INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY: APPLIED BUSINESS AND EDUCATION RESEARCH

2026, Vol. 7, No. 9, 3847 – 3873
http://dx.doi.org/10.11594/ijmaber.07.09.08

Research Article

KineQuest: A Game-Based Strategy in Improving Conceptual Understanding and Problem-Solving Skills in Kinematics

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Article history:
Submission 24 May 2026
Revised 02 September 2026
Accepted 23 September 2026

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ABSTRACT

This study examined the changes students' conceptual understanding and problem-solving skills in kinematics following the implementation of KineQuest as a game-based strategy. A pre-experimental design, specifically the one-group pretest-posttest design supported by a descriptive normative design, was implemented among 32 students. The developed Lesson Exemplar integrating KineQuest was rated from Very Satisfactory to Outstanding, while KineQuest was rated Outstanding by the Learning Resource Evaluators (LREs) across all criteria. Based on the KAT, students' conceptual understanding shifted from Nearly Proficient to Proficient in velocity, while in acceleration they remained at Nearly Proficient level. In problem-solving skills, students improved from Low Proficient to Nearly Proficient in velocity and from Nearly Proficient to Proficient in acceleration. The statistical analysis revealed a significant increase in pre-test and post-test scores ($p = 0.00$) following exposure to KineQuest. Furthermore, a moderately positive correlation ($\rho = 0.632$, p-value = <.001) was found between conceptual understanding and problem-solving skills, highlighting the association between conceptual knowledge and the application of knowledge through problem-solving. The findings suggest that KineQuest has potential as a curriculum-aligned and developmentally appropriate game-based strategy for supporting students' conceptual understanding and problem-solving skills. Given the pre-experimental design, the findings should be interpreted with caution. It is recommended that science teachers consider game-based strategies like KineQuest as supplementary learning activities. Further research may be done involving larger samples, comparison group and longer implementation periods is needed to validate the results.

Keywords: *Board games, Educational innovation, Lesson exemplar, Physics instruction*

How to cite:
Peralta, D. G. B. (2026). KineQuest: A Game-Based Strategy in Improving Conceptual Understanding and Problem-Solving Skills in Kinematics. *International Journal of Multidisciplinary: Applied Business and Education Research*. *7*(9), 3847 – 3873. doi: 10.11594/ijmaber.07.09.08

Introduction

Physics is one of the fundamental disciplines in understanding technological advancements and natural phenomena encountered in everyday life. It plays a significant role in developing students' scientific literacy, analytical reasoning, and problem-solving skills. Globally, students face considerable challenges in learning physics due to its abstract concepts and overreliance on mathematical operations (Palmgren, Kokkonen, & Brunn, 2025). International studies report that despite its importance, physics is often perceived as one of the most difficult branches of science—intimidating and complex (Taangahar & Okwori, 2022). This can be attributed to the student's lack of mathematical skills and their views on physics as a difficult subject. These challenges significantly affect students' engagement and their ability to comprehend physics concepts.

In the Philippine context, several initiatives have been implemented to strengthen students' conceptual understanding and problem-solving skills in physics through the Department of Education's K to 12 Curriculum and the recently introduced MATATAG Curriculum. Despite these efforts, studies and national assessments continue to reveal persistent challenges in physics education across the country. Conventional teacher-centered approaches remain prevalent in 21st-century classrooms, often resulting in limited student engagement and insufficient support for understanding abstract concepts, particularly in kinematics. In a study involving Grade 7 Filipino learners, findings revealed a significant gap in students' conceptual understanding of physics, especially in mechanics (force, motion, and energy), with only one student meeting the general proficiency standard (Nabua, Madca, Balinton, & Agustin, 2025). Another study reported poor conceptual understanding, limited analytical skills, and weak problem-solving abilities in physics, leading to misconceptions and low motivation to learn (Amaro, Ballesteros, Buffe, & Tino, 2023).

Among the branches of physics, kinematics introduces the fundamental concepts of motion and the relationships among distance, displacement, speed, velocity, and acceleration. Despite its foundational importance, many students struggle to apply kinematics principles in solving quantitative and situational problems. These difficulties create learning gaps and decrease students' motivation toward physics. Given that conceptual understanding serves as the foundation for meaningful problem-solving, strengthening both areas is essential to improving students' overall performance in physics.

To address these challenges, there is an urgent need for innovative instructional strategies that enhance students' interest and learning outcomes. Educational games have been identified as promising interventions for improving students' conceptual understanding and problem-solving skills in kinematics (Nguyen et al., 2024). Game-Based Learning (GBL) is a learner-centered approach that enables students to acquire knowledge and skills through digital or non-digital games (Grace, 2019). Research indicates that this approach significantly enhances students' engagement and motivation, particularly in developing conceptual understanding, higher-order thinking, problem-solving, and decision-making skills (Chen, Tsai, Liu, & Chang, 2021). Furthermore, gamified learning has been found to improve academic performance and foster collaboration through social interaction during gameplay (Othman & Ching, 2024). These findings suggest that well-structured educational games can deepen conceptual understanding and strengthen problem-solving skills while creating an engaging and intellectually stimulating learning environment.

Unlike digital games, board games provide tangible interaction, allowing students to physically engage with peers and opponents, thereby promoting collaboration and meaningful discussion (Chen, Tsai, Liu, & Chang, 2021). Such face-to-face interaction enhances peer learning and supports deeper conceptual processing of physics concepts. Several studies in physics education demonstrate promising outcomes using board games. For instance, a board game entitled "Catch a Flight" was designed to reinforce the teaching of Newton's Laws of Motion, particularly on the resolution of forces. The findings indicated improved conceptual understanding and increased motivation among students (Low, Balakrishnan, & Yaacob,

2023). Similarly, a well-designed escape room integrated with board game mechanics enhanced students' knowledge acquisition and motivation in physics (Bräuninger, Motz, Lüpke, & Seifert, 2024). These studies highlight how structured board game-based strategies can transform abstract concepts into interactive learning experiences.

Despite the promising results of game-based strategies in both international and local contexts, a significant research gap remains in the local setting. In Masbate, no study has yet explored the use of board games as a strategy for improving conceptual understanding and problem-solving skills in kinematics. Previous research revealed that students demonstrate only developing and partial understanding of kinematics concepts, particularly acceleration and velocity (Ole, & Gallos, 2021). Another study found that the least mastered competencies in physics include distance, displacement, speed, velocity, and acceleration (Gaviño, & Aliazas, 2024). These findings underscore the need for context-specific research to determine whether a board game-based strategy can effectively address learning gaps in kinematics at the local level.

To determine the effectiveness of an instructional innovation, empirical measurement through pre-test and post-test assessments is necessary to establish whether significant improvement occurs after the intervention. Moreover, examining the relationship between conceptual understanding and problem-solving skills is important, as strong conceptual foundations are often associated with improved problem-solving performance in physics learning.

In response to the identified research gap, the present study introduced KineQuest: A Game-Based Strategy in Improving Conceptual Understanding and Problem-Solving Skills in Kinematics. This innovative board game integrated key kinematics concepts into structured and engaging activities designed to enhance students' conceptual understanding of velocity and acceleration, as well as their problem-solving skills. Through pre-test and post-test assessments, this study sought to determine whether exposure to the KineQuest board game resulted in significant improvement in students' performance. Furthermore, the study examined the relationship between students' conceptual understanding and problem-solving skills following the implementation of the game-based strategy.

Based on the findings, a lesson exemplar aligned with the MATATAG Curriculum was developed. The KineQuest board game and the lesson exemplar were subjected to evaluation by qualified Department of Education (DepEd) personnel based on the Minimum Qualification Standards (MQS) for Learning Resource Evaluators (LRE). By measuring students' conceptual understanding and problem-solving skills, this study aimed to contribute to the growing body of literature on game-based learning and its potential to enhance teaching-learning practices in kinematics.

