, which focuses on all students being physically balanced human beings, knowledgeable with high moral standards, and aware of their Thai citizenship and globalization. Students need to have an essential knowledge skill set as well as the proper attitude necessary to continue learning throughout a lifetime through education. Furthermore, the emphasis is on students believing that everyone can learn and develop themselves to reach their full potential and on empowering students to achieve five key competencies. These include the ability to communicate, the ability to think, problem-solving capabilities, the ability to use life skills, and the ability to use technology. Besides, it is also necessary to improve one's quality of life (Ministry of Education, 2017). In addition, achieving this goal necessitates a learning process in various fields of science, where mathematics plays a vital role in the development of human thought. It makes people more creative, organized, and think rationally (S. Turgut & G. I. Turgut, 2020).

Mathematics is one of the significant subjects which students need to be taught in schools. It can also be used to study science, technology, and other related sciences (Abu-Hilal & Abed, 2019; Fauzi & Chano, 2022). Moreover, it is a creative discipline that is a crucial part of modern life which provides students with powerful tools to comprehend the world, including logical reasoning, abstract thinking, and problem-solving (S. Turgut & G. I. Turgut, 2020). Goulding (1997) stated that mathematics equips students with the duties required for their futures as well as being active citizens. Elementary school is where students first engage and experience success or failure in mathematics. So, it could be expressed that every student should have basic mathematical skills at an early age (Goulding, 1997; S. Turgut & G. I. Turgut, 2020; Fauzi & Chano, 2022).

Additionally, Athan (2006) expressed that mathematics teaches students how to carefully analyze problems and situations, allowing them to anticipate, plan, make decisions, and correctly apply them in everyday life. Also, to assist students to be physically, mentally, intellectually, emotionally, and socially balanced, capable of thinking, and living happily with others. Therefore, in order to achieve educational goals, it is crucial to promote and

develop quality mathematics learning management (Institute for the Promotion of Teaching Science and Technology, 2012).

However, previous teaching and learning arrangements for mathematics learning strands were discovered to be less successful than they should have been. Students had low academic achievement, which was consistent with PISA (Programme for International Student Assessment, 2018) assessment results, which revealed that mathematics is the primary assessment by the Institute for the Promotion of Teaching Science and Technology (2021). The PISA test is used to determine how well the education system prepares students for real-life situations (Haara et al., 2017; OECD, 2019). The results of the mathematical literacy assessment of Thai students as a whole were found to be below average. Only 0.5% of Thai students achieved the highest level of mathematics, while 50% of Thai students, who were unfamiliar with mathematics, could meet the minimum requirement (OECD, 2019).

The National Basic Education (O-Net) test in 2020 for grade 6 students yielded an average score of 34.76 in mathematics, which was less than 50 percent of the total score. This could be due to several reasons and factors, such as curriculum, content, teachers, student environment, guardians, teaching activities, as well as teaching techniques, and methods of teaching, etc. (The National Institute of Educational Testing Service, 2021). Furthermore, teachers may believe it is sufficient to teach mathematics by explaining the content and allowing students to do exercises. Conversely, teachers must try to get students to practice alongside calculations, proof, and examinations. In some ways, teachers must demonstrate and understand the principles and explain them to students (Pattiyathani, 2022).

In Thailand, teaching and learning processes have not been conducive to developing open-minded people with long-term thinking and moral imperatives, in particular, the mathematics field. This is because the teaching and learning processes are still solely focused on the ability to convey content rather than the process for the students to develop critical thinking, synthesis, giving opinions, and the pursuit of knowledge (Reangnok & Poonputta, 2022). Therefore, there is an urgent need to improve the educational system, specifically learner-centered teaching and learning. Various activities are available to encourage students to stay alert and explain their responses to surveys, the information from which can be monitored, data queried, and analyzed (Wongsaphan & Ninnuan (2022).

