Development of Grade 8 Human Nutrition Learning Outcomes through The 5 E's of Inquiry-based Learning Combined with Board Games

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Abstract

The purpose of this study is to: 1) create the 5E's of Inquiry-Based Learning management system integrated with the board game "Magic Land of Nutrients" to achieve the 80/80 efficiency criterion; 2) assess improvements in learning outcomes on the "Nutrients in Humans" topic for Grade 8 students using the "Magic Land of Nutrients" board game and the 5E's of inquiry-based learning approach; and 3) assess students' satisfaction with the integration of the two learning methods. The target group consists of twenty-three Suankularb Wittayalai Thonburi School Grade 8 students. Among the study tools are 1) learning management plans, 2) board games, 3) an assessment of learning achievement, and 4) a survey on student satisfaction. Data analysis involves identifying the relative gain score, mean, standard deviation, developmental testing of media and instructional packages (E1/E2). The research was grounded in the 5E model and game-based learning theory. Development score is calculated by the utilization of relative gain score to evaluate student improvement.

The results show that: 1) the "Magic Land of Nutrients" board game and the 5E's of inquiry-based learning management plan exceeded the 80/80 efficiency requirement with an efficiency of 84.06/80.22. 2) Students had an overall average relative gain score of 65.66 in academic achievement on the topic of Human Nutrition, indicating a high level of improvement. 3) Students expressed a high level of satisfaction (μ = 3.92, σ = 0.80).

Keywords: Learning Achievement / The 5E's of Inquiry-Based Learning / Board Game / Human Nutrition / Student Satisfaction

Background and Significance of the Problem

Science is vital to both the contemporary and forthcoming world. It is pertinent to all individuals in their daily activities and many professions, as well as in the technology, instruments, and products that humans employ to enhance their lives and work. These outcomes are the product of scientific knowledge integrated with creativity and various other fields. Science enhances human cognitive abilities, encompassing logical reasoning, creative thought, and critical analysis. These competencies are crucial for knowledge acquisition, problem-solving, and decision-making based on verified information. Science is a hallmark of contemporary civilization, emblematic of a knowledge-driven society, wherein all students ought to be cultivated to attain scientific literacy. This allows individuals to comprehend nature and human-engineered technologies and to apply their knowledge judiciously, creatively, and ethically (Ministry of Education, 2008).

Suankularb Wittayalai Thonburi School is an educational institution that implements the International General Certificate of Secondary Education (IGCSE) curriculum from the University of Cambridge. Students are required to complete standardized tests and attain a score exceeding 60% or a grade of C or above. Despite the emphasis on scientific literacy globally, localized challenges remain as the results of the 2023 academic year indicated that most students failed to pass the 60% mark, with human nutrition being one of the subjects exhibiting comparatively low student performance (Suankularb Wittayalai Thonburi School, 2024). This may be due to the abstract and complex nature of the subject matter, with numerous key concepts that students need to understand. Students struggle to explain balanced

nutritional intake, identify sources of essential nutrients, and analyze the importance of carbohydrates, fats, proteins, vitamin C, vitamin D, calcium, iron, fiber, and water. They also have difficulty explaining the adverse effects of nutrient deficiencies. Furthermore, the researcher, as a teacher, lacked effective teaching methods and learning materials that could foster students' thinking processes and self-directed knowledge construction. Consequently, students struggled to synthesize their own knowledge and experienced boredom, leading to some students scoring below the curriculum's standard in achievement tests.