Statement of the Problem

Game-Based Learning (GBL), particularly through board games, provided a promising strategy in supplementing the teaching-learning practice in physics by making it interactive, enjoyable and meaningful. However, there was limited empirical evidence supporting the effectiveness of board game-based strategies in improving the student's conceptual understanding and problem-solving skills in Kinematics. To address the need for innovative strategy that strengthen the student conceptual understanding and problem-solving skills this study introduced KineQuest board game, which was designed to supplement learning gaps in kinematics. This study aimed to investigate whether KineQuest, as board game-based strategy, can significantly improve the students' conceptual understanding and problem-solving skills. Specifically, this study sought to answer the following questions:

1. What lesson exemplar can be developed in kinematics integrating a game-based strategy?
2. What is the expert's evaluation on the lesson exemplar in kinematics in terms of:
   a. learning competencies;
   b. content;
   c. coherence and clarity of thought;
   d. lay-out and design; and
   e. readability of materials?

3. What is the experts' evaluation on the KineQuest in terms of:
   a. Content;
   b. instructional and technical design; and
   c. other findings?
4. What is the level of students' conceptual understanding in kinematics before and after the implementation of KineQuest?
5. What is the level of students' problem-solving skills in kinematics before and after the implementation of KineQuest?
6. Is there a significant difference between student's mean pre-test and post-test scores when exposed to KineQuest?
7. Is there a significant relationship between conceptual understanding and problem-solving skills in KinQuest game-based strategy in kinematics?

Materials and Methods

Research Design

This study utilized pre-experimental design, specifically a one-group pretest-posttest design, which was deemed appropriate for examining changes in students' conceptual understanding and problem-solving skills in kinematics following the implementation of KineQuest as game-based strategy. This design was supplemented by a descriptive normative design supported by a Likert scale in determining the experts' evaluation of the modified board game and lesson exemplar.

Respondents

The participants of this study were selected using purposive sampling, a non-probability sampling technique in which participants were intentionally chosen based on predetermined criteria aligned with the objectives of the study. The participants of the study were Grade 8 students enrolled at Cabitan National High School during School Year 2025–2026, had the class schedule aligned with the implementation timeline of the study, had stable class size and consistent attendance record, must have at least 80% of the attendance during the implementation period to ensure consistent exposure to KineQuest.

Table 1. Demographic Profile of the Participants

Variables	Frequency	Percentage
Age		
13	13	40.63%
14	16	50%
15	3	9.38%
Gender		
Male	15	46.88%
Female	17	53.13%
Address		
Alas, Mandaon, Masbate	1	3.13%
Bat-Ongan, Mandaon, Masbate	8	25%
Cabitan, Mandaon, Masbate	18	56.25%
Dayao, Mandaon, Masbate	2	6.25%
Managanaga, Aroroy, Masbate	1	3.13%
Manamoc, Aroroy, Masbate	1	3.13%
Santa Fe, Mandaon, Masbate	1	3.13%

Table 2 presents the panel of experts who evaluated the KineQuest board game in terms of its instructional suitability for supporting conceptual understanding and problem-solving skills in Kinematics, as well as the developed lesson exemplar. This study modified the Minimum Qualification Standards (MQS) stated in the Learning Resource Evaluators (LREs) as prescribed by the DepEd Memorandum No. 217, s. 2016. A total of five (5) Learning Resource Evaluators (LREs) evaluated the Lesson Exemplar while ten (10) on the KineQuest board game.

Table 2. Profile of the Learning Resource Evaluators

Respondent Number	Bachelor's Degree	Graduate/Post Graduate Degree	Number of Years of Teaching	Position
1	BSEd – Gen Sci	MAEd – Science	26	MasterTeacher III
2	BS – Nursing	MAEd – Sci Ed	14	Teacher VI
3	BSEd – Gen Sci	MAEd – Science	18	Teacher III
4	BSEd – Physics	MAEd – Sci Ed	13	Teacher III
5	BSEd – Physics	MAEd – AS	13	Teacher III
6	BSED – BioSci	MAEd – Science	18	Teacher III and Science Coordinator
7	BSEd – Bio Sci	MAEd – Science	10	Teacher III
8	BSEd – Bio Sci	MAEd – Educational Management	9	Teacher III Science Coordinator
9	BSEd – Bio Sci	MAEd – Science	8	Teacher III
10	BSEd – Bio Sci	MAEd – Science	7	Teacher III
11	BSEd – Bio Sci	MAEd – Science	5	Teacher III
12	BSEd – Bio Sci	MAEd – Science	5	Teacher III
13	BSEd – Bio Sci	MAEd – Science	6	Teacher I and Science Coordinator
14	BS – Nursing	MAEd – Sci Ed	6	Teacher III
15	BS – Nursing	MAEd – AS	7	Teacher III

Sample and Sampling Techniques

Purposive sampling was used as the sampling method in this study. The researchers selected one group of Grade 8 students at Cabitan National High School based on the criteria set by the researcher. The researcher utilized one group of grade 8 students as participants of the study and were exposed to the KineQuest board game as an intervention strategy.

Instrumentation

The study used a 20-item multiple-choice test to assess the participants' prior knowledge on the topic's velocity and acceleration, with the emphasis on conceptual understanding and problem-solving in kinematics. Three science educators, consisting of Teacher III and Science Coordinators evaluated the test to determine its content validity. A similar group of students, who were not part of the study took part in the pilot testing. The result showed that the computed KR-20 value of the test was 0.80, which indicated a high level of reliability. This value is greater than the commonly accepted minimum reliability coefficient of 0.50 for a teacher-made test.

Table 3. Reliability Analysis of KineQuest Achievement Test Using KR-20

K	20
Σpq	4.26
var (s^2)	17.8347
KR20	0.80

The modified KineQuest board game was a combination of two (2) board games from previously published research. The first source of inspiration was adapted from Electriciladders board game from Malicoban et. al., (2021) on their study on the Development of a STE board game electriciladders for grade 8 students. The board game consisted of fifty (50) tiles with seven (7) ladders, nine (9) lightning strikes and VIP. The second board game was adapted from "Mystery of Motion" by Nyugen et. al., (2024) on their study Let's play! Transforming STEM education with board games. The Mystery Motion game incorporates cards like normal cards and functional cards which was adapted in KineQuest board game.

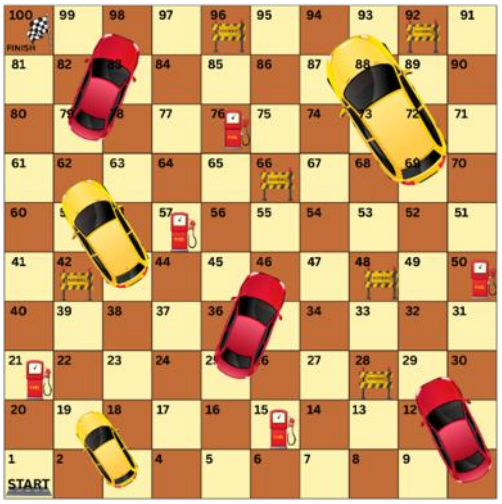

Figure 1. The KineQuest Board

Figure 1 presents the KineQuest board game, a redesigned and enhanced version of the two existing educational board game Electriciladders and Mystery of Motion. Unlike the original Elictriciladders, which consisted of fifty (50) tiles, KineQuest board game comprised of one hundred (100) and incorporated new elements such as Motion Cars and Gas Station feature. Motion Cars allows an upward movement, while Gas Station allowed the players to advance to a higher tile when Learned Card was answered correctly. Additionally, a "Checkpoint" feature was also added in KineQuest, it prevented the player from playing the game for 1 turn.

Figure 2. The KineQuest Categorical Cards

Figure 2 presents the KineQuest categorical cards which were originally introduced in Mystery of Motion board game but were modified to include Normal Cards, Functional Cards and Learn Cards. Normal Cards included velocity, acceleration, time, and displacement cards. Whereas Functional cards were also incorporated, Stop card (prevents another player from taking their turn), Minus Card (reverse players move or negative value), Plus Card (chance to draw additional card or move to another tile), Approximate Card (allows the player to round

off decimal numbers), and Change Card (swap position from the opponent or replace cards). Additionally, Learned Card were also adapted from Mystery of Motion.

