Learning Management Innovation Based on Phenomenon - Based Learning and Play-Based Learning to Enhance Creative Thinking Skills and Science Process Skills of Elementary School Students

Prapatchit Techa[1], Sakda Swathanan[2], Wichaya Pewkam[3], Natad Assapaporn[4]

[1-4]Curriculum and Instruction, Faculty of Education, Chiang Mai University, Chiang Mai, Thailand
[4] prapatchit_t@hotmail.com

Abstract

The purpose of this research was to design and evaluate a learning management innovation model based on Phenomenon-Based Learning and Play-Based Learning for elementary school students. This article presents only step 2: designing and evaluating the quality of the innovation of the research project, focusing specifically on the design and preliminary examination of the innovation model by experts. The research employed a research and development process in the designing and innovation creation phase. Relevant concepts, theories, and research were studied to synthesize the conceptual framework for innovation development. The innovation model was then designed and developed according to the framework, and its accuracy and appropriateness were verified by experts. The results of this phase yielded a learning management innovation model comprising principles, objectives, 6 steps of learning, role of the teachers, role of the learners, learning materials and resources, assessment and evaluation. The model received high-level evaluations from experts and provides a theoretical foundation for future implementation and testing in actual classroom settings in subsequent phases of the research.

Keywords: Phenomenon-Based Learning, Play-Based Learning, Learning Management Innovation, Elementary Level.

Background and Statement of the problem

Education in the current era faces significant challenges in preparing learners to cope with a rapidly changing world. Therefore, learning management approaches need to be adjusted to align with social contexts and the needs of 21st century learners (Panich, 2012; Office of the Education Council, 2017), especially creative thinking skills and science process skills. These are essential skills that will help learners be ready to face future challenges, with abilities in analytical thinking, problem-solving, adapting to new situations, and creating innovations that respond to society's needs. (Chanbang, 2021)

Traditional learning approaches that emphasize knowledge transmission from teachers to students and separate content by subject cannot effectively develop these skills. (Samahito, 2021) Phenomenon-Based Learning is a learning concept that has gained attention and has been widely implemented in Finland, a country with an education system ranked among the best in the world. This concept focuses on learning through holistic studies of real-life phenomena rather than separating learning by subject. This allows learners to see connections between knowledge in various disciplines and its application in real life (Silander, 2015). Phenomenon-Based Learning can encourage learners to develop knowledge, skills, and conclusions that promote lifelong learning (Wanichwatanaworrachai, 2023) as learners face complex, real-life problem situations without fixed answers (Symeonidis & Schwarz, 2016).

At the same time, Play-Based Learning is another concept that is important for elementary students' development. Play is a natural learning mechanism for children, promoting physical, emotional, social, and intellectual development (Whitebread et al., 2017). Play provides a safe space for experimentation, exploration, and understanding the world around them (Robertson, Morrissey & Rouse, 2018), which aligns with scientific processes that emphasize observation, questioning, hypothesis formation, experimentation, and conclusion (Thongchumnoom, 2004). Drew (2024) discusses the benefits and importance of Play-Based Learning, stating that it can promote intellectual, social, emotional, and physical development in children, as well as creative thinking and problem-solving abilities better than rote learning or lecture-based teaching.

From studying the learning management conditions in Thai elementary schools, it was found that there is still an emphasis on rote learning and traditional knowledge transmission from teachers to students. This limits students' opportunities to fully develop creative thinking skills and science process skills (Serbram, Sawanjinda & Wisavateeranon, 2021). Additionally, current science teaching at the elementary level often emphasizes content knowledge over learning processes, causing students not to see the connection between science and daily life and lacking motivation to learn (Trijamchan, 2019).

According to the Programme for International Student Assessment (PISA) 2022 report, Thai students scored only 409 points in science, which is significantly below the OECD average (485 points). This represents a declining trend compared to 2018, when Thailand scored 426 points. Thailand ranked 58th among 81 participating countries/economies (Institute for the Promotion of Teaching Science and Technology, 2023). Furthermore, Thai students' creative thinking scores reached only 21 points, substantially lower than the OECD average of 33 points. In comparison with other ASEAN nations, Thailand ranks behind Singapore, Malaysia, and Brunei in this domain.