Therefore, the researcher sought teaching methods and learning materials to improve student achievement. The 5E's of inquiry-based learning model was identified as a method that promotes analytical thinking rather than rote memorization, stimulates curiosity, encourages student participation, and provides a dynamic learning environment beyond the classroom. It enables students to conduct self-directed research, develop logical thinking and problem-solving skills, think independently, observe keenly, reason effectively, and express their ideas confidently. This approach allows students to apply their knowledge and abilities through scientific learning processes and reach conclusions, with the teacher acting as a facilitator and guide (Pimphan Dechakupt, 2001). Additionally, the 5E's of inquiry-based learning model utilizes various activities and emphasizes hands-on practice, aligning with the current use of board games not only for lesson introductions and reviews but also for constructing new knowledge. Integrating board games with the 5E's of inquiry-based learning model helps students select evidence from data through careful consideration before making claims and effectively linking reasoning with evidence (Phaton Phongphaijit et al., 2024). Few studies have examined board games as a tool for inquiry-based learning in human nutrition. However, Luchi, K. C. G. et al. (2019) had also implemented the usage of educational board game resulted in significantly improved learning compared guided study in the learning of the physiology of the muscular system, so similar improvements were expected from human nutrition topic.

Consequently, the researcher is interested in implementing the 5E's of inquiry-based learning model in conjunction with board games to engage students in hands-on activities and enhance the appeal of the lesson content. Students will gain knowledge while enjoying the fun embedded in the board game, which focuses on human nutrition.

Objectives

1. To create the 5E's of inquiry-based learning lesson plans with the "Magical Land of Nutrients" board game with an efficacy of 80/80.
2. To assess improvements in learning outcomes in Human Nutrition among Grade 8 students utilizing the 5E's of inquiry-based learning approach through the "Magical Land of Nutrients" board game.
3. To assess student satisfaction with the 5E's of inquiry-based learning approach utilizing the "Magical Land of Nutrients" board game.

Expected Benefits

1. Students will be capable of reviewing and comprehending course material adequately to attain a score of 60% or above on standardized assessments.
2. Teachers will get principles for designing and enhancing the 5E's of inquiry-based learning lesson plans utilizing the "Magical Land of Nutrients" board game, applicable to several topic areas.

Conceptual Framework

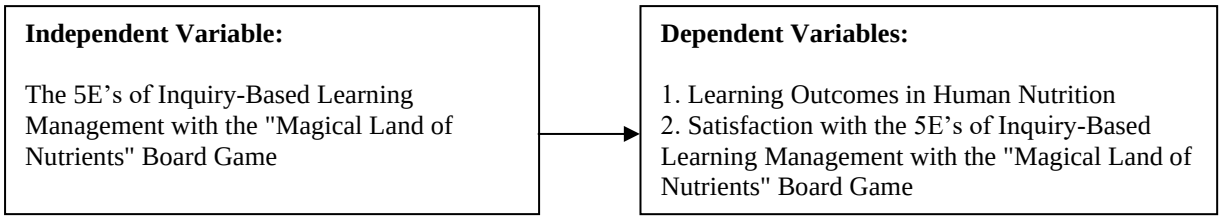

Figure 1: Conceptual Framework

The researcher studied the conceptual framework concerning the 5E's of inquiry-based learning process, based on the Institute for the Promotion of Teaching Science and Technology (IPST, 2014), which states that the 5E's of inquiry-based learning process consists of five steps: 1) Engage, 2) Explore, 3) Explain, 4) Elaborate, and 5) Evaluate. Additionally, the researcher studied the concepts related to the use of board games by Udomluck Olar (2018), who stated that board games are a modern learning medium that is highly

beneficial. Besides allowing players to develop hard skills in conjunction with soft skills effectively, board game designers and players must be creative, possess analytical skills, know how to assess risks, have correct logical reasoning for thinking and making decisions, and be able to see through situations from beginning to end to reach their goals. This is illustrated in Figure 1.

Research Methodology

Target Group: The target group consisted of twenty-three Suankularb Wittayalai Thonburi School Grade 8 students from International Program, Suankularb Wittayalai Thonburi School, enrolled in the second semester of the 2024 academic year.

Research Duration: The research was conducted over 3 weeks, with 1 session per week, 2 hours per session, totaling 6 hours.

Content: The content was derived from the Grade 8 students biology curriculum, focusing on "Human Nutrition," as outlined in the University of Cambridge's International General Certificate of Secondary Education (IGCSE) curriculum.