Table 4. KineQuest Board Game Mechanics

Component	Mechanics
Players	• Kinequest can be played by six (6) participants with each having their own game piece and individually complete kinematics challenge.
Starting the Game	• Each player starts at the beginning with a piece placed on the "start" tile. • The players will draw 8 cards from the deck of cards at the start of the game.
Playing a turn	• Use Normal cards to calculate acceleration, speed, velocity, time or distance. • Play Functional cards strategically either to help yourself or block others. • Move your piece according to the result of your calculation.
Gas Station Tiles	• If a player lands on a Gas Station tile, they must draw a LEARN card and answer the question. • When answered correctly, you can earn advantage (extra movement or extra card) • Incorrect answer might cause penalties (move backward or lose cards).
Motion Car	• When a player lands on a Motion car, the player piece can move upward to a higher tile.
Checkpoints	• If a player lands on a Checkpoint tile, the player will temporarily stop and wait for the next turn to place a complete set of equation and move a tile.
No Valid Combination	• When there is no valid combination, the player can skip movement that round, draw another card or use any functional card instead.
Duplicate Cards	• When the player draws duplicates, the player can swap one duplicate for a missing variable on the deck of cards or exchange the cards with the opponent. • The player must wait for the next turn to place combinations and move a tile.

To determine the experts' evaluation of the modified KineQuest board game, the study utilized an existing tool on the Guidelines and Processes for Learning Resource Management and Development System (LRMDS) Assessment and Evaluation V1.0. In evaluating the lesson exemplar, the study adapted and modified an existing evaluation tool used for Finalized Division Contextualized Learning Resources (DCLRs) as prescribed in Regional Memorandum No. 0057, also known as Field Testing Validation Instrument (FTVI).

Data Gathering Procedure

The process of data collection followed a step-by-step 2-week duration with approval from the Assistant Schools Division Superintendent, principal, parents and guardians. Research instruments were validated by the School's Quality Assurance team and pilot-tested for reliability using KR-20. The lessons were carried out during the course of 1 week following their regular class schedules. After the intervention, qualified Learning Resource Evaluators (LREs) evaluated the lesson exemplar and KineQuest board game using standardized evaluation tools. The data gathered were statistically analyzed to determine the effectiveness of the intervention.

Statistical Analysis

Several statistical tools were used to interpret the data gathered these tools includes percentage calculation, frequency count, weighted mean, standard deviation, Likert Scale, Shapiro-Wilk Tests, Hake Gain, paired t-test and Spearman's Rank Correlation Coefficient. These statistical tools were used to determine the distribution of pre-test and post-test scores, evaluate the effectiveness of lesson exemplar and the modified KineQuest board game, measure the learning gain, test the normality of the data, and identify significant differences between the students pre-test and pos-test scores, and examine the relation between conceptual understanding and problem-

solving skills after the implementation of KineQuest.

Results and Discussion

Developed Lesson Exemplar in Kinematics Integrating a Game-based Strategy

The researcher developed a lesson exemplar aligned with Grade 8 Science Quarter Four focusing on the topics of velocity and acceleration. It incorporated the game-based strategy through the use of KineQuest board game, which was designed to supports students' conceptual understanding and problem-solving skills while strategizing to accomplish the game. The developed Lesson Exemplar was anchored to the content standards, performance standards and learning competencies as prescribed by the Grade 8 MATATAG Curriculum.

Experts Evaluation of the Developed Lesson Exemplar

The Expert's Evaluation of the Developed Lesson Exemplar focused on determining the overall quality of the developed instructional material in terms of learning competency alignment, content, coherence and clarity of thought, layout and design, and readability of materials by the qualified Learning Resource Evaluators (LREs). The following results presented how the lesson exemplar aligns with the curriculum standards supports the teaching and learning process. Through the expert's evaluation, the study aimed to ensure that the lesson exemplar developed was curriculum-aligned, pedagogically effective, learner-centered, and developmentally appropriate for the intended users.

Table 5. Experts Evaluation of the Lesson Exemplar in Terms of Learning Competency

I. Learning Competencies	Weighted Mean	SD	Verbal Interpretation
The teaching methods, learning activities, and evaluation measures congruent with the learning objectives.	4.0	1.0	Very Satisfactory
The content and activities are age and developmentally appropriate to target users?	4.4	0.6	Outstanding
Grand Mean	**4.2**		**Very Satisfactory**

Table 5 presents the experts' evaluation of the lesson exemplar based on its alignment with the learning competency under the MATATAG Grade 8 Curriculum. The findings revealed a grand mean of 4.2, which is interpreted as Very Satisfactory, indicating that the lesson exemplar meets the criteria in terms of learning competency alignment. Research studies show that an effective curriculum alignment with learning activities and assessment tools can significantly help the teacher and students achieve their desired learning outcomes (Beting, 2024). This suggests that the lesson exemplar can be a reliable source of curriculum-aligned instructional resources that facilitates integrative teaching-learning practice and assessment in kinematics. It also implies that the integration of game-based learning does not compromise the competency standards. More importantly, it emphasizes academic potential for broader implementation to enhance the standardization of instructional delivery.

Indicator number 1 revealed (M = 4.0, SD = 1.0) which can be interpreted as Very Satisfactory, this means teaching methods, learning activities, and evaluations are Very Satisfactory. Teaching methods also play a significant role in ensuring that the students will acquire the necessary knowledge and skills; as for this study, the game-based strategy will serve as the basic foundation (Aguilar-Moya, Diamanti, & Melero-Fuentes, 2025). This implies that integrating a game-based strategy like KineQuest may support students' engagement with kinematics principles and boost instructional delivery. It also signifies that relevant instructional strategies and evaluations may facilitate conceptual understanding and problem-solving skills among students. Furthermore, it promotes the adoption of innovative teaching methods in teaching the principles of kinematics.

Indicator number 2 got (M = 4.4, SD = 0.6), which can be interpreted as Outstanding, this means that the content and activities included

in the lesson exemplar are developmentally appropriate for the intended learners. This finding suggests that the lesson exemplar is well-crafted and aligned to the current age, cognitive abilities and developmental stage of the students. Thereby, initiating a meaningful engagement with the learning tasks without being overwhelmed to the kinematics concepts or being under-challenged in the problem-solving tasks. There is also a need for content and activities alignment with the age and developmental level of the students, as this alignment enhances engagement and facilitates effective learning experiences. Research has shown that students acquire knowledge and skills significantly when their individual developmental needs and interests are met; however, it is mostly disrupted by standardized testing, academic performance, and measurable outcomes (Ledé, 2025). This suggests that the lesson exemplar is developmentally appropriate to the cognitive level of the students, especially in improving their conceptual understanding, engagement and retention of knowledge on the kinematics concepts. Furthermore, it underscores the relevance of creating a learner-centered teaching materials that are responsive to the capabilities, needs and interest of the learners. When the teachers design materials with the learners in mind, they are creating a learning environment that is inclusive and responsive. When the instructional material is developmentally appropriate to the intended learners, it allows them to easily grasp the content of the material minimizing the cognitive load. Thereby, resulting to cognitive retention and skills refinement due to the meaningful interaction of the content and learning activities.