While the results of the Ordinary National Educational Test (O-NET) in science for Grade 6 students have shown slight improvement with mean scores of 34.31 points in academic year 2021, 39.34 points in 2022, 40.75 points in 2023, and 42.87 points in 2024 (National Institute of Educational Testing, 2024) these scores remain below 50%, indicating significant gaps in Thai students' scientific capabilities.

Integrating Phenomenon-Based Learning with Play-Based Learning is an interesting alternative to address these issues, as both concepts align in terms of promoting learning through direct experience, learner participation, and connecting learning to real life. However, integrating these two concepts and applying them in the Thai educational context still has limitations and challenges in various aspects, both in terms of teacher understanding, appropriate activity design, and integration with the core curriculum. Additionally, research on integrating these two concepts in the Thai educational context is still limited, resulting in a lack of concrete guidelines for application.

Given the importance and issues mentioned, the researcher is interested in developing a learning management innovation based on Phenomenon-Based Learning and Play-Based Learning to enhance creative thinking skills and science process skills for elementary students. This research defines learning management innovation as a structured learning management model that encompasses essential components systematically organized according to philosophical principles, theories, concepts, or various beliefs. This model has been proven or tested for effectiveness in enabling learners to achieve its intended objectives. It comprises seven components: principles, objectives, steps of Learning, role of the teachers, role of the learners, learning materials and resources, assessment and evaluation. This research will focus on designing and evaluating learning management innovation that can be practically applied in the Thai elementary school context. The research results will benefit the development of elementary education quality and promote the development of essential 21st century skills for learners.

Objective

To design and evaluate the quality of a Learning Management Innovation based on Phenomenon-Based Learning and Play-Based Learning for elementary school students.

Expected benefits

This research will yield a learning management innovation based on Phenomenon-Based Learning and Play-Based Learning to enhance creative thinking skills and science process skills for elementary students, which can be applied in Thai elementary school contexts.

Conceptual Framework

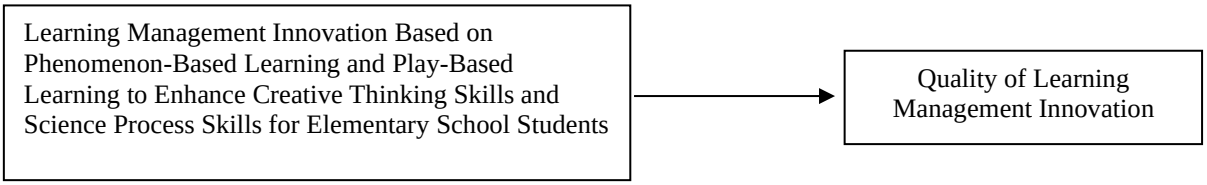

Figure 1 Research Conceptual Framework

Research Methodology

Research Design

This research is a research and development (R&D) study aimed at designing and evaluating a learning management innovation based on Phenomenon-Based Learning and Play-Based Learning for elementary school students.

The complete research process consists of four phases: 1) studying relevant data and information, 2) designing and evaluating the quality of the innovation, 3) implementing the innovation, and 4) evaluating the results of the innovation's implementation. This article presents only phase 2, focusing on the design and expert evaluation of the innovation's quality, prior to its experimental implementation with the sample group

Population and Sample

The population used in this research includes 3 experts in educational innovation and 2 experts in science teaching, totaling 5 experts.

Expert qualifications:

1. Hold a doctoral degree or have an academic position not lower than Assistant Professor.
2. Have at least 10 years of work experience in related fields.
3. Have academic or research works related to teaching innovations or learning management.

Research Instruments

The instrument used in this research is a quality assessment form for the learning management innovation, which was developed to assess the accuracy and appropriateness of the innovation.

Research Procedure

1. Study documents and research related to Phenomenon-Based Learning and Play-Based Learning.
2. Analyze information from interviews about learning management conditions and needs to design the learning management innovation, considering each component of the innovation.
3. Design and create a learning management innovation that integrates Phenomenon-Based Learning and Play-Based Learning, comprising 7 components: principles, objectives, 6 steps of Learning, role of the teachers, role of the learners, learning materials and resources, assessment and evaluation. The learning activity steps consist of 6 steps: 1) Connecting with Phenomenon, 2) Reacting through Play, 3) Experiencing and Exploring Knowledge through Play, 4) Articulating and Sharing Ideas, 5) Transforming Knowledge into Application and 6) Evaluating and Reflecting.
4. Submit the learning management innovation based on Phenomenon-Based Learning and Play-Based Learning to enhance creative thinking skills and science process skills for elementary students to 5 experts (3 in educational innovation and 2 in science teaching) to assess the quality of the innovation in terms of accuracy and appropriateness of its components using a quality assessment form that has been verified and improved.
5. Improve the learning management innovation according to expert suggestions.
6. Prepare the complete learning management innovation based on Phenomenon-Based Learning and Play-Based Learning to enhance creative thinking skills and science process skills for elementary students, ready for trial implementation.