Variables:

Independent Variable: The board game "Magical Land of Nutrients" combined with the 5E's of inquiry-based learning management.

Dependent variables are 1) student achievement in human nutrition and 2) satisfaction with the "Magical Land of Nutrients" board game and the 5E's of inquiry-based learning management.

Research Design: The research employed a One Group Pretest-Posttest Design, involving a single experimental group (X) with pre- and post-tests.

Research Instruments: The research instruments were divided into two parts: experimental tools and data collection tools.

1. Experimental Tools:

1.1 The 5E's of inquiry-based learning management Lesson Plans on Human Nutrition: A set of 3 lesson plans, including: 1) Lesson Plan on Food, 2) Lesson Plan on Food Testing, and 3) Lesson Plan on Balanced Diet. Each lesson plan required 2 hours, totaling 6 hours. The quality and suitability of each lesson plan were assessed by 3 experts, yielding an overall average of 4.23, indicating a high level of suitability. When assessed individually, all plans were rated as highly suitable. The lesson plan with the highest average was the Lesson Plan on Balanced Diet (4.47), followed by the Lesson Plan on Food Testing (4.17) and the Lesson Plan on Food (4.06). Experts also provided suggestions for improvements, such as standardizing the writing style across all plans (e.g., providing answer guidelines) and clarifying the experimental activity steps.

1.2 "Magical Land of Nutrients" Board Game: A set of 1 board game consisting of 3 sub-games. The researcher created the board game activities using content from Grade 8 students biology textbook on human nutrition. The quality and suitability of each board game were assessed by 3 experts, yielding an overall average of 3.75, indicating a high level of suitability. All sub-games were rated as highly suitable. The sub-game with the highest average was "Nutrients in Your Hand" (4.00), followed by "The Land of Eating Monopoly" (3.67) and "The 5 Food Group Festival" (3.58). Experts suggested improvements such as using a white background for clearer and more attractive images and enhancing the board game missions to promote analytical thinking skills and challenge players' abilities, shown in Figure 2 to 4.

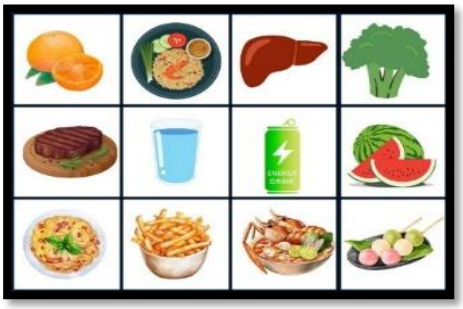

Figure 2: "Magical Land of Nutrients" Board Game,
Activity 1: The 5 Food Group Festival Game

Figure 3: "Magical Land of Nutrients" Board Game, Activity 2: Nutrients in Your Hand Game

Figure 4: "Magical Land of Nutrients" Board Game, Activity 3: The Land of Eating Monopoly Game

2. Tools for Data Collection

2.1 The Achievement Test on Human Nutrition is a 4-choice multiple-choice test consisting of 20 questions. The test created by the researcher has undergone validation for accuracy, appropriateness, and content validity by 3 experts, resulting in a content validity index (IOC) ranging between 0.67-1.00. Additionally, a tryout was conducted with 30 students who are not in the target group, to analyze the difficulty index (p), the discrimination index (r), and the reliability of the test. The difficulty index ranged from 0.21 to 0.73, the discrimination index from 0.20 to 0.61, and the reliability coefficient was 0.87.

2.2 The Satisfaction Questionnaire is a 5-point Likert scale consisting of 12 items across 4 domains: content, learning media, learning activities, and practical application. The questionnaire developed by the researcher has been validated for content validity, with a content validity index (IOC) ranging between 0.67-1.00. The reliability of the questionnaire was assessed using Cronbach's alpha coefficient, which yielded a reliability coefficient of 0.91.

Data Collection

1. A pretest was conducted with the target group of students using an achievement test in the subject of Biology on Human Nutrition, consisting of 20 questions, with a testing duration of 30 minutes.