Also, learning management must be regarded as the most crucial instrument for students. To encourage students to develop their knowledge through practical application based on their individual aptitudes and interests, teachers must transition from being educators or preachers to facilitators and advocates (Linder, 2011; Arthur et al., 2017). This is relevant to Akita-based learning management, which aims to ensure that students learn as much as possible. This improves problem-solving and communication in the classroom more effectively and allows students to have the opportunity to express their opinions (Akita Improvement Investigating Committee, 2017). Also, exchange ideas between students and teachers, as well as between students themselves. In addition, this can influence teachers and students to learn various methods that are beneficial in learning management activities (Saburo & Seiyuu, 2016).

According to the Akita approach, there are four stages of learning: the observational stage of learning, the self-concept phase, the discussion stage in pairs or groups, and the review of content and learning methods. It is a teaching method that focuses on problem-solving skills and allows students to use rational thought processes aimed at learning on their own. Teachers are simply problem solvers who encourage students to think for themselves (Akita Improvement Investigating Committee, 2017; Chookhampaeng, 2018). In this research study, the researcher conducted learning management based on the Akita approach to ensure student achievement and learning persistence, which will serve as the foundation for further learning.

1.1 Research Question

Are there any differences in academic achievement after studying and after students have finished studying for two weeks by using learning management based on the Akita approach?

1.2 Objectives of the Research Study

1. To determine the effectiveness of learning management of grade 3 students based on the Akita approach in accordance with the criteria efficiency of 75/75.

2. To explore the index of effectiveness of learning management pursuant to the Akita approach.

3. To discover students' learning retention based on the Akita approach.

4. To study students' satisfaction with learning management based on the Akita approach.

2. Literature review

2.1 Learning Standards and Indicators, Mathematics Learning Department (Revised Edition in 2017), According to the Core Curriculum of Basic Education A.D. 2008

The basic education core curriculum (A.D. 2008) has set a standard for learning and indicators for the mathematics learning department in grade 3 (Revised Edition 2017), which includes three learning areas and seven learning standards with the aim of enabling students to read and write numbers. Furthermore, students are able to count up to 100,000; they should have the skills of addition, subtraction, multiplication, and division and be able to apply them in various situations. It has been determined that the curriculum structure for studying at the elementary school level should be 200 hours (Ministry of Education, 2017).

Additionally, students will also practice their skills in money problem-solving, addition, subtraction, multiplication, division, and general problem-solving. These tasks can be arranged by organizing experiences or creating situations that are familiar to students, such as research, studied and practiced skills, experimentation, and summarization in order to develop skills and processes in computational thinking as well as problem-solving, giving reasoning, linking and mathematical descriptiveness (mathematical interpretation). Furthermore, apply the experience of knowledge, ideas, skills, and processes every day to learn new things, improve performance, and maintain a positive attitude toward mathematics. Thus, students will be able to work systematically, methodically, carefully, responsibly, and critically. Following that, students can be creative and have self-confidence (Ministry of

Education, 2017).

2.2 Learning Management Based on the Akita Approach

Learning management based on the Akita approach is a learning management practice in AKITA city, Japan, that originated in 2003 to develop learning management by applying inquiry-based learning in collaboration with the concept of proactive learning development. Furthermore, the main principles are deep learning, which aims to empower students to discover and solve problems independently (Akita Improvement Investigating Committee, 2017). Additionally, to develop conversational learning in order to broaden one's thinking and teach students how to anticipate and do things to the best of their abilities. Therefore, learning activity management is divided into four stages: observations, having your own ideas, group discussions, and reviewing learning method content. As a result, PISA's assessment results for elementary and middle school students in Japan in Akita Prefecture are among the highest in the country. In particular, students' ability for application purposes (Office of the Secretariat of the Council of Education, 2018).

2.3 Learning Management Plan

A learning management plan is created by combining subjects or groups of experienced that must be taught throughout the semester. In addition, the use of teaching materials and evaluation measurements for the content and small learning objectives relate to the purpose or the focus of the curriculum. Furthermore, the school's readiness to prepare materials and equipment, as well as to match with local real-life or to provide optimal conditions for the students. In other words, a learning management plan is used to plan ahead of time written instruction or as a regular teaching record (Chano, 2012; Witarsa & Rizki, 2022).