Research Results

1. Results of Creating and Quality Assessment of the Learning Management Innovation

1.1 The learning management innovation consists of principles, objectives, 6 steps of Learning, role of the teachers, role of the learners, learning materials and resources, assessment and evaluation, as shown in the figure.

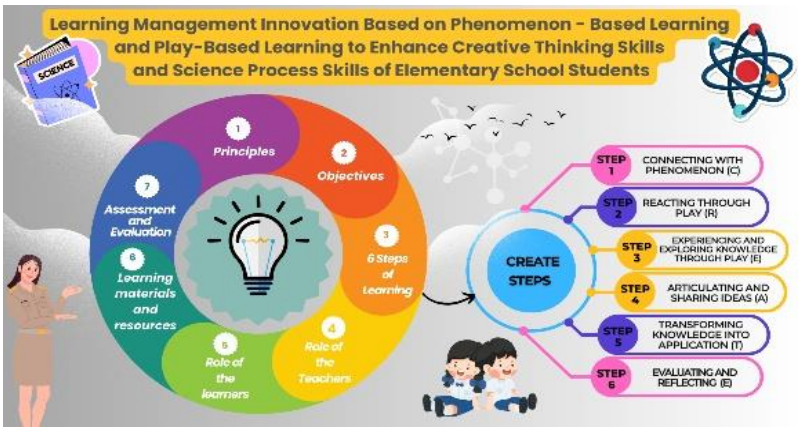

Figure 2 Learning Management Innovation Based on Phenomenon - Based Learning and Play-Based Learning to Enhance Creative Thinking Skills and Science Process Skills of Elementary School Students

The learning management innovation in this research was developed following a Research and Development process, beginning with an in-depth study and analysis of concepts, theories, and research related to Phenomenon-Based Learning and Play-Based Learning, as well as an analysis of the problems and needs in science learning management at the elementary education level in the Thai context. The innovative aspect of this learning management approach lies in the integration of Phenomenon-Based Learning, a teaching approach that has been successful in Finland, a country with a globally recognized education system, with Play-Based Learning, which responds to the natural learning tendencies of elementary school children. The integration of these two concepts creates a new learning management approach that has not been systematically studied and developed in the Thai educational context before. The researcher synthesized key elements from both concepts and developed five principles for the innovation, which led to the design of a unique 6-step learning process that differs from existing teaching models: 1) Connecting with Phenomenon 2) Reacting through Play 3) Experiencing and Exploring Knowledge through Play 4) Articulating and Sharing Ideas 5) Transforming Knowledge into Application and 6) Evaluating and Reflecting, known as the "CREATE Steps." This design seamlessly connects learning through real-life phenomena with play activities. Furthermore, this innovation clearly defines the roles of teachers and students in each step, representing a shift from traditional teacher-centered instruction to learning where students play a crucial role in constructing their own knowledge, with teachers facilitating the learning process, which aligns with 21st-century educational directions. The developed learning management innovation consists of principles, objectives, a 6-step learning process, teacher roles, student roles, learning materials and resources, and assessment and evaluation methods, as shown in Figure 2.

2. Results of the quality assessment of the learning management innovation by 5 experts:

Table 1 shows that the quality assessment results of the learning management innovation based on Phenomenon-Based Learning and Play-Based Learning for elementary students, by component, found that the 6 Steps of learning and role of the teachers components had the highest quality, with a mean for both accuracy and appropriateness of 4.60 (SD = 0.51), at the highest level. Next were Learning materials and Resources with a mean of 4.55 (SD = 0.69), at the highest level ; role of the learners with a mean of 4.53 (SD = 0.52), at the highest level ; and assessment and evaluation with a mean of 4.50 (SD = 0.53), at the highest level. The principles and objectives components had the lowest means at 4.47 (SD = 0.52), at a high level, except for the appropriateness of principles with a mean of 4.53 (SD = 0.52), at the highest level.