Table 6. Experts Evaluation of the Lesson Exemplar in Terms of Content

Indicators	Weighted Mean	SD	Verbal Interpretation
The activities are appropriately contextualized to the learner's environment and experiences.	4.0	0.7	Very Satisfactory
The content is properly and comprehensively developed.	4.4	0.9	Outstanding
The lesson exemplar is free from conceptual, factual and computational errors?	4.2	0.8	Very Satisfactory
The lesson exemplar is free from grammatical and spelling errors?	4.2	0.8	Very Satisfactory
All copyrighted texts and visual images are properly cited	3.8	1.3	Very Satisfactory
The lesson exemplar contains updated and relevant information.	4.4	0.9	Outstanding
The lesson exemplar does not contain content that violates social, cultural, or ethical standards.	4.6	0.6	Outstanding
The visuals, photos, illustrations, etc. are relevant and not misleading to the concepts presented.	3.8	1.3	Very Satisfactory
The contextualization used in the lesson exemplar effectively facilitates learning.	4.0	0.7	Very Satisfactory
Grand Mean	**4.16**		**Very Satisfactory**

Table 6 presents the experts' evaluation of the lesson exemplar in terms of its content. The grand mean revealed a 4.16, which is interpreted as "Very Satisfactory," indicating that the contextualization, accuracy, visuals, and ethical consideration in developing an instructional material meet the indicators. Indicator number 1 (M = 4.0, SD = 0.7) and indicator 9 (M = 4.0, SD = 0.7) were both rated as Very Satisfactory. A quasi-experimental study revealed that contextualized instructional material can significantly improve the students' least mastered competencies (Adonis, 2020). A similar study suggests that learning competencies can be easily achieved when the learning materials are culturally rooted, responsive, and

personalized to individual students (Luzano, 2022). This implies that the lesson exemplar is relevant for classroom utilization as it incorporates relevant context that support the students' conceptual understanding and problem-solving skills. It indicates that ethically appropriate and contextually relevant materials may support students' engagement and understanding. Moreover, it underscores the significance of anchoring instructional materials in the real-life situations of learners.

The accuracy of conceptual and factual errors (M = 4.2, SD = 0.8) and grammatical and spelling errors (M = 4.2, SD = 0.8) were both rated as very satisfactory. The comprehensiveness and accuracy of the instructional materials, like lesson exemplars, are crucial, especially in terms of content. Such rigor guarantees the validity and relevance of the information being presented; it must be free from any conceptual, factual, and grammatical errors. A study on the development and validation of contextualized learning material highlights the importance of coherence and clarity of thought, grammar and syntax, and spelling and punctuation in improving the students' performance (Aguelo, 2024). This finding suggests that the lesson exemplar is reliable source of curriculum-aligned instructional material as it minimizes the conceptual and grammatical errors that may confuse the learners. Indicating that a precise and well-crafted instructional material may support students' conceptual understanding and problem-solving skills in kinematics. The indicator on the updated and relevant information (M = 4.4, SD = 0.9) was rated "Outstanding" by the Learning Resource Evaluators. This indicates that the lesson exemplar was rated highly in terms of relevance to current educational standards. It indicates that current materials may support student engagement and motivation in the study of kinematics. Moreover, it underscores the necessity of always revising educational materials to preserve their efficacy.

Another crucial factor of writing lesson exemplars is the appropriate use of citations and references (M = 3.8, SD = 1.3), and the indicator in visuals and photos (M = 3.8, SD = 1.3) was both rated as Very Satisfactory. The writer must provide credit to the original source of information because it acknowledges their original work and allows the readers to track down the development of information and verify the evidence presented. The use of proper citations and references is essential in ensuring the academic integrity of the lesson exemplar as it gives due credit to the original source of information. Moreover, it allows the reader to trace the development of knowledge and verify the sources of information. Thus, strengthening the reliability and credibility of the lesson exemplar. Research suggests that incorporating visuals, photos, and interactive elements does not only cater to engagement with the material but also adds value in developing a deeper connection with it (Saborío-Taylor, 2025). A study on the role of aesthetics in technology education emphasizes the significance of visually engaging materials in enhancing the students' motivation and appreciation of the subject material (Andrée, Anderhag, Björnhammer, & Salomonsson, 2024). This indicates that the lesson exemplar fosters academic credibility and instructional effectiveness while also enhancing learner engagement using visual and academic materials. The inclusion of relevant and accurate information in the content as well as utilizing credible references makes the lesson more meaningful. It also indicates that although the lesson exemplar is already rated Very satisfactory, enhancing its visual design and citation guidelines might further improve the quality of lesson exemplar. Furthermore, it emphasizes the relevance of well-crafted resources that combines academic rigor and visual design can effectively enhance the understanding of abstract kinematics concepts.

Table 7. Experts Evaluation of the Lesson Exemplar in Terms of Coherence and Clarity of Thought

Indicators	Weighted Mean	SD	Verbal Interpretation
Statements or phrases are clear and meaningful.	4.2	0.8	Very Satisfactory

Indicators	Weighted Mean	SD	Verbal Interpretation
The thoughts/ideas are organized and logically sequenced.	4.2	0.8	Very Satisfactory
Appropriate conjunctions and transitional phrases are used to link sentences or paragraphs.	4.4	0.9	Outstanding
Word choice and expressions are appropriate for the target learners?	4.6	0.6	Outstanding
Sentences are clear and not too long or complex.	4.2	0.8	Very Satisfactory
Grand Mean	**4.32**		**Outstanding**

Table 7 presents the experts' evaluation in terms of the coherence and clarity of thought. The findings revealed a grand mean of 4.32, which can be interpreted as outstanding, indicating that the lesson exemplar has shown a high level of clarity, organization, and appropriateness in presenting the information. The coherence and clarity of concept and material are essential in developing instructional materials like lesson exemplars, as they directly influence how the students understand, engage, and apply the information (Purwaningtyas, Fitriati, & Haryanti, 2024). This finding implies that the lesson exemplar effectively outlines the kinematics concepts, supporting student in understanding concepts that are too abstract. This also suggest that a well-constructed lesson exemplar minimizes the student's confusion and misconceptions about the principles of kinematics. Thereby, highlighting the importance of clarity of thought and instructional design of the lesson exemplar in improving the students' conceptual understanding and problem-solving skills in kinematics.

The statements and phrases (M = 4.2, SD = 0.8), organization of thoughts (M = 4.2, SD = 0.8), and clarity of sentences (M = 4.2, SD = 0.8) were all rated as Very Satisfactory. Whereas the appropriate use of conjunctions and transitional phrases (M = 4.4, SD = 0.9) receives an Outstanding rating. The clarity of instructional materials can be achieved when appropriate word choice, phrases, and paragraphs are used in order for the student to easily understand the concept and avoid misconception and confusion. In the study on writing instruction, the findings suggest that when a writer focuses on the clarity of materials, the readers can efficiently process the information (Graham et al., 2025). Academic writings follow a specific formal tone and style to maintain seriousness and credibility of the material; this process includes proper choice of words and expressions by means of avoiding casual language, slang, and colloquial expressions.

This indicates that the lesson exemplar persuasively conveys kinematics principles in a coherent and logically connected manner, thus allowing the students to effectively track the flow of information on each topic. The systematic arrangement of content allows the students to develop their prior knowledge into understanding and refined skills. This is particularly significant in kinematics, where concepts like velocity, and acceleration are interconnected and require a sequential understanding. By structuring the lesson exemplar in a coherent manner, students are more actively engaged in knowledge acquisition, as opposed to facing discontinuous or isolated information. It also suggests that the use of clear and concise sentences and appropriate use of conjunctions and transitional phases contributes to the conceptual understanding of the students. Thereby, minimizing the cognitive load and confusion, allowing the students to focus more on understanding rather than interpreting to abstract concepts and disjointed explanations.

Table 8. Experts Evaluation of the Lesson Exemplar in Terms of Layout and Design

Indicators	Weighted Mean	SD	Verbal Interpretation
Page layout occupy at least half of the text area to fully utilize the paper.	4.4	0.6	Outstanding

Indicators	Weighted Mean	SD	Verbal Interpretation
Spacing between lines, paragraphs and section is appropriate and consistent.	4.4	0.6	Outstanding
The paragraph endings have one word or half a word on the last line of a paragraph.	4.6	0.6	Outstanding
Words are not awkwardly split or hyphenated at page endings.	4.6	0.6	Outstanding
The pages do not contain bad breaks which affect readability.	4.4	0.9	Outstanding
The labels placed only on the left and right margins.	4.4	0.9	Outstanding
Grand Mean	**4.47**		**Outstanding**

Table 8 presents another important factor in developing instructional material: layout and design. The findings revealed a grand mean of 4.47, which is interpreted as "Outstanding." Layout and design are fundamental aspects of legibility and readability of the material that influence the perception and understanding of the material (Suroya, Torrens, & Downs, 2024). This implies that the lesson exemplar is well-designed and constructed, allowing the students to understand the kinematics concepts and principles. It also suggests that an effective lay-out and design minimizes the student's confusion and cognitive load thereby enhancing the student's engagement to the lesson exemplar. The page layout (M = 4.4, SD = 0.6), spacing between lines and paragraphs (M = 4.4, SD = 0.6), and labels properly placed on the margins (M = 4.4, SD = 0.6) were all rated as Outstanding, indicating that proper spacing contributes to the appearance of the lesson exemplar, allowing the students to process the information more efficiently. A study suggests that the appropriate and consistent usage of spacing can significantly impact the instructional material's readability, which improves students' reading performance but does not directly or indirectly affect reading comprehension (Day, Atilgan, Giroux, & Sawyer, 2024). This implies that the lesson exemplar is well organized in a manner that allows easier understanding and content navigation. Especially the used of proper spacing and lay-out, it minimizes visual clutter and enhances the students focus on the material.