2.4 Learning Achievement

Learning achievement is the ability to attempt to access knowledge, which is caused by coordinated actions and necessitates a significant amount of effort, including not only intellectual elements but also non-intellectual elements expressed in the form of success. Besides, this can be observed and measured using cognitive tools or a general achievement test (Kunhertanti & Santosa, 2018). In other words, this is the process of ensuring that students have developed to reach the curriculum goals and possess desirable attributes in accordance with the criteria. In addition, there are two types of achievement tests: first, teacher-created tests are used to assess the progress of specific groups of students. Second, standardized tests developed by experts to measure the achievements of ordinary students, which can be analyzed and improved to the point where the tests are of high-quality and, reach the required standards, and can be compared with one another (Office of the Royal Society of Thailand, 2003; Lastri, Kartikowati, & Sumarno, 2020).

2.5 Learning Retention

Retention in learning is the maintenance of learning outcomes. To illustrate, it is also the ability to recall stimuli that have been previously learned or experienced for a while. Consequently, the next step is to evaluate the changes that have occurred through learning

and the persistence of remembering (Adams, 1967). Thus, the period of learning retention measurement should be approximately two weeks after the teaching has finished by using a Math's Achievement Test at that point in order to measure the learning retention of mathematics (Pornpawitkul, 2006).

2.6 Satisfaction

Satisfaction is one of the most critical factors influencing learning and educational success, resulting in the effective achievement of the goals set out. Additionally, if a person is willing to achieve the goal, they will be satisfied with their work if it is both materially and psychologically rewarding and meets their basic needs (Dale, 1958). In accomplishing this, questionnaires have been distributed as an instrument to collect the data. It consists of a series of questions to which the sample needs to respond by crossing or writing answers. In the case that if the sample cannot read or has difficulty reading, the interview method may be used in conjunction with questionnaires in order to define facts and express the opinions of individuals (Srisa-ard, 2010).

2.7 Criteria Efficiency

Criteria Efficiency is the level of effectiveness of a lesson plan or learning plan with the purpose of assisting students in achieving level-based learning while also satisfying the teacher who created the lesson plan or learning plan. Moreover, if the lesson plan or learning plan is used in conjunction with a purposeful teaching style, it has already achieved the necessary level of efficiency (Sukhothai Thammathirat University, 1997). Simultaneously, a lesson plan or learning plan is also beneficial when applied in teaching and learning with students. It is defined as a criterion by which teachers expect students to learn or change their behavior successfully. It is also specified as the average percentage of all practice work scores during class. The results of teaching outcomes of all students are E1/E2: Efficiency of Process (E1) and Efficiency of Product (E2) (Brahmawong, 1994).

3. Method

3.1 Research Design

This research study was experimental research. The research aimed to develop learning management based on the Akita approach. Participants in the research study were grade 3 primary school students in their second semester of the academic year 2021 from a primary school in the northeast of Thailand. In addition, 75 students from 3 classrooms were selected by cluster random sampling. Consequently, the total sample size was one classroom. Furthermore, the teaching materials were derived from the school's curriculum obtained from the mathematics department for grade 3 primary school students studying multiplication and division for one hour over ten lessons in the second semester of the academic year 2021. The independent variables were learning management based on the Akita approach, the period after studying, and the period after finishing studying for two weeks. Besides, academic achievement was the dependent variable.

3.2 Data Collection

The researchers gathered the data in stages, beginning with orienting students, clarifying the objectives, and introducing learning activities. Additionally, students were informed of the collaboration agreements so that they could understand them. Then, Students completed a pre-test comprised of 20 items. Following that, ten one-hour lessons were conducted using the Akita approach for learning management. Later, after completing all the lessons, students took a post-achievement test consisting of 20 items, and after finishing studying for two weeks, students retook the post-achievement test. Furthermore, students completed a satisfaction survey questionnaire about learning management. Finally, the researchers analyzed the scores and interpreted the findings and results.