Table 1 shows results of the quality assessment of the learning management innovation by component

Component	Assessment Aspect	Mean	Standard Deviation	Interpretation
1. Principles	Accuracy	4.47	0.52	High
	Appropriateness	4.53	0.52	Highest
2. Objectives	Accuracy	4.47	0.52	High
	Appropriateness	4.47	0.52	High
3. 6 Steps of Learning	Accuracy	4.60	0.51	Highest
	Appropriateness	4.60	0.51	Highest
4. Role of the Teachers	Accuracy	4.60	0.51	Highest
	Appropriateness	4.60	0.51	Highest
5. Role of the Learners	Accuracy	4.53	0.52	Highest
	Appropriateness	4.53	0.52	Highest
6. Learning materials	Accuracy	4.55	0.69	Highest
and Resources	Appropriateness	4.55	0.69	Highest
7. Assessment and	Accuracy	4.50	0.53	Highest
Evaluation	Appropriateness	4.50	0.53	Highest

Table 2 shows Overall quality assessment results of the learning management innovation

Quality of Learning Management Innovation	Mean	Standard Deviation	Interpretation
1. Accuracy	4.53	0.54	Highest
2. Appropriateness	4.54	0.54	Highest
Total	4.54	0.53	Highest

Table 2 shows that the overall quality assessment of the learning management innovation based on Phenomenon-Based Learning and Play-Based Learning for elementary students found that the innovation had overall quality at the highest level, with a total mean of 4.54 (SD = 0.53). When considered by aspect, the appropriateness aspect had a slightly higher mean than the accuracy aspect, with appropriateness having a mean of 4.54 (SD = 0.54), at the highest level, and accuracy having a mean of 4.53 (SD = 0.54), at the highest level.

Summary of the Study

This research aimed to design and evaluate a learning management innovation based on the integration of Phenomenon-Based Learning and Play-Based Learning approaches to enhance creative thinking skills and science process skills for elementary school students. The study employed a research and development methodology to design and create an innovative learning model appropriate for the Thai elementary education context.

The innovation consists of seven key components: principles, objectives, 6 steps of learning, role of the teachers, role of the learners, learning materials and resources, assessment and evaluation. The learning activity procedures include six stages: 1) Connecting with Phenomenon, 2) Reacting through Play, 3) Experiencing and Exploring Knowledge through Play, 4) Articulating and Sharing Ideas, 5) Transforming Knowledge into Application and 6) Evaluating and Reflecting.

The quality assessment of the innovation by five experts in educational innovation and science teaching revealed that the overall quality was at an excellent level ($\bar{x}$ = 4.54, SD = 0.53). The highest-rated components were the 6 steps of learning and role of the teachers ($\bar{x}$ = 4.60, SD = 0.51), followed by learning materials and resources ($\bar{x}$ = 4.55, SD = 0.69), and role of the learners ($\bar{x}$ = 4.53, SD = 0.52).

The findings indicate that the integration of Phenomenon-Based Learning and Play-Based Learning is suitable for elementary education, offering a holistic learning approach that connects academic content with real-world phenomena through playful activities. This integration supports the development of 21st-century skills, particularly creative thinking and science process skills, by providing meaningful learning experiences where students can actively construct knowledge through direct experiences in a fun and engaging environment.

Discussions

From the quality assessment results of the learning management innovation based on Phenomenon-Based Learning and Play-Based Learning to enhance creative thinking skills and science process skills for elementary students, the following can be discussed

The developed learning management innovation has overall quality at the highest level ($\bar{x}$ = 4.54, SD = 0.53), reflecting that integrating Phenomenon-Based Learning with Play-Based Learning is appropriate for elementary level learning management. This aligns with Butkratanyoo 's (2018) research, which states that Phenomenon-Based Learning helps create a holistic perspective and access to the learners' real world, helping learners better connect knowledge with real life. Regarding Play-Based Learning, research findings align with Drake (2009), who found that Play-Based Learning creates fun, stimulates interest, and increases learner participation in learning activities, especially for elementary students who naturally enjoy play and movement. This is consistent with Khammani (2012), who states that play is a natural learning method for children, and incorporating play in learning management helps children learn effectively.