The paragraph ending (M = 4.6, SD = 0.6) and words at page endings (M = 4.6, SD = 0.6) were both rated as Outstanding. A well-designed instructional material effectively communicates through both words and visual elements, enhancing the visual appeal and comprehension of its content (Yang, Agrawal, Fragkogiannis, & Mulay, 2024). Academic writing, like lesson exemplars, should follow a formal structure and presentation. These include guidelines on the proper font type and size, margins, line spacing, and the use of headings and subheadings, which helps in creating professional and polished materials that meet the academic standards for publications. This indicates that the lesson exemplar is well formatted, facilitating seamless reading and avoiding interruptions in learners' understanding throughout the pages. It indicates that appropriate paragraph and page-end layout improves visual coherence, facilitating comprehension and readability of the material. Moreover, it underscores the significance of meticulous design in enhancing readability and the entire educational experience.

Table 9. Experts Evaluation of the Lesson Exemplar in Terms of Readability of the Material

Indicators	Weighted Mean	SD	Verbal Interpretation
Sentence and paragraph structures are appropriate, varied, and interesting.	4.2	0.8	Very Satisfactory
The instructions, exercises, questions, and activities are clear to the target users.	4.2	0.8	Very Satisfactory

Indicators	Weighted Mean	SD	Verbal Interpretation
The lesson exemplar facilitates understanding and comprehension for the target users.	4.2	0.8	Very Satisfactory
The language is appropriate for the target learners.	4.6	0.6	Outstanding
The headings or titles accurately reflect the content of each section.	4.6	0.6	Outstanding
Words, whether local or foreign, are correctly Spelled and properly used.	4.6	0.6	Outstanding
Grand Mean	**4.40**		**Outstanding**

Table 9 presents the experts' evaluation of the lesson exemplar in terms of the readability of the materials. The findings showed a grand mean of 4.40, which is interpreted as "Outstanding," indicating that the lesson exemplar is highly readable and appropriate for the target learners. This suggests that the instructional material may support student's comprehension through clear language use and organization of content.

The appropriateness of sentences and paragraphs (M = 4.2, SD = 0.8), clearness of instructions, questions, and activities (M = 4.2, SD = 0.8), and its ability to facilitate understanding (M = 4.2, SD = 0.8) were all rated as Very Satisfactory. The results suggest that the lesson exemplar is well-written and clear there is still a need for sentence structure improvement and simplification of instructions to minimize possible confusion. Instructional materials that utilize appropriate sentence and paragraph structures can improve students' understanding. Studies on reading materials showed that the readability of material can significantly influence students' comprehension (Zainurrahman, Yusuf, & Sukyadi, 2024). This indicates that the lesson exemplar offers coherent and structured instructions that facilitates students' understanding of kinematics principles effectively. It indicates that appropriate use of sentence structure may support students' comprehension and minimize confusion of the abstract concepts. Moreover, it underscores the significance of clarity in instructional design to improve student learning outcomes.

The appropriateness of the lesson exemplar to the target users (M = 4.6, SD = 0.6), headings and titles (M = 4.6, SD = 0.6), and proper spelling of words and sentences (M = 4.6, SD = 0.6) all received an Outstanding rating. A study conducted a readability analysis for EFIC textbooks suggest the importance of text alignment with target users; instructional materials should be well-designed to match the students' proficiency to facilitate understanding and comprehension (Fadzillah, Untsa Rohmah, & Kamisah Ariffin, 2024). Effective instructional materials require clear and concise language; sentences should be well structured, and jargon should be explained thoroughly to avoid unnecessary complexity and ensure understanding of the material. This indicates that the lesson exemplar is developmentally appropriate to the intended learners, ensuring that the information can be read, process and understand. It indicates that appropriate language use and information structuring enhance readability and successfully direct learners through the content. Moreover, it underscores the need for aligning instructional materials with learners' needs and interest to optimize its purpose.

Experts Evaluation of the Modified KineQuest Board Game

The Expert's Evaluation of the modified KineQuest board game focused on determining the overall assessment results on the modified instructional material in terms of content, instructional and technical design, and other findings by the qualified Learning Resource Evaluators (LREs). This section specifically examined the quality and instructional suitability of KineQuest for supporting students' conceptual understanding and problem-solving skills. The following results presented how the KineQuest aligned with the Curriculum standards and effectively supported the teaching and

learning process. Through the experts' evaluation the study aimed to ensure that the KineQuest was content aligned, learner-centered, and developmentally appropriate for the intended users

Table 10. Expert Evaluation on the Content Quality of the KineQuest Board

Indicator	Weighted Mean	SD	Verbal Interpretation
The board game reinforces, enriches, and/or leads to the mastery of certain learning competencies for the level and subject it was intended.	4.7	0.5	Outstanding
Material has the potential to arouse interest of the target users.	4.9	0.3	Outstanding
The Learn cards present conceptually accurate physics questions aligned with kinematics concepts.	5	0	Outstanding
Numerical values and equations formed using Normal Cards are scientifically accurate.	5	0	Outstanding
Game features (motion cars, gas stations, checkpoints) meaningfully represent realworld motion concepts.	5	0	Outstanding
Visuals are suitable to the age level and interest of the target user.	4.8	0.4	Outstanding
Visuals are clear and adequately convey the message of the subject or topic.	5	0	Outstanding
Typographic layout/design facilitates understanding of concepts presented.	5	0	Outstanding
The overall layout, size and physical design of the board game is appropriate for use in school.	5	0	Outstanding
Material is easy to use and durable.	5	0	Outstanding
Grand Mean	**4.94**		**Outstanding**

The evaluation findings reveal that the KineQuest board game achieved a grand weighted mean of 4.94, which can be interpreted as outstanding. This finding suggests that the KineQuest Board Game is highly rated and considered appropriate for supporting students' conceptual understanding and problem-solving skills in kinematics. This indicates that the board game met the established evaluation standards for instructional materials in science education.

Based on the table above, the respondents reported outstanding remarks, indicating that the board game reinforces, enriches, and leads to the mastery of certain learning competencies for the level and subject it was intended for. This finding suggests that the KineQuest Board Game supports the student's mastery of learning competencies, especially in kinematics. The science education reforms emphasize the alignment of instructional materials and learning competencies, which is a critical aspect of a standard-based curriculum reform. The purpose of this revision is to enhance the students' learning outcomes and active engagement (Zhao, Zhao, & Li, 2023). This implies that the modified KineQuest can strengthen the mastery of the learning competencies for the Science 8 curriculum with the focus on kinematics concepts, while promoting active engagement in the lesson. The item, material, has the potential to arouse the interest of the target users," suggesting that KineQuest Board Game has the potential to engage the students to participate in the teaching-learning process.

Studies have shown that game-based learning can outperform traditional methods of teaching in terms of students' performance and intrinsic motivation, which fosters the fundamental psychological needs such as autonomy and relatedness. and competence (Othman & Ching, 2024). This suggests that the game-

based material like KineQuest has the potential to enhance the student's motivation and active participation in understanding the principles of kinematics. It also suggests that the use of game-based strategy support the learner-centered learning environment that contributes to the sustained student's engagement.