3.3 Data Analysis

In contemplation of data analysis, the researchers examined the effectiveness of learning management in accordance with the Akita approach, determining the efficiency of the process (E1) from the subtest of the students by using statistics, including average mean score, standard deviation, and percentage. Moreover, to determine the efficiency of the product (E2) from the achievement test after studying the learning management plan based on the Akita approach on the topics of multiplication and division, the department of mathematics learning, by using the average mean score, standard deviation, and the percentage. Besides, the efficiency (E1/E2) of the criteria efficacy of 75/75. In addition, the achievement test comparison was analyzed using dependent samples t-test. Finally, analyze student satisfaction by using mean and standard deviation.

4. Results

Table 1. The results of the research study

(1) Learning management plan based on the Akita approach to the multiplication and division of grade 3 students had an efficiency of 86.46/85.29, which was higher than the criteria efficiency of 75/75.
(2) The index of effectiveness of the learning management plans based on the Akita approach on students' multiplication and division was equal to 0.6835 or 68.35 percent.
(3) For Students who studied using Akita-based learning management plans on multiplication and division topics, the post-test scores after studying and the post-test scores after they had finished studying for two weeks appeared to reveal no difference, which showed the persistence of students in learning.
(4) Students were satisfied with Akita-based learning management plans for multiplication and division, with the highest overall satisfaction score at ($\bar{x}$ = 4.78) level.

5. Discussion

As the research study showed the findings and results of learning management based on the Akita approach on multiplication and division of grade 3 students, the researchers discussed the results as follows:

(1) The researchers developed a learning management plan for grade 3 students based on the Akita approach to multiplication and division. The learning management plan's effectiveness (E1/E2) was 86.46/85.29, which means that students achieved 86.46% of the average score from the achievement test that was used to measure learning achievement for each of the ten learning plans on average. It demonstrates how the Akita-based learning management system performed. To illustrate, it assists students in developing self-awareness so students can improve their level of academic accomplishment. It can be determined that the aforementioned occurred as a result of learning management based on the Akita approach had been applied from inquiry-based learning in collaboration with the concept of proactive learning development (Akita Improvement Investigating Committee, 2017; Chookhampaeng, 2018). This focuses on a process that allows schoolchildren to solve problems by brainstorming solutions through group discussions. Thus, students at all levels can express their opinions on their learning topics (The Office of the Education Council, 2018). Therefore, it encourages students to develop deep learning, which aims to enable them to discover and solve problems independently as part of the learning process, which includes the "learning, applying, searching" method. That is why students can engage in conversational learning to broaden and deepen their thinking by interacting with others both inside and outside the classroom. Additionally, students can predict and do things to the best of their abilities, review their learning activities, and be guided to the next learning level, which is active learning (Chookhampaeng, 2018).

As a result, the researchers' learning management plan for grade 3 students based on the Akita approach to multiplication and division had a level of effectiveness of lesson plan that exceeded the efficiency criteria, which is valuable when used in teaching and learning with students (Sukhothai Thammathirat University, 1994). This finding was consistent with the results of Phimbutpha (2018), who investigated the development of learning activities on single variable linear equations in grade 1 using the proactive teaching methods of Akita Prefecture (Akita Action). The results showed that the measurement efficiency of teaching activities using the proactive teaching methods of Akita Action is greater than the 80/80 efficiency criterion.

(2) The index of effectiveness of the Akita approach-based learning management plans on multiplication and division of grade 3 students was 0.6835 (E.I.) or 68.35 percent. This means that the students had made progress, accounting for 68.35 percent of the time. Furthermore, learning based on the Akita approach encouraged students to make observations in their learning. In addition, the essential things for students to learn from active learning are that the topic must be appealing, attractive, and interesting and increase the desire to learn. Students must have their own idea using thinking tools to organize ideas easily, in particular, using a mind map, comparison tables, or providing consistent examples to lead to discussions

in pairs or group discussions (Akita Improvement Investigating Committee, 2017).