When considering the innovation's components, the 6 steps of learning and role of the teachers components had the highest means (M = 4.60, SD = 0.51) in both accuracy and appropriateness. This may be because the 6 steps of learning design is clear and aligned with learning theories and principles, and the role of the teachers are appropriately defined for learner-centered context. This aligns with Khammani (2012), who suggests that good learning management should increase student-centered learning characteristics, allowing students to learn independently through practice, from textbooks, books, and other learning resources, with teachers facilitating and providing guidance as necessary. This is consistent with Lahdemaki (2018, cited in Chaiwan & Nukulthum, 2021), who states that Phenomenon-Based Learning emphasizes changing teacher roles from knowledge transmitters to learning facilitators, and with Gronlund (2016, cited in Yoo-ampai, 2016), who states that teachers play a role in facilitating learning activities to maximize student learning through play.

Learning materials and resources component had the second-highest mean ($\bar{x}$ = 4.55, SD = 0.69), showing that this innovation includes a variety of learning materials and resources appropriate to the content and learners' age. This is consistent with Jitchayawanit (2020), who states that using diverse and appropriate media for learners stimulates interest and promotes effective learning, and with Raksutthi (2010), who found that using diverse learning materials and resources promotes multidimensional learning, clear content understanding, and happy learning.

The role of the learners component had the third-highest mean ($\bar{x}$ = 4.53, SD = 0.52), possibly because the researcher defined roles consistent with 21st-century learning principles that emphasize students as active learners, according to Piangduangjai (2015), who states that science teaching to develop creativity should include activities where students practice and develop science process skills to build knowledge independently. This indicates that active learning helps stimulate creativity and develop science process skills.

The assessment and evaluation component was the next highest ($\bar{x}$ = 4.50, SD = 0.53), possibly because the assessment and evaluation methods used in the innovation are diverse and cover knowledge, skills, and attitudes, focusing on authentic assessment to reflect learners' actual abilities. This approach aligns with Tangkijwanit et al. (2013), who state that effective assessment should shift from content memorization to performance assessment or authentic assessment, evaluating understanding by measuring the ability to apply knowledge and deep understanding to real-life problems, and with Sihmhasarn and Yuktanan (2003, cited in Wetchayalak, 2019), who suggest that effective assessment should consider all learning components and use diverse methods to gather complete data that reflect learners' actual conditions.

The principles and objectives components had the lowest means ($\bar{x}$ = 4.47, SD = 0.52), at a high level. In terms of principles, this reflects the alignment and appropriateness of integrating Phenomenon-Based Learning with Play-Based Learning. This may be because both concepts align in terms of learner-centered focus and creating meaningful learning experiences, consistent with Silander (2015), who states that Phenomenon-Based Learning connects to real situations and integrates various disciplines, and with Danniels and Pyle (2018), who state that learning through play helps children gain knowledge in a fun way that connects to life experiences. Regarding objectives, the assessment results reflect clarity and practical

feasibility, responding to the elementary education context, consistent with Tyler (1966), who states that educational objectives should be clear, measurable, and appropriate for learners. However, principles and objectives could still be improved to be clearer and more comprehensive, consistent with Jitchayawanit (2020), who states that defining clear learning objectives is a fundamental basis for designing effective learning management.

The integration of phenomenon-based learning and play-based learning approaches in this innovation represents a significant strength, earning high and highest quality ratings from expert evaluators. This is attributed to the seamless, harmonious, and academically sound integration of core elements from both pedagogical approaches. Phenomenon-based learning demonstrates strength in stimulating students' interest in knowledge acquisition to understand everyday phenomena, which aligns with the research of Mahawichit (2019), who found that applying phenomenon-based learning concepts alongside active learning approaches enhances students' 21st-century learning skills. Meanwhile, play-based learning demonstrates strength in creating an enjoyable learning atmosphere that reduces stress and anxiety, encouraging students to express themselves and fully participate in activities. This corresponds with the concept proposed by Pariputh and Kwangsawad (2018), who stated that personalized learning founded on play effectively promotes students' ability to reflect on their task performance.

Integrating these two concepts is theoretically consistent with constructivist learning theory, which emphasizes learners constructing knowledge through direct experience (Thoomthong, 2016). Phenomenon-Based Learning helps learners learn from real-life problems or phenomena, while Play-Based Learning makes the learning process fun, challenging, and engaging, consistent with Piaget's theory of cognitive development, which explains that elementary students learn best through practice and concrete experiences. (Kowtrakoole, 2016)

Additionally, integrating these concepts aligns with Dewey's experience-based learning concept (Dewey, 1916, cited in Sutthinarak, Abdulsata & Sutthinarak, 2021), which emphasizes learning from experience. Phenomenon-Based Learning connects academic content with the real world, while Play-Based Learning allows learners to interact with their environment through fun activities, making learning meaningful and lasting, consistent with Lillard et al. (2017), who found that integrating hands-on learning approaches with fun activities develops both academic achievement and learning attitudes.