Several indicators related to content accuracy and conceptual alignment reported outstanding ratings. These include conceptual, scientific, and numeral accuracy as well as the integration of real-world scenarios through the adaptation of motion cars, gas stations, and checkpoints. The integration of real-world scenarios into science contexts increases the students' engagement and motivation (Costa, Domingos, Teodoro & Vinhas, 2022). Integrated science instruction can enhance students' capacity to transcend disciplinary boundaries, cultivate conceptual comprehension and problem-solving abilities, and participate in significant learning experiences (Laius & Presmann, 2024). This implies that integrating real-world scenarios in instructional material like the KineQuest allows the students to better understand the abstract concepts since the information is highly relatable to their everyday experiences. It also suggests that contextualized materials, promotes deeper conceptual understanding and problem-solving skills. This method of contextualization fosters the vision of the 21st century classroom which is transforming the teaching-learning practice into interdisciplinary and applied learning in science education.

The visual and design indicators of the board game received the same positive feedback, having outstanding ratings. These include alignment of physical design, visuals, and typographical layout to the age level of the learners. Studies showed that the game components, like the physical design of the board game, brought a significant effect on the students' engagement and positive learning influence (Li, Hou, & Lin, 2024). Physical components of the board game provide a structured and contextualized learning experience that supports knowledge retention and cognitive integration while minimizing cognitive processes (Jhang, Lin, & Lin, 2025). This indicates that the effective visual and physical design of instructional materials such as KineQuest enhances learner retention and understanding. It indicates that minimizing cognitive load through well-organized design improves knowledge retention. Furthermore, it underscores the need of developmentally suitable and visually stimulating educational resources in science instruction.

Table 11. Expert Evaluation on the Instructional and Technical Design of KineQuest Board Game

Indicators	Weighted Mean	SD	Verbal Interpretation
The game provides adequate instructional support (rules, instructions and examples).	4.8	0.4	Outstanding
The game mechanics promote active learning, problem-solving, and conceptual understanding.	4.9	0.3	Outstanding
The board game supports innovative pedagogy such as game-based learning and collaborative learning.	5	0	Outstanding
Board game is safe to use.	5	0	Outstanding
The size, material and design of the board, tiles and cards are appropriate for intended learners.	5	0	Outstanding
Game mechanics and required manual tasks are compatible with the motor skills of the intended users.	4.9	0.3	Outstanding
Grand Mean	**4.93**		**Outstanding**

The table above presents the results of the evaluation of Learning Resource Evaluators for the KineQuest Board Game in terms of instructional and technical design. The data showed a consistently high evaluation with a grand weighted mean of 4.93, interpreted as

Outstanding. This finding indicates that the board game was highly rated in terms of its instructional design, gameplay mechanics, and technical suitability for the target learners.

The board game received positive ratings for its instructional support, especially with the clarity of its rules, instructions, and examples. This indicates that clear instructions and organized examples in the KineQuest Board Game may support learners' understanding and minimize confusion during play. It indicates that instructional clarity is essential for creating meaningful learning experiences. In terms of game mechanics promoting active learning, problem-solving, and conceptual understanding, this indicator also received a significantly high rating. Incorporating active engagement can support students' interest and conceptual understanding (Zubair et al., 2024). The engaging components of the game mechanics may stimulate students' motivation to participate in gameplay and engage in problem-solving tasks (Chen, Tsai, Liu, & Chang, 2021). This indicates that the game mechanics of KineQuest may support active engagement, consistent with the aims of the study to support conceptual understanding and problem-solving skills in kinematics. It indicates that repeated gameplay may support student motivation and learning. Furthermore, it underscores the value of active learning methodologies in science education.

When it comes to integrating innovative pedagogy, the board game also received an Outstanding rating from the Learning Resource Evaluators. Studies indicated that the utilization of board games in science education has the potential to foster collaborative learning and problem-solving as students work together, negotiate strategies, and share knowledge to achieve a common goal of winning the game (Othman, Mat, & Sim, 2025). Through this innovative pedagogical tool, systematized learning outcomes such as memory and problem-solving as well as psychological outcomes such as creativity, empathy, and self-confidence are reported in the literature (Sousa et al., 2023). This indicates that the KineQuest board game may promote collaboration and a learner-centered approach, allowing students to build knowledge through active engagement with peers during gameplay. It indicates that game-based pedagogy may support cognitive and social development. Moreover, it underscores the potential value of collaborative learning environments in supporting knowledge acquisition and skills refinement.

The technical aspects of the board game, such as safety, size, and design, also received an Outstanding rating from the Learning Resource Evaluators (LREs). Moreover, the Learning Resource Evaluators (LREs) rated the indicator for compatibility of game mechanics with the motor skills of the learners as Outstanding, indicating that the game components and gameplay align well and are manageable for the intended target learners. The components of the game can support creative thinking through provocative design goals (Mora, Gianni, & Divitini, 2017). This indicates that KineQuest's physical and technical design was rated as suitable for safe, accessible, and potentially supportive learning experiences for students. It indicates that well-structured materials may support creativity and involvement in understanding abstract concepts. Furthermore, it underscores the significance of incorporating usability and physical design in the production of educational games.

Table 12. Evaluation on the Concepts and Grammar of KineQuest Board Game

Indicators	Weighted Mean	SD	Verbal Interpretation
Absence of conceptual errors in kinematics concepts.	4.8	0.42	Outstanding
Absence of factual errors.	4.8	0.42	Outstanding
Absence of grammatical and/or typographical errors	4.9	0.32	Outstanding
Other error (i.e. computational errors, obsolete information, errors in the visuals, etc.)	4.8	0.42	Outstanding
Grand Mean	**4.83**		**Outstanding**

The table above presents the evaluation results for Factor C of the KineQuest board game, which significantly attained a high grand weighted mean of 4.83, interpreted as outstanding. This finding suggests that the game components maintain a high level of accuracy and absence of conceptual, factual, and grammatical errors in the content presented in the board game and categorical cards. These errors cannot be ignored because they hinder the students' conceptual understanding of the lessons and can negatively affect the students' achievement and performance (Rabab'ah, 2025). This also emphasizes the significant role of teachers in selecting and developing appropriate instructional materials before utilization, as it plays a vital role in instigating and bringing desirable changes in the students' learning (Portana et al., 2021). This indicates that the KineQuest Board Game is a reliable instructional tool that ensures precise delivery of kinematics principles, hence reducing the possibility of misconceptions among students. It indicates that ensuring high content accuracy in educational materials enhances student comprehension and performance. Moreover, it underscores the significance of teacher engagement in ensuring the quality and validity of instructional materials utilized in science education.

Level of Conceptual Understanding Before and After Implementation

This section presents the comparative analysis of the student's conceptual understanding before and after the implementation of KineQuest, especially in the kinematics concepts like velocity and acceleration. It highlighted the level of students' prior knowledge and the changes in their conceptual understanding after the implementation of the intervention. This finding indicates that students demonstrated higher conceptual understanding following the implementation of the modified KineQuest board game. Thereby, adding to the growing empirical evidence on the effectiveness of game-based strategy in enhancing the students' learning outcomes.

