

Supporting Science Process Skills of Primary Students through Active Learning with Board Games

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The objectives of this research aimed to compare science process skill and learning achievement of primary students between before and after instruction using active learning with board games. This research was an experimental study using a one-group pretest-posttest design. The participants were 33 of grade 2 students in academic year 2025 from Mahasarakham province, Thailand. The research instruments were: 1) a lesson plan using active learning with board games on the topic of “light and living things”, and 2) and science process skill assessment test. Data analysis revealed that students who learned using active learning with board games had an average score of science process skill by post-test score higher than pre-test score at the 0.05 level of statistical significance. The scores of science process skill can be shown that the instruction supported students to deal with science lessons as well.

Keywords: Active learning, Board games, Science process skills

INTRODUCTION

Science significantly influences sociocultural aspects, and it also fosters the development of a learning community for a rational society. The study of science and technological knowledge enhances cognitive development in learners. It provides a procedural framework that employs information in a systematic and innovative way (Martin, 2024; Anbazhagan, 2025). Numerous methods and strategies exist for acquiring knowledge in science as well as natural phenomena in their lives. Even though the learning should be promoted through the nature of science, but students required more attitudes and motivation to the lesson. Science learning should help students succeed in a satisfying manner. It is a pedagogical approach that enables effective information acquisition and engagement, which makes learning an enjoyable and captivating activity for the learner (Yao, 2023). This paradigm does not only promote a more profound understanding of scientific concepts but also encourages cooperation and critical thinking among the students. The educator can develop a dynamic learning environment that encourages the learner to explore and experiment, which eventually results in a more profound appreciation for the subject matter.

The board game is an educational innovation because it combines the pleasure of games with teaching strategy (Hashim et al., 2023; Randl & Lasansky, 2023; Santos, 2023; Emihovich, 2024). This type of learning can create a scenario, thereby enhancing the understanding of the lesson. It obtains scientific knowledge through direct and enjoyable experience. Students comprehend the context and apply the information practically, which helps them learn both understanding and pleasure at the same time (Bavishi, et al., 2022). This aspect of board games makes the learning process both enjoyable and stimulating. Students

can comprehend the complex or challenging information easily (Arayapisit et al., 2023). These types of experiences not only improve the critical thinking skills of the learners but also enhance their capacity for teamwork and effective communication (Chen et al., 2021). This type of learning creates a dynamic environment for teaching, encouraging students to learn and work together (Wiwatworanai et al., 2025; Jin & Zhong, 2026).

Science process skills are essential scientific competences that underpin scientific literacy and sustained academic achievement. This approach aligns with direct experiences gained from hands-on activities. The teaching methods should allow students to have active learning, which has repeatedly demonstrated an enhancement in student engagement, conceptual comprehension, and retention. Boardgames provide organised engagement, problem-solving opportunities, prompt feedback, and collaborative educational experiences (Che et al., 2021; Hou et al., 2021; Assapun & Thummaphan, 2023). Despite the growing interest in digital educational games, science teachers still rarely examine conventional board games, especially in elementary school settings with limited resources. This study investigates how organised board games, as a form of active learning, can systematically enhance the development of science processing abilities in primary school students.

Nevertheless, board games have developed in a more varied manner. It is aesthetically pleasing, engaging, and available on several platforms. Numerous modalities of offline games necessitate players engaging with one another in person. The game employs items and equipment positioned on the playing area or board (Wijoyo et al., 2025). The playing surface mimics a board, presenting a unique image or pattern that players must interact with during gameplay (Treher, 2011). These interactions often foster social connections and strategic thinking, making board games an enduring favourite among diverse age groups. Consequently, the researchers aim to implement this learning management system by using board games to enhance scientific processing abilities. The objectives of this research aimed to compare science process skill and learning achievement of primary students between before and after instruction using active learning with board games. The research findings will serve as a resource for science educators to enhance teaching and learning and cultivate students' talents.