Also, compare ideas derived from self-thinking to improve problem-solving skills. Then divide the group into groups to discuss or discuss with everyone in the class. In other words, finding a standard solution, correcting thoughts, providing on-the-spot advice, and recognizing good points will help students maintain and improve their thinking skills from various perspectives. It is critical to emphasize that the preceding can lead to fruitful discussion. Then, by outlining what can be done and understood in their own words, they will gain proper understanding and increase their willingness to learn the next time. Thus, after discussion, the students can summarize their ideas in their own words in a notebook or review board of what they have learned during class hours. Not only should what has been learned to be reviewed, but other things should also be reviewed. For instance, the advantages of cooperative learning and memorization with applied problems will train students to anticipate their future learning (Saburo & Seiyuu, 2016; Chookhampaeng, 2018).

This research study was discovered to be relevant to Saenubon (2019), who had conducted research on the development of scientific problem-solving ability in grade 4 students through problem-based learning with the Akita action model. As a result of the improvement in scientific problem-solving ability for grade 4 students compared to the criteria of 70%, it was discovered that students who received learning management by using problem-based learning activities in collaboration with the concepts of the Akita action model were able to have the scientific problem-solving ability as follows: to begin with, students had an average score of 63.50 percent in the first practice cycle. The student then had an average score of 79.32 percent in the second practice cycle. Students had an average score of 79.32 percent in the most recent practice cycle. In summary, students outperformed the average in the second and third practice cycles.

(3) Students who studied multiplication and division using Akita-based learning management plans had an average achievement score of 17.06 after studying. Furthermore, the average achievement score after two weeks of study was 16.91, indicating a minimal difference. It was discovered that the research hypotheses were accepted and that students were focused and persistent in their learning. This is because learning management based on the Akita approach was the development of learning by applying inquiry-based learning in conjunction with the concept of proactive learning development (Akita Improvement Investigating Committee, 2017; Chookhampaeng, 2018).

Consequently, it focuses on a process that allows students to come up with solutions through group discussions. Moreover, students at all levels can express their opinions on their learning topics (The Office of the Education Council, 2018). It is appropriate for teaching and learning in all subjects, particularly mathematics, because it organizes learning using the Akita approach. As a result of providing an external environment that facilitates the student's internal learning process, it also promotes the learning process within the brain. Furthermore, it can assist students in learning other content effectively and remembering what they have learned for a long time (Gagne, 1977).

These research findings are similar to those of Pragobsri (2018), who investigated learning

achievement and retention in addition, subtraction, multiplication, and division by using skill exercises with Polya's problem-solving technique for grade 4 students. It was found that students who studied with the skill exercises model on the problem of addition, subtraction, multiplication, and division using Polya's skill exercises and problem-solving technique had the ability to focus on their studies after two weeks of schooling. There were no differences in pre and post-study testing, in other words, indicating that students were persistent in their learning.

(4) Students' satisfaction with learning management in accordance with the Akita approach on multiplication and division of grade 3 students was at the highest level. This is because learning activities based on the Akita approach were methods that allowed students to understand multiplication and division methods by thinking critically, rationally, and systematically. The researchers investigated the outcomes of learning management based on the Akita approach to assist students in promoting thinking in the use of everyday problematic situations that are close to them and appropriate for primary school students' ages. Moreover, this provided students with a clearer picture of how to solve problems. As a result of the activities, students were engaged, active, enthusiastic, happy, and challenged. Additionally, it was also discovered to be an ideal activity for elementary school students.

Similarly, Samang (2017) conducted research on the development of mathematics ability in solving word problems for grade 6 students using learning management based on the Polya method. Students appeared to be most satisfied with overall learning management. Likewise, Phimbutpha (2018) investigated the development of learning activities on single variable linear equations for grade 1 students using Akita Prefecture's proactive teaching methods (Akita Action). Overall, students were delighted with the teaching and learning arrangements.

6. Conclusion

For learning management based on the Akita approach to multiplication and division for grade 3 students, the researchers created a learning management plan with an efficiency of 86.46/85.29, which was higher than the criteria efficiency of 75/75. As a result, the effective index of the learning management plan based on the Akita approach on multiplication and division for grade 3 students was equal to 0.6835 or 68.35 percent. Students' test scores after studying and after they had finished studying for two weeks showed no difference, indicating that they had learning retention. Finally, students were delighted with learning management based on the Akita approach at the highest level.