2. Learning activities were organized using the 5E's of inquiry-based learning plan along with the "Magical Land of Nutrients" board game, focused on Human Nutrition, with the target group of students over 3 sessions totaling 6 hours. The researcher taught each learning plan personally, following these steps:

2.1 Engage: This step introduces the lesson or interesting topic that may arise from curiosity.

2.2 Explore: Once students thoroughly understand the issue or question to be studied, they plan and outline an exploratory strategy, formulate hypotheses, define possible options, and engage in activities to collect information or various phenomena. The verification methods can be conducted in multiple ways.

2.3 Explain: After gathering sufficient information from exploration, students analyze the data, summarize the findings, and present the results in various forms.

2.4 Elaboration: This step involves linking the newly constructed knowledge with existing knowledge or additional researched concepts or using the conclusions to explain other situations or events. The board game that aligns with the learning content is utilized to help expand the students' knowledge and connect the relationships between the acquired experiences and prior knowledge logically.

2.5 Evaluate: This step assesses what knowledge the students have and how much they possess by having them take a test to measure their understanding through playing the "Magical Land of Nutrients" board game.

3. At the end of the 5E's of inquiry-based learning plan combined with the "Magical Land of Nutrients" board game on Human Nutrition, the researcher conducted a posttest with the target group of students using the same achievement test in Biology on Human Nutrition as in the pretest, but with the questions and answer choices shuffled, and a testing duration of 30 minutes.

4. Students in the target group were asked about their satisfaction after the learning activity using the 5E inquiry-based approach along with the "Magical Land of Nutrients" board game through a questionnaire consisting of 12 items, with a time allowance for evaluation of 10 minutes.

Statistics Used for Data Analysis

1. The efficiency analysis of the 5E's of inquiry-based learning plan combined with the "Magical Land of Nutrients" board game was conducted using the 80/80 criteria. The efficiency was calculated using the

formula E_1/E_2 to test the efficiency of the process (Process-E_1) and to evaluate the efficiency of the outcomes (Product- E_2).

2. The study of the development level of academic achievement in the topic of Human Nutrition among grade 8 students was carried out using the 5E's of inquiry-based learning plan in conjunction with the "Magical Land of Nutrients" board game. The relative gain score formula was utilized to calculate the developmental score, which was then interpreted according to a developmental level criterion divided into 4 levels (Siri-Chai Kanjanawasi, 2009) as follows:

Relative Gain Score	**Development Level**
76-100	Very High
51-75	High
26-50	Medium
0-25	Low

3. The study of student satisfaction levels regarding the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game was conducted using basic statistics, including the mean (μ) and standard deviation (σ). The average was then compared with the criteria to interpret the scores (Boonchom Srisaat, 2010) as follows:

4.51-5.00	Extremely High
3.51-4.50	High
2.51-3.50	Medium
1.51-2.50	Low
1.00-1.50	Very Low

Research Results

1. The development results of the 5E's of inquiry-based learning plan combined with the "Magical Land of Nutrients" board game achieved efficiency according to the 80/80 criteria, as shown in Table 1.

Table 1 presents the efficiency of the 5E's of inquiry-based learning plan combined with the "Magical Land of Nutrients" board game.

Experimental Group	**Number of Students**	**Percentage of Average Score During Learning (E_1)**	**Percentage of Average Score After Learning (E_2)**	**Effectiveness (E_1/ E_2)**
Individual	3	77.78	66.32	77.78/66.32
Small Group	9	83.33	75.00	83.33/75.00
Field Group	20	83.50	81.00	83.50/81.00
Target Group	23	84.06	80.22	84.06/80.22

From Table 1, it is found that when testing the efficiency of the development the 5E's of inquiry-based learning plan combined with the "Magical Land of Nutrients" board game among grade 8 students on the topic of Human Nutrition with a single experimental group of 3 students who have varying learning capabilities, the efficiency value E_1/E_2 is 77.78/66.32, which is below the 80/80 efficiency criterion. In the small experimental group of 9 students, the efficiency value E_1/E_2 is 83.33/75.00, also below the 80/80 criterion. However, in the field experimental group of 20 students, the efficiency value E_1/E_2 is 83.50/81.00, which exceeds the 80/80 criterion. Finally, when testing the efficiency of the 5E's of inquiry-based learning plan combined with the "Magical Land of Nutrients" board game among the target group of 23 students, the efficiency value E_1/E_2 is 84.06/80.22, which is also higher than the 80/80 criterion.