METHOD

This research employed experimental research; the one-group pretest-posttest design was used. The effectiveness of the intervention was assessed by comparing the results of the pretest and posttest measurements. This approach allowed for a detailed analysis of changes in the participants' performance over the course of the study. The participants of this research were Grade 2 students of Mahasarakham Kindergarten. In the second semester of the 2025

academic year, a total of 33 students. The purpose of the study was to determine the impact of the specific intervention on the students' learning outcomes. Data collection was done through assessment before and after the intervention. This helped in analyzing the performance of the students. The dependent variable was the application of active learning management through board games on the science topics "light and living things". Science process skills and learning satisfaction were the independent variables. The researcher followed the protocol for data collection methods and experiment procedures in the study. A pretest was done through the test of science process skills. They implement active learning through board games. Learning satisfaction was measured through the range of average and interpreted data based on the criteria for interpreting the results as follows: Highest Level (4.50 - 5.00), High (3.50 - 4.49), Moderate (2.50 - 3.49), Low (1.50 - 2.49), and Lowest (1.00 - 1.49). The results showed increased student engagement and understanding, especially those who experienced active learning. By using innovative teaching methods, the researcher aimed at enhancing not only the understanding of science concepts but also the entire learning experience of the students.

RESULTS AND DISCUSSION

The score of science process skills can be shown that students had posttest higher than pretest (Table 1). This improvement indicates that the instructional methods used were effective in enhancing students' understanding and application of scientific concepts. Consequently, it suggests that further emphasis on these skills could lead to even greater academic achievements in the future.

Table 1. Science process skills score between before and after implementation

Test	Mean	SD	df	t	p
Pre-test	6.56	2.71	32	12.045	0.00
Post-test	11.94	2.17			

From Table 1, the average score of the students in the scientific process skills before the class was 6.56 points, the standard deviation was 2.71 points, the average score after the study was 11.94 points and the standard deviation was 2.17 points. When comparing the average difference in scientific process skill scores between pre-class and post-class. It was found that after the experiment, the group of students who studied with management Learn Active leaning with board games The average score of advanced scientific process skills was statistically significantly higher than before the class at .05.

Table 2 Relative developmental score

Relative Development Score	Developmental level	No.	Percentage
51-75	High	14	42.43
26-50	Moderate	11	33.33
0-25	Low	8	24.24

Table 2 showed the progression of students' science process skills as reported by pretest and posttest scores (maximum score = 20). Among 33 students, 14 (42.43%) had a high level of developmental growth (51-75%), 11 (33.33%) displayed moderate development (26-50%), and 8 (24.24%) indicated low development (0-25%). The results pointed out that 75.76% of the students have achieved moderate to high levels of learning growth, which shows the impact of the teaching methodology on the students is mostly positive. If the results are interpreted in the context of active learning, important insights can be gained about the impact of teaching design on the development of science process skills. This can be shown in Table 3.

Table 3. Level of developmental science process skills

No	Pretest (20)	Posttest (20)	Developmental score	Level of development
1	7	13	46.15	Moderate
2	4	8	25.00	Low
3	8	11	25.00	Low
4	6	15	64.28	High
5	6	8	14.28	Low
6	5	9	26.66	Moderate
7	8	10	16.66	Low
8	4	7	18.76	Low
9	4	13	56.25	High
10	4	13	56.25	High
11	8	12	33.33	Moderate
12	7	13	46.15	Moderate
13	4	10	37.50	Moderate
14	8	13	41.66	Moderate
15	3	8	29.41	Moderate
16	5	9	26.66	Moderate
17	6	15	64.28	High
18	8	11	25.00	Low
19	4	13	56.25	High
20	8	10	16.66	Low
21	4	7	18.75	Low
22	4	14	62.50	High
23	5	15	66.66	High
24	5	12	46.66	Moderate
25	7	13	46.15	Moderate
26	6	14	57.14	High
27	5	12	46.66	Moderate
28	4	13	56.26	High
29	6	14	57.14	High
30	4	14	62.50	High
31	7	14	53.84	High

No	Pretest (20)	Posttest (20)	Developmental score	Level of development
32	5	15	66.66	High
33	7	14	53.84	High

The constructivist theory, which is the basis for active learning, holds that the development of knowledge is a result of active involvement, interaction, and reflection and not passive learning (Cattaneo, 2017; Hailikari et al., 2021). This form of scientific education involves processes like inquiry, experimentation, asking questions, discussion, and problem-solving. Science process skills like observation, classification, measurement, inference, prediction, experimentation, and interpretation are essentially experiential in nature. This enhancement in the posttest results implies that the education probably involved the student in some crucial scientific processes.

The significant percentage of students (42.43%) who achieved high developmental scores implies that active learning was highly efficacious for a large group of the student cohort. Some students have shown remarkable development, with increases in scores of eight to ten points from the pretest to the posttest. This demonstrates not just the maintenance of scientific information but also actual development in scientific processes. In active learning strategies like laboratory studies, collaborative problem-solving projects, guided inquiry projects, and reflective dialogues, students must apply ideas, evaluate hypotheses, and analyze information (Lombardi et al., 2021). This helps improve scientific processes by immersing students in real scientific processes.