7. Recommendations

For learning management based on the Akita approach, students must have basic multiplication and division knowledge and ability before beginning any activities because studying starts with learning to figure out the answers from a situation given by the teacher, and students need to figure out the answers on their own. Teachers should adjust their learning activities to students' needs while remaining environmentally conscious. Besides, teachers should take into account the differences between individuals and prepare appropriate materials and learning resources. Moreover, teachers should also pay close attention and

employ psychological principles to assist students in conducting experiments, for instance, reinforcement, which will motivate students to become more interested.

References

Abu-Hilal, M. M., & Abed, A. S. A. (2019). Relations among engagement, self-efficacy, and anxiety in mathematics among Omani students. *Electronic Journal of Research in Educational Psychology, 17*(2), 241-266. https://doi.org/10.25115/ejrep.v17i48.2182

Adams, J. A. (1967). *Human Memory.* New York: McGraw-Hill.

Akita Improvement Investigating Committee. (2017). *School improvement supporting plan*. Akita Prefecture: Ministry of Education.

Arthur, C., Badertscher, E., Goldenberg, P., Moeller, B., McLeod, M., Nikula, J., & Reed, K. (2017). *Strategies to improve all students' mathematics learning and achievement*. Waltham, MA: EDC.

Athan, C. (2006). *Curriculum and Mathematics Learning Management for Elementary Level*. Mahasarakham: Taksila Printing.

Brahmawong, C. (1994). *Educational technology and communications unit 1-5*. Nonthaburi: Sukhothai Thammathirat Open University.

Chano, J. (2012). *Instructional design Backward Design*. Mahasarakham: Mahasarakham University.

Chookhampaeng, C. (2018). AKITA Action Learning Management. *Journal of Educational Technology and Communications, Faculty of Education, Mahasarakham University, 1*(1), 9-16.

Dale, Y. (1958). *Handbook of Personnel Management and Labor Relations.* New York: McGraw-Hill.

Fauzi, I., & Chano, J. (2022). Online learning: How does it impact on student's mathematical literacy in elementary school? *Journal of Education and Learning, 11*(4), 220-234. https://doi.org.10.5539/jel.v11n4p220

Gagne, R. M. (1977). *The Condition of Learning and Theory of Instruction.* New York: Holt Rinchert and Winstin.

Goulding, M. (1997). *Learning to teach mathematics*. London: David Fulton.

Haara, F. O., Bolstad, O. H., & Jenssen, E. S. (2017). Research on mathematical literacy in school-aim, approach, and attention. *European Journal of Science and Mathematics Education, 5*(3), 285-313. https://doi.org/10.30935/scimath/9512

IPST (The Institute for the Promotion of Teaching Science and Technology). (2012). *Professional math teacher, the path to success*. Bangkok: 3-Q Media.

IPST (The Institute for the Promotion of Teaching Science and Technology). (2021). *PISA*

assessment results 2018: Reading, mathematics and science. Bangkok: The Institute for the Promotion of Teaching Science and Technology.

Kunhertanti, K., & Santosa, H. R. (2018). The influence of students' self-confidence on mathematics learning achievement. *Journal of Physics: Conference Series*, 1-7. https://doi.org/10.1088/1742-6596/1097/1/012126

Lastri, Kartikowati, S., & Sumarno. (2020). Analysis of Factors That Influence Student Learning Achievement. *Journal of Educational Sciences, 4*(3), 679-693. https://doi.org/10.31258/jes.4.3.p.679-693

Linda, S. M. (2011). The facilitator's role in elementary mathematics professional development. *Mathematics Teacher Education and Development, 13*(2), 44-66.

Ministry of Education. (2009). *Educational reforms in the second decade (A.D. 2009-2018).* Bangkok: The Office of the Education Council.

Ministry of Education. (2017). *Basic Education Core Curriculum, A.D. 2017*. Bangkok: Office of Education Council, Thailand.