2. The results of the study on the developmental level of academic achievement in the topic of Human Nutrition among grade 8 students based on the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game are shown in Table 2.

From Table 2, it was found that the grade 8 students who participated in the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game had an overall average relative gain score of 65.66 in academic achievement in the topic of Human Nutrition, indicating a high level of improvement. Most students showed high development levels, with 14 students (60.87%) at this

level. Additionally, 6 students (26.09%) exhibited very high development levels, while 3 students (13.04%) were at a medium level of development.

Table 2 presents the relative gain scores and the developmental levels of academic achievement in the topic of Human Nutrition according to the 5E the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game for grade 8 students.

No.	Pretest Score	Posttest Score	Score Difference	Relative Gain Score
1	5	14	9	60.00
2	7	11	4	30.77
3	7	17	10	76.92
4	11	16	5	55.56
5	7	16	9	69.23
6	8	16	8	66.67
7	10	17	7	70.00
8	6	14	8	57.14
9	5	13	8	53.33
10	7	16	9	69.23
11	8	13	5	41.67
12	1	15	14	73.68
13	10	15	5	50.00
14	4	14	10	62.50
15	8	17	9	75.00
16	11	18	7	77.78
17	12	20	8	100.00
18	11	16	5	55.56
19	10	19	9	90.00
20	12	18	6	75.00
21	13	19	6	85.71
22	10	18	8	80.00
23	12	17	8	62.50
Mean	**8.48**	**16.04**	**7.57**	**65.66**

3. The results of the study on student satisfaction with the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game are shown in Table 3.

Table 3 presents the mean, standard deviation, and levels of satisfaction regarding the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game from the students.

Assessment Items	μ	Σ	Level of Satisfaction
Content Area	3.91	0.80	High
1. The content sequence is continuous, making it easy to understand	3.91	0.79	High
2. The content is appropriate for the students' age, not too hard or too easy	3.87	0.81	High
3. The amount of content per hour is appropriate for the time level	3.96	0.82	High
Learning Media Area	3.87	0.82	High
4. The board game has variety, is interesting, and encourages students to want to learn	4.04	0.82	High
5. The board game is suitable for the content and time duration	3.74	0.81	High
6. The board game helps to understand the lesson content better	3.83	0.83	High
Learning Activities Area	3.96	0.81	High
7. Participating in learning activities fosters pride in one's own work done with the group	4.09	0.79	High
8. Engaging in learning activities encourages self-research	3.65	0.78	High
9. Participating in learning activities is fun and not boring	4.13	0.81	High
Utilization Area	3.94	0.78	High
10. The content on Human Nutrition connects to everyday life events	3.87	0.81	High
11. The knowledge of Human Nutrition guides planning for healthy eating	4.00	0.74	High
12. The knowledge of Human Nutrition helps to adjust eating habits in daily life	3.96	0.82	High
Total	**3.92**	**0.80**	**High**

From Table 3, it was found that the grade 8 students expressed a high overall level of satisfaction with the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game ($\mu = 3.92$, $\sigma = 0.80$). When considering each aspect, all areas had a high level of satisfaction, with the average for the learning activities being the highest ($\mu = 3.96$, $\sigma = 0.81$). This was followed by the utilization area ($\mu = 3.94$, $\sigma = 0.78$), the content area ($\mu = 3.91$, $\sigma = 0.80$), and the learning media area ($\mu = 3.87$, $\sigma = 0.82$).