From the above discussion, it can be seen that the learning management innovation based on Phenomenon-Based Learning integrated with Play-Based Learning for elementary school students differs from other science teaching models in the Thai context that typically maintain a more rigid structure focused on content delivery. This innovation emphasizes student agency, natural curiosity, and open-ended exploration while still maintaining alignment with curriculum standards. The innovation can promote creative thinking skills and science process skills for elementary students as it responds to children's developmental needs and their natural learning preferences for playful activities. Children can develop creative thinking skills through play and exploration, as well as science process skills through inquiry into real-world phenomena. This innovation was designed to address the current problems in science teaching that often emphasize content knowledge over learning processes, connecting academic content with real-world phenomena through fun play activities, making learning meaningful and sustainable. What distinguishes this innovation model from others is its unique integration of the structural strengths of Phenomenon-Based Learning with the engagement elements of Play-Based Learning, specifically tailored for the Thai educational context

In summary, the learning management innovation based on Phenomenon-Based Learning and Play-Based Learning for elementary students developed in this study has quality at the highest level, demonstrating the feasibility of implementing it to effectively develop elementary students.

Recommendations

Recommendations for Implementation

1. Teachers should thoroughly study and understand the concepts of Phenomenon-Based Learning and Play-Based Learning before implementation to ensure effective application of the innovation in their classrooms.

2. School administrators should provide professional development opportunities for teachers to enhance their understanding of these learning approaches and to develop their skills in designing appropriate learning activities.

3. The implementation of this innovation requires sufficient preparation time and resources. Schools should allocate adequate time for teachers to plan, create learning materials, and prepare learning environments that facilitate phenomenon exploration and playful learning.

Recommendations for Future Research

1. Learning management innovations using other theoretical concepts that enhance science process skills and creative thinking skills should be developed.

2. Future research should focus on implementing the innovation in actual classroom settings to evaluate its effectiveness in enhancing students' creative thinking and science process skills.

3. Research exploring the application of this innovation in different subject areas beyond science would contribute to understanding its versatility and adaptability.

Acknowledgment

I would like to express sincere gratitude to the Faculty of Education, Chiang Mai University, for the support and opportunity to conduct this research. Special appreciation is extended to the experts who devoted their time and expertise to evaluate the quality of the learning innovation and provide valuable suggestions for improvement.

I am grateful to school administrators, teachers, and students who participated in preliminary discussions that informed the design of this innovation. Their insights into the practical challenges and needs in elementary science education were invaluable in developing a relevant and applicable learning model.

Finally, I would like to thank my colleagues and family for their continuous encouragement and support throughout the research process.

Reference

Butkratanyoo, O. (2018). Phenomenon-Based Learning for holistic viewpoint and accessing learners' real world. *Journal of Chulalongkorn Education, 46*(2), 348-365.

Chaiwan, T., & Nukulthum, K. (2021). Phenomenon-based learning management: Integrated learning to enhance students' knowledge in the real world. *Journal of Graduate Studies, Valaya Alongkorn Rajabhat University under the Royal Patronage, 15*(2), 251-263.

Chanbang, M. (2021). *Development of science process skills and creative thinking with inquiry-based learning for grade 5 students.* [Master's thesis, Department of Curriculum and Instruction, Faculty of Education, Silpakorn University].

Danniels, E., & Pyle, A. (2018). *Defining Play-based Learning*. https://www.ceril. cl/index. php/articulos?id=594

Drake, J. (2009). *Planning for children's play and learning: Meeting children's needs in the later stages of the EYFS*. Routledge.

Drew, C. (2024, May 31). *Play Based Learning – Benefits And Challenges.* https://helpfulprofessor. com/play-based-learning/

Institute for the Promotion of Teaching Science and Technology. (2023). *Evaluation results.* https://pisathailand.ipst.ac.th/keywords/results/

Jitchayawanich, K. (2020). *Learning Management.* Chulalongkorn University Press.

Khammani, T. (2012). *Science of Teaching: Knowledge for effective learning process organization* (15th ed.). Dansutthakarnpim Company Limited.