Ministry of Education. (2017). *Education in Thailand*. Bangkok: Office of Education Council, Thailand. Retrieved from https://www.bic.moe.go.th/images/stories/pdf/education_in_thailand_2017.pdf

National Institute of Educational Testing Service. (2020). *O-Net Exam Result 2020.* Retrieved from https://www.niets.or.th/th

National Institution of Education Testing Service. (2021). *2020 Ordinary National Educational Test (O-Net) results*. Retrieved from http://www.niets.or.th/th

OECD. (2019). *PISA 2018 results*. Retrieved from https://www.oecd.org/pisa/Combined_Executive_Summaries_PISA_2018.pdf

OECD. (2019). *PISA 2018 results*. Retrieved from https://www.oecd.org/pisa/publications/PISA2018_CN_THA.pdf

Office of the Education Council. (2018). *Knowledge summarizing materials and the discussion and exchange of academic knowledge of fiscal year 2018*. Bangkok: Research and Educational Development, Office of the Education Council, Ministry of Education.

Office of the Education Council. (2018). *Knowledge summarizing materials and the discussion and exchange of academic knowledge of fiscal year 2018.* Bangkok: Research and Educational Development, Office of the Education Council, Ministry of Education.

Office of the Royal Society of Thailand. (2003). *The Royal Institute's Dictionary, 1999*. Bangkok: Nanmeebooks.

Pattiyathani, S. (2022). *Educational measurement.* Kalasin: Prasan Printing.

Phimbutpha, S. (2018). *Development of Learning Activities on Linear Variable Equations for Mathayomsuksa I by Applying the Akita's Active Learning Management (Akita Action).*

Master of Education Thesis Program in Mathematics Education Graduate School Ramkhamhaeng University (Master thesis, Ramkhamhaeng University, Thailand).

Pornpawitkul, P. (2006). *Effects of using a concept formation model in organizing mathematics activities on mathematical concepts and learning retention of fifth grade students in Bangkok* (Master thesis, Chulalongkorn University, Thailand).

Pragobsri, K. (2018). *A Study of Learning Achievement and Retention of Learning in Addition Subtraction, Multiplication and Division by Using Skill Exercises with Polya's Problem Solving Technique for Prathomsuksa 4 Students* (Master thesis, Buriram Rajabhat University, Thailand).

Reangnok, M., & Poonputta, A. (2022). Developing grade 10 student learning achievement of relation using deductive learning management with online exercises. *Journal of Educational Issues, 8*(2), 152-161. https://doi.org/10.5296/jei.v8i2.20065

Saboro, M., & Seiyuu, T. (2016). Abundance of formative assessment a local, traditional lesson mode in elementary mathematics with an abundance of formative assessment. *Journal of Education, Khon Kaen University, 39*(2), 1-12.

Saenubon, C. (2019). *The Development in Scientific Problem-solving Ability by Problem Based Learning with Akita action model of Mattayomsueksa 4 student* (Master thesis, Mahasarakham University, Thailand).

Samang, W. (2017). The Development of Mathematics Ability in Word Problems Solving by Learning Management Based on Polya Method of Prathomsuksa 6 Students. *Humanities and Social Sciences Journal of Graduate School, Pibulsongkram Rajabhat University, 11*(1), 52-61.

Srisa-ard, B. (2010). *Introduction of Research*. Bangkok: Suweerivasarn Company Limited.

Sukhothai Thammathirat Open University. (1994). *Teaching Materials for Teaching Skills Group 2 Mathematics Unit 1-7.* NBI: Sukhothai Thammathirat Open University.

Turgut, S., & Turgut, G. I. (2020). Me while I am learning mathematics: Reflections to elementary school students' drawings. *International Electronic Journal of Elementary Education, 13*(1). 139-154. https://doi.org/10.26822/iejee.2020.179

Witarsa, R., & Rizki, M. L. (2022). An analysis of student pedagogical skills in applying mathematics learning in elementary schools. *Al-Ishlah: Jurnal Pendidikan, 14*(2), 1777-1784. https://doi.org/10.35445/alishlah.v14i1.1795

Wongsaphan, M., & Ninnuan, K. (2022). Implementation of the learning management model based on cognitive development theory to enhance mathematical problem-solving ability for prathomsuksa 6 students. *Journal of Educational Issues, 8*(2). 58-71. https://doi.org/10.5296/jei.v8i2.19963