Furthermore, the collaborative nature of active learning may have contributed to these improvements. Students work in pairs to discuss and collaborate. They share thoughts, clear misconceptions, and improve understanding (Bulkani et al., 2021; Kanphukiew & Nuangchalerm, 2024). Social interactions help students cognitively because they expose learners to different ideas and help them think more critically. The active nature of the classroom makes the students more engaged in the outcome of the learning process.

Collaboration and involvement were identified as aspects of enjoyment that were particularly significant. The highest mean ratings were for encouragement to work together and independently and for opportunities to ask questions. The aspect of promoting creativity and collaboration in discourse received the highest rating. These results are in excellent concordance with the social constructivist theory on which active learning is based. Knowledge construction occurs as a result of interaction, debate, and collaborative problem-solving. Collaborative activities allow for the expression of logic, dispelling misconceptions, and fusing diverse views together. At the same time, individual activities promote individual

accountability and independent thought processes. This balance between collaborative and individual learning opportunities reflects a sophisticated approach to active learning methodologies.

The moderate development group consists of 33.33% of the students. This group consists of learners who have developed significantly but not to the maximum level like the first group. These learners have surely developed; however, the development has not reached the maximum level. This can be easily understood from the active learning concept. This approach makes the learners more engaged in the learning process. However, for the active learning approach to be successful, scaffolding and cognitive readiness must be implemented (Salisbury & Irby, 2020; Li et al., 2023). The learners may need more inquiry and procedural explanations to assimilate scientific reasoning skills. The learners' development indicates that they are moving from shallow knowledge to deep knowledge (Jones, 2017).

The presence of 24.24% of the students in the low development group calls for careful consideration. The development of these students still faced challenges despite some advancements. It has been noted that active learning environments, despite being dynamic and student-centered, might pose challenges for those students who lack basic knowledge, self-confidence, and self-regulation skills (Gijlers et al., 2009). This, in essence, brings into focus an important aspect of active learning because mere interaction does not imply deep learning. Deep learning in active education involves differentiation, scaffolding, and continuous assessment for equal development.

The development stages illustrate a normal pattern in active learning environments. High-performing children may prosper in learning environments where independence and exploration are valued. Such children seize opportunities for exploration and display fast improvement in skills. Moderately performing students benefit from active participation but may require more concrete examples of scientific reasoning. Students with lower performance may face challenges unless additional instruction aides are provided. Thus, the statistics measure performance and illustrate the interplay between instruction and different students. Active learning enables students to move from passive receivers of knowledge to active seekers and solvers of knowledge. The significant improvement in posttest results for many individuals shows active participation in knowledge construction.

Additionally, the developmental score framework is consistent with the formative assessment principles, which are basic in active learning. It is possible for teachers to evaluate student development by comparing student performance before and after instruction, instead of focusing on the final achievement. This form of evaluation emphasizes student

development as a formative process, which is in line with constructivist teaching. This form of evaluation helps in improving teaching methods based on student response trends. A large percentage of the students showed substantial developmental development, although the majority showed small development. Although some students showed little development, it is evident that active learning, exploratory assignments, and collaborative learning helped improve the scientific reasoning skills of the students considerably. To improve student development in the future, education will have to apply differentiated scaffolding and feedback mechanisms for students at different developmental stages. With careful adjustments, active learning will help develop high science process skills in different settings.

Table 4 Students' learning satisfaction towards learning activities

Item	Mean	SD	Level of satisfaction
1 The teacher has prepared for teaching	4.94	0.24	Highest
2. The classroom atmosphere is conducive to teaching and learning	4.90	0.20	Highest
3. The content taught is modern and practical	4.88	0.33	Highest
4. The teacher clearly stated the purpose of the learning	4.87	0.32	Highest
5. Teaching and learning activities are in line with the teaching and learning objectives	4.94	0.24	Highest
6. Teachers encourage students to work together in groups and individually	4.97	0.17	Highest
7. Teachers encourage students to be creative and collaborative in discussion	4.94	0.24	Highest
8. Fun and interesting learning activities	4.88	0.33	Highest
9. The teacher gives students the opportunity to ask questions	4.97	0.17	Highest
10. Teachers use a variety of teaching methods and media	4.90	0.20	Highest

Table 4 showed the outcomes of students' satisfaction about learning activities, indicating remarkably elevated levels across all assessed items. The average scores varied from 4.87 to 4.97 out of a maximum of 5.00, accompanied by modest standard deviations ranging from 0.17 to 0.33. All items were assessed at the utmost level of satisfaction. These findings indicate not just favourable student impressions but also a uniform agreement among participants regarding the quality of the learning experience. When analysed through the lens of active learning, the findings offer compelling evidence that the instructional design and classroom execution effectively incorporated student-centered approaches.