When examining individual items, the top three items with the highest average scores were: engaging in learning activities is fun and not boring ($\mu = 4.13$, $\sigma = 0.81$); participating in learning activities fosters pride in one's own work done with the group ($\mu = 4.09$, $\sigma = 0.79$); and the board game has variety, is interesting, and encourages students to want to learn ($\mu = 4.07$, $\sigma = 0.82$), respectively.

Research Summary

1. The 5E's of inquiry-based learning plan combined with the "Magical Land of Nutrients" board game achieved an efficiency score of 84.06/80.22, which exceeds the 80/80 efficiency criterion.

2. Students who participated in the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game had an overall average relative gain score of 65.66 in academic achievement on the topic of Human Nutrition, indicating a high level of improvement.

3. Overall, students who experienced the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game expressed a high level of satisfaction ($\mu = 3.92$, $\sigma = 0.80$).

Discussion

1. The study's findings indicate that the 5E's of inquiry-based learning plan combined with the "Magical Land of Nutrients" board game achieved an efficiency score of 84.06/80.22, which exceeds the established efficiency criterion of 80/80. This demonstrates that the 5E's of inquiry-based learning plan combined with the "Magical Land of Nutrients" board game developed by the researcher is a suitable tool for facilitating learning for students. The researcher followed quality development processes in creating the media and tested the efficiency of the materials before actual implementation. As Phromwong (2013) stated, media should be tested for efficiency before actual use. The efficiency testing involves a two-step process: initial testing (Try Out) and real teaching trials (Trial Run) to assess the quality of the materials based on three criteria: 1) increasing students' knowledge, 2) aiding students in successfully navigating the learning process and performing well on final assessments, and 3) ensuring student satisfaction with the results for potential adjustments before final production. This finding is consistent with the research of Kongphakdi (2020), which found that a learning activity set using the 5E inquiry-based approach combined with a science game on Earth changes had an efficiency score of E1/E2 equal to 85.25/87.50, exceeding the 80/80 criterion. It aligns with the study by Chaikas (2022), which found that the 5E's of inquiry-based learning plan combined with board games had an efficiency score of E1/E2 equal to 72.69/74.27, surpassing the set criterion of 70/70.

2. The study found that students who participated in the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game had an average relative gain score of 65.66 in academic achievement on the topic of Human Nutrition, indicating a high level of improvement. This demonstrates that the 5E's of inquiry-based learning approach is a process aimed at prompting students to become curious, actively seek out information, and explore various methods on their own, subsequently relating what they have learned to their existing knowledge or experiences. The teacher's role is to facilitate and guide, encouraging students to construct knowledge independently, leading to meaningful learning. As stated by the Science and Technology Promotion Institute (2019), the 5E's of inquiry-based learning process consists of five steps: 1) Engagement, 2) Exploration, 3) Explanation, 4) Elaboration, and 5) Evaluation. In each step of the inquiry-based learning activities, students must construct new knowledge by employing scientific process skills, fostering a learning environment that does not rely solely on lecture-based instruction. The teacher's important role is to encourage self-directed learning within a supportive environment. In the elaboration step, the use of the "Magical Land of Nutrients" board game simulates scenarios that create a learning process distinct from conventional instruction, making the learning experience enjoyable and helping students understand the content of the Human Nutrition lesson more easily through the game's structured processes and rules. This support contributes to the high level of improvement in students' academic achievement in the topic of Human Nutrition. This finding aligns with

the study by Jansuk and Chukamphang (2022), which found that 4th-year secondary students who experienced the 5E's of inquiry-based learning approach in conjunction with board games showed an average improvement in systemic thinking of 63.10%, indicating a high level of growth. Additionally, it is consistent with the research of Hongyim (2017), which found that students engaged in the 5E's of inquiry-based learning approach had an average post-test score of 23.88 on cell respiration in the Biology subject, reflecting an increase in their learning achievement.

3. The study found that students who participated in the 5E the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game expressed a high level of satisfaction overall ($\mu = 3.92