Table 13. Level of Student's Conceptual Understanding in Kinematics

Topic	Number of Items	Test	Mean	MPS	VI	Hake Gain	VI
Velocity	5	Pre-test	2.94	58.75	Nearly Proficient	0.48	Medium Gain
	5	Post-test	3.94	78.75	Proficient		
Acceleration	5	Pre-test	2.78	55.63	Nearly Proficient	0.07	Low Gain
	5	Post-test	2.94	58.75	Nearly Proficient		

The table above presents the level of students' conceptual understanding based on the pre-test and post-test of the KineQuest Achievement Test (KAT). Before the implementation of KineQuest, the students' pre-test scores in velocity showed (M = 2.94, MPS = 58.75) which can be interpreted as Nearly proficient. This indicates the before the implementation the students already had a basic knowledge and understanding on the concepts of velocity. A study on the students' conceptual understanding in kinematics revealed that the majority of the students initially lack adequate knowledge, and a lot of students still need to learn more about physics concepts (Handhika, Widiyaningrum, & Denata, 2023). But after the implementation of KineQuest there is a noticeable change in the students' conceptual understanding of velocity. The post-test revealed (M = 3.94, MPS = 78.75) which can be interpreted as "Proficient." This finding suggests that after the exposure to KineQuest the students developed a strong and more accurate understanding of velocity. Whereas the computed Hake gain (0.48) which is interpreted as medium gain, indicates a moderate but meaningful changes in learning achievement. This finding aligns with Lichtenberger, Hofer, Stern, & Valerlaus (2025), which suggests that structured interventions resulted in significant

improvements compared to students who received traditional instruction. Similar studies have shown significant improvement after the implementation of intervention, showing a substantial shift in conceptual understanding after the implementation (Salazar & Tajures, 2025). Conceptual understanding is the interaction between concepts and procedures; hence, this finding indicates that the participants were able to grasp the concepts. Facts are no longer isolated but transferable into different areas of study (Nwankwo, 2021). Successful knowledge construction strengthens knowledge retention through reactivation of prior knowledge during acquisition of new knowledge (van Kesteren, Krabbendam, & Meeter, 2018). The integration of encoding, chunking, meta-cognition and transfer helps in the organization of previous knowledge to newly acquired information (Schneider & Simonsmeier, 2025). This finding suggests that the modified KineQuest board game is effective in improving the students' conceptual understanding after the implementation.

On the other hand, for acceleration, the pretest score showed (M = 2.78, MPS = 55.63) is interpreted as Nearly Proficient. This indicates that the students have a lower initial understanding of the concepts of acceleration as compared to velocity. However, the post-test showed a slight increase in the post-test scores (M = 2.94, MPS = 58.75), which is still interpreted as Nearly Proficient. The Hake Gain showed (0.07), interpreted as low gain, suggesting minimal improvement in the students' conceptual understanding after the implementation. This finding is consistent with Madsen, McKagan, & Sayre (2015) and highlights that students who already demonstrated expert-like partial knowledge tend to maintain their stable performance levels even after the implementation of instruction (Madsen, McKagan, & Sayre, 2015). Similar studies have reflected the same findings: that few of the students remain at the same levels if prior understanding is low, highlighting the need for diagnostic tests before the implementation of intervention (Peligro, 2024). Studies suggest that lower mastery hinders students' ability to transfer knowledge to new problems; thus, improving conceptual understanding through student engagement can be a solution to this challenge (Balacuit, Nabua, & Saludares, 2025).

The overall findings imply that the KineQuest board game has a potential in causing changes to the students' conceptual understanding, but the level of learning gain varies depending on the complexity of the topic and the students' prior knowledge. The noticeable learning gain in velocity suggests that when the concepts are moderately complex, the integration of game-based strategy like KineQuest can reveal a significant changes in students' learning outcomes. This supports the idea that interactive learning promotes better conceptual understanding and helps the students move from Nearly Proficient to Proficient level.

However, the low gain in acceleration suggests that more abstract and mathematically complex concepts require additional instructional support. This suggests that although students demonstrated an increase in scores following the intervention, the observed change may not have been sufficient to address higher-level conceptual difficulties. More importantly, this result implies the need for differentiated instruction, as students do not improve similarly across all concepts. Students with lower understanding may need more support and repeated exposure to observe significant change. Abstract and complex concepts like acceleration may require more structured instructional strategies in addition to game-based learning.

Level of Problem-Solving Skills Before and After the Implementation

This section presents the analysis of students' ability to apply kinematics concepts in solving velocity- and acceleration-related problems before and after the implementation of the KineQuest board game. It also examined the changes in students' performance through the administration of pre-test and post-test assessments, with emphasis on their ability to apply kinematics concepts and appropriate formulas in velocity and acceleration. By comparing the pre-test and post-test results, the study aimed to examine changes in students' problem-solving skills following the implementation of KineQuest and identify areas that required additional instructional support.

Table 14. Level of Student's Problem-Solving Skills in Kinematics

Topic	Number of Items	Test	Mean	MPS	VI	Hake Gain	VI
Velocity	5	Pre-test	2.47	49.38	Low Proficient	0.35	Medium Gain
	5	Post-test	3.34	66.88	Nearly Proficient		
Acceleration	5	Pre-test	3.44	68.75	Nearly Proficient	0.24	Low Gain
	5	Post-test	3.81	76.25	Proficient		

The table above presents the level of students' problem-solving skills before and after the students' exposure to KineQuest. Prior to the implementation, the pre-test revealed (M = 2.47, MPS = 49.38) which is interpreted as Low Proficient. This finding indicates that the students initially had difficulty in solving velocity-related problems and difficulty in applying formulas and concepts correctly. After the students' exposure to KineQuest, the post-test revealed (M = 3.34, MPS = 66.88), which is interpreted as Nearly Proficient. The Hake gain of (0.35), is interpreted as Medium Gain, indicates a moderate change in enhancing the students' problem-solving skills in velocity. This finding suggests that students have gain changes in problem-solving to velocity questions; additional instructional support is needed in applying appropriate computational strategies and reasoning when solving problems. Another study claims a well-structured intervention can influence the significant increase in the students' performance from low pre-test to significantly higher post-test outcomes (Galarosa & Tan, 2022). It indicates that when students showed mastery of the content and problem-solving process, they developed their metacognitive process required for problem-solving, which aids in their success in strategizing in the gameplay (Vo, Sakhar, White & Yuriev, 2024). The study indicates that the students face difficulties in problem-solving due to their attempts to memorize algorithms (Vo, Sakhar, White & Yuriev, 2024). Another study suggests that the challenge in teaching and improving problem-solving skills lies in the presentation of problems, which are presented in a structured manner that lacks the integration of real-world scenarios (Kailani, Newton, & Pedersen, 2019). Studies suggest that students' problem-solving skills can be difficult to improve because their knowledge acquisition is implicit, so one gameplay session can shift their full mastery of the problem-solving process (Liu & Israel, 2022).

On the other hand, the results showed that prior to the implementation of KineQuest, the students had substantial skills in solving acceleration-related problems compared to velocity as observed in the pre-test (M = 3.34, MPS = 68.75), which is interpreted as Nearly Proficient. Following the intervention, the post-test revealed a higher score (M = 3.81, MPS = 76.25), which is interpreted as Proficient. However, the Hake gain (0.24) is interpreted as Low Gain, suggesting that although a noticeable increase was observed, the gain was less substantial as compared to velocity. The relatively smaller learning gain may be related to students' prior knowledge, which was already higher compared to velocity, thus leaving less room for large measurable gains. Hwang, Hung & Chen (2014) emphasized that personal factors like knowledge levels, learning habits and cognitive processes can influence the effectiveness of game-based strategy. Similarly, Cai, Zhang, Liu, & Zhan (2025) noted that although game-based strategy revealed positive effects, this finding does not directly apply across all contexts. Furthermore, Bao & Koenig (2019) explained that novice learners have fragmented knowledge that affects their ability to put concepts into practice, like problem-solving. This finding suggests that students demonstrated improved performance in solving problems, which may reflect positive changes in problem-solving skills (Sabangan, 2025). A similar finding also revealed that students' problem-solving skills and scores improved

after the integration of game-based strategy (Assapun & Thummaphan, 2023).

Overall, the results imply that the game-based strategy through the use of KineQuest board game can effectively enhance the students' problem-solving skills, particularly for topics where students showed low proficiency. The moderate gain in velocity suggests that for students who showed limited skills in certain topics, the interactive intervention can significantly help in bringing out positive change with regard to their ability to apply concepts, interpret problems and use appropriate formulas. Highlighting the importance of learner-centered and interactive instructions in bridging the gaps between conceptual understanding and practical application.

Whereas, the relatively low gain in accelerations suggests that the improvement in students' problem-solving skills is not solely dependent on instructional materials or teaching strategy but may also be influenced by students' prior knowledge and their ability to apply that knowledge. Additionally, students who already developed a certain level of proficiency may show smaller measurable learning gains, as shown in the acceleration's Hake gain, suggesting that a single intervention may not lead to substantial improvement. Thus, indicating a need for considering students' learning variability before designing an instructional material or choosing a teaching strategy.

The Pre-test and Post-Test Scores of the Participants

This section presents the comparative analysis of students' performance before and after the implementation of KineQuest as measured through the KineQuest Achievement Test (KAT). To determine whether there was a statistically significant difference in students' learning outcomes, the study compared the mean scores and variability of the pre-test and post-test scores using the paired t-test.

Table 15. Comparative Analysis Between Pre-test and Post-test Scores

	N	**Mean**	**SD**	**t**	**df**	**Two-tailed (α = 0.05)**	
Pre-test	32	11.63	3.70	-8.0012	31	Critical Value (CV)	p-value
Post-test	32	14.03	3.00			+/-1.98	0.00

The results of the paired t-test showed that the participants' post-test scores (M = 14.03, SD = 14.50) were significantly higher than their pre-test scores (M = 11.63, SD = 3.70) following the implementation of the KineQuest board game. This difference is statistically significant, as indicated by t(31) = -8.0012, p-value = 0.00. Since the p-value is lower than the significance level (α = 0.05), the null hypothesis is rejected. A study conducted to test the effects of blended instruction through concrete and virtual manipulatives showed a significant improvement in students' performance, indicating that the structured interventions were significant (Siller & Ahmad, 2024). A semi-experimental study examining the effects of Game-based Learning (GBL) also reported a significant increase in pre-test and post-test scores, indicating that the structured intervention materials can effectively bridge learning, motivation, and academic performance (Partovi & Razavi, 2019). A quasi-experimental study conducted in the Philippines on the multiplication automaticity skills among Filipino math learners also reported a significant improvement in pre-test and post-test scores after the intervention (Nalusay, Demoral, & Suguis, 2024). Another study suggests that although game-based learning can be an effective teaching approach in improving students' learning outcomes, the long-term effect cannot be guaranteed, as there was no evaluation of retention after the intervention (Cardinot & Fairfield, 2022). In other words, the findings showed a statistically significant increase in students' scores following the implementation of the intervention program. The significant increase in students' academic performance following the intervention is consistent with previous research suggesting that well-designed instructional materials may support positive learning outcomes. It also suggests that game-based instructional materials may support students' academic performance by addressing learning gaps in kinematics. However, the findings still emphasize the need for further investigation of long-term effects on

knowledge and skills retention to fully establish empirical evidence regarding the sustained impact of game-based strategy.

The Relationship Between Conceptual Understanding and Problem-Solving Skills

This section presents the analysis of how the students' level of conceptual understanding was linked to the students' ability to apply the concepts they have learned in solving kinematics related problems. This analysis aimed to determine whether there was a significant relationship between the conceptual understanding and problem-solving skills through the use of an appropriate statistical tool. Through Spearman's rank correlation coefficient, the strength and direction of the relationship were determined, thereby showing the relationship of the two variables.

Table 16. Relationship Between Conceptual Understanding and Problem-Solving Skills

Variables	N	Spearman's ρ	S-value	p-value	Level of Significance
Conceptual Understanding	32	0.632	2007.5	<.001	0.05
Problem-solving					

The table above presents the results of the Spearman rank correlation coefficient used to determine the relationship between conceptual understanding and problem-solving skills in the KineQuest game-based strategy in kinematics. The findings revealed a moderately positive correlation, $\rho = 0.632$, p-value < .001, with a sample size of N = 32. Since the p-value is less than the level of significance (0.05), the results indicate that the correlation is statistically significant. This suggests that participants who scored high on the conceptual understanding assessment also achieved high scores in problem-solving, whereas those who scored lower in conceptual understanding questions also received lower scores in problem-solving questions. The results indicate that there is a strong link between problem-solving skills and understanding of concepts. This indicates that a strong conceptual foundation is associated with students' ability to organize and apply their knowledge when solving problems, which aligns with findings from a study on the positive relationship between student engagement, conceptual understanding, and problem-solving through an integrated instructional approach in improving learning in plane geometry (Gebremeskel, Ayele, & Wondimuneh, 2025). A descriptive quantitative method using meta-analysis showed a strong positive correlation between problem-solving skills and students' academic achievement, indicating that a student with strong conceptual independence tends to achieve higher learning outcomes (Banawi et al., 2024). Furthermore, the significant positive correlation suggests that students with higher conceptual understanding tended to demonstrate stronger abilities to evaluate, strategize, and solve kinematics problems. Additionally, it indicates that teaching methodologies should prioritize the integration of operational skills and conceptual knowledge so that students can go beyond rote memorization and apply ideas in their everyday experiences. It also emphasizes the need for instructional strategies that intentionally link conceptual understanding with problem-solving skills in order to promote deeper comprehension, academic success, and application of knowledge in practical contexts.

Limitations of the Study

This study has several limitations that should be considered when interpreting its findings. First, this study utilized a one-group pretest-posttest pre-experimental design without a control group or comparison group to test its significant effect. Therefore, the observed changes on the students' conceptual understanding and problem-solving skills after the implementation cannot be solely attributed to exposure to the KineQuest board game. Other factors such as history, maturation, and testing effects may have contributed to the observed improvement. Second, the study involved only 32 Grade 8 students from a single section in one group, thus, limiting the generalizability of the

findings to other grade levels, schools, and student population. Third, the implementation period was relatively short, which only covered one week duration; thus, the study does not establish whether the observed gains would be sustained over a longer period. Future studies, may address these limitations by employing on a larger population size, more diverse sample, incorporation of control group, and extending the implementation period to examine the sustained effects of KineQuest as a game-based strategy.

Conclusions

Based on the findings of the study, the following conclusions are presented regarding the implementation of KineQuest and its association with students' conceptual understanding and problem-solving skills in kinematics.

1. The lesson exemplar integrating the KineQuest was well-designed, curriculum-aligned and developmentally appropriate for the intended learners while effectively incorporating the game-based strategy in kinematics.
2. The lesson exemplar was rated from Very Satisfactory to Outstanding across all criteria, indicating that it was considered appropriate for supporting classroom instruction in kinematics and for providing learning activities related to conceptual understanding and problem-solving.
3. The KineQuest board game received outstanding ratings from Learning Resource Evaluators across all aspects. The evaluation indicates that the board game was considered well-designed, curriculum-aligned, technically appropriate, and suitable for supporting learning activities involving kinematics concepts.
4. The students' conceptual understanding showed higher post-test scores compared to pre-test scores both in velocity and acceleration following the implementation of Kinequest. In more comprehensible topics like velocity a shift from Nearly Proficient to Proficient levels was observed. While in a complex topic like acceleration, a slight changes was observed with students remaining at the Nearly Proficient level and low Hake gain.
5. The use of KineQuest board game showed higher post-test scores compared to pre-test scores in problem-solving performance. Students moved from Low Proficient to Nearly Proficient in velocity and from Nearly Proficient to Proficient in acceleration, with learning gains varying between the two topics.
6. There was a significant difference between the students' pre-test and post-test scores following the implementation of KineQuest. However, because the study employed a one-group pretest-posttest pre-experimental design without a comparison group, the observed increase cannot be attributed solely to the KineQuest intervention.
7. There was a significant, moderately positive correlation between conceptual understanding and problem-solving skills. This finding suggests that students who demonstrated higher conceptual understanding also tended to demonstrate stronger problem-solving performance in kinematics.

Acknowledgement

The researcher wishes to convey her sincere appreciation to all individuals who contributed to the completion of this study. Appreciation is extended to all the panel of experts and researcher's thesis adviser for their constructive feedback and recommendations for the improvement of this research. As well as to the grammar critic and statistician in polishing and checking this study. The researcher is extremely grateful to the school, student-participants, and science teachers for their time and willingness to take part in the study. Heartfelt appreciation is given to the researcher's family and friends who have been a source of encouragement and support both emotionally and financially.

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