Active learning focuses on student participation, collaboration, and knowledge development. Unlike traditional teaching methods, active learning does not view students as passive receivers of knowledge. Instead, active learning puts the student at the core of learning (Letina, 2020). The high satisfaction ratings for teacher preparation and alignment

between teaching activities and learning objectives. Preparation for effective active learning is necessary since activities have to be significant, goal-oriented, and mentally stimulating for active learning to be effective (Tsai et al., 2021). The explication of learning objectives further supports this argument. This is because when students are aware of the objectives of learning activities, they are more likely to self-direct their learning, evaluate their learning progress, and relate activities to expected outcomes. This is important for metacognitive development in active learning.

Moreover, the results show that the classroom environment was very favourable for learning. The classroom environment was encouraging and stimulating. The classroom environment in active learning settings was considered to be very significant because the students were expected to express their thoughts, ask questions, and talk. The presence of psychological security and respect for one another was significant in creating an environment that was favourable for active learning. The high levels of pleasure from enjoyable and stimulating activities show that the involvement was not just intellectual but also emotional. The active learning approach recognizes the importance of motivation in sustaining interest and deep understanding. When students find the activities for learning to be enjoyable and significant, their level of intrinsic motivation increases.

Several instructional techniques and media resulted in exceptionally high satisfaction ratings. Active learning thrives in the presence of numerous teaching techniques. These techniques include debate, case studies, multimedia materials, simulation, inquiry-based learning, and experience-based learning. The diversity of teaching techniques not only maintains students' interest in the subject but also meets the diversity of students' learning styles and cognitive types. Additionally, the students considered the materials presented as contemporary and applicable. This indicates the students considered the education they received as applicable to real-life situations. The element of relevance is an integral part of active learning. This is because it improves the relationship between the students' knowledge and application. Students tend to be more engaged in the subject if they consider the knowledge applicable.

From the educational perspective, the high levels of satisfaction on the part of the students not only reflect a sense of pleasure but also intricately relate to the achievement of learning outcomes (Saithongdee & Sirirat, 2024). Research in the field of educational psychology has established a positive relationship between the experience of pleasure and the achievement of academic success, perseverance, and the development of advanced cognitive skills (Sousa et al., 2023). From the perspective of the concept of active learning, satisfaction

reflects the effective facilitation of interaction, autonomy, and cognitive challenge. Statistics reflect the instructor's effective transition from a teacher to a facilitator, where the students were guided to experience significant learning.

In conclusion, the learning activities were received by the students with the utmost satisfaction. The results have robustly validated the effectiveness of active learning methodology in creating a well-equipped, objective-driven, interactive, collaborative, and stimulating classroom atmosphere. The increased satisfaction levels for all questions and low variability in response suggest that the learning design has efficiently integrated the essential elements of active learning methodology. These results suggest that active learning can be effective in developing academic skills and shaping student perspectives in a positive way. This study highlights the importance of active learning as an effective education paradigm in contemporary education.

CONCLUSION

The results indicated a significant improvement in both science process skills and learning satisfaction among the students. These findings suggest that incorporating board games as an active learning strategy can enhance engagement and understanding in science education. The science process skills of students can conclude that students who study using active learning management and board games. The average score of scientific process skills at the integrated level after learning is significantly higher than before studying. Statistical significance at the level of .05. They have a developmental score between before and after school. Active learning management with board games to create skills, integrated scientific processes, and academic development of students. Teachers must reduce their roles but give students more opportunities to participate in learning. Otherwise, students will not be able to build integrated scientific process skills on their own.

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Availability of data and material

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Ethics approval

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Patient consent statement

Informed consent was obtained from all individual participants included in the study.

Permission to reproduce material from other sources

No material from other sources was used in this manuscript.

Clinical trial registration

This study is not a clinical trial and does not require registration.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author used QuillBot in order to improve the language and readability. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the publication.

Credit authorship contribution statement

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Declaration of competing interest

The authors declare that they have no competing financial or non-financial interests in relation to this study.

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