Kowtrakoole, S. (2016). *Educational psychology* (12th ed.). Chulalongkorn University Press.

Lillard, A. S., Heise, M. J., Richey, E. M., Tong, X., Hart, A., & Bray, P. M. (2017). Montessori preschool elevates and equalizes child outcomes: A longitudinal study. *Frontiers in Psychology, 8,* 1783. https://doi.org/10.3389/fpsyg.2017.01783

Mahawichit, P. (2019). Applying phenomenon-based learning concepts with active learning in elementary education courses to enhance 21st-century learning skills. *Journal of Education, Khon Kaen University, 42*(2), 73-90.

National Institute of Educational Testing. (2024). *O-NET Exam Results Announcement System.* https://newonetresult.niets.or.th/AnnouncementWeb/Login.aspx?ReturnUrl=%2fAnnouncementWeb%2fdefault.aspx

Office of the Education Council. (2017). *National Education Plan 2017-2036.* Prik Wan Graphic Co., Ltd.

Panich, V. (2012). *Ways to create learning for students in the 21st century.* Sod Sri-Saritwong Foundation.

Pariputh, P., & Kwangsawad, T. (2018). Effects of personalized learning model based on play to enhance task performance reflection ability. *Journal of Education, 19*(1), 113-124.

Piangduangjai, N. (2015). *Development of a science learning management model using projects combined with inquiry techniques according to the flipped classroom concept to enhance innovation creation ability and scientific mind of Mathayom Suksa 3 students*. [Master's thesis, Curriculum and Supervision Department, Faculty of Education, Silpakorn University].

Raksutthi, S. (2010). *Manual for creating media, innovations, and plans accompanying innovation media*. Perm Sap Printing House.

Robertson, N., Morrissey, A. M., & Rouse, E. (2018). *Play-based learning can set your child up for success at school and beyond.* https://theconversation.com/play-based-learning-can-set-your-child-up-for-success-at-school-and-beyond-91393

Samahito, C. (2021). Lesson learned from projects and problem-based learning through the 13 Wild Boars trapped in cave: Question reflection for knowledge seeking. In S. Aksornsrit (Ed.), *Phenomenon-Based Learning* (pp. 71-79). Faculty of Education, Kasetsart University.

Serbrumme, T., Suwanjinda, D., & Wisavateeranon, S. (2021). Effects of phenomenon-based learning management with R-C-A questioning technique on science learning achievement and science problem-solving ability of grade 5 students at Maitri Uthit Community School, Nonthaburi Province. *Journal of Research and Development, Suan Sunandha Rajabhat University, 13*(1), 82-97.

Silander, P. (2015). *Phenomenon-Based Learning*. http://www.phenomenaleducation.info/phenomenon-based-learning.html

Suttinarakorn, W., Abdulda, P., & Suttinarakorn, S. (2021). *Competency-based curriculum development and meaningful learning management.* Siam Paritat.

Symeonidis, V., & Schwarz, J. F. (2016). Phenomenon-based teaching and learning through the pedagogical lenses of phenomenology: The recent curriculum reform in Finland. *Forum Oświatowe, 28*(2), 31–47.

Tangkijwanit, S., et al. (2013). *Strategy development for basic education to create responsibility.* Thailand Development Research Institute Foundation.

Thongchumnoom, P. (2004). *Science teaching at elementary level.* Odeon Store.

Toomthong, B. (2016). *Theory and development of learning management models.* Triple Education.

Trijamchan, N. (2019). *Development of science process skills and project abilities of Prathom Suksa 5 students with project-based learning management* [Master's thesis, Curriculum and Supervision Department, Silpakorn University].

Tyler, R. W. (1966). The objectives and plans for a national assessment of educational progress. *Journal of Educational Measurement, 3*(1), 1-4.

Wanichwatanaworrachai, S. (2023). *Contemporary teaching methods*. Silpakorn University Press.

Wetchayalak, N. (2019). *Principles of Learning Management.* Chulalongkorn University Press.

Whitebread, D., Neale, D., Jensen, H., Liu, C., Soleimani, N., Hopkins, E., Hirsh-Pasek, K., & Golinkoff, R. M. (2017). *The role of play in children's development: A review of the evidence.* The LEGO Foundation.

Yoo-ampai, K. (2016). Child-centered curriculum: Differentiated instruction approach. *Journal of Education, Silpakorn University, 14*(1), 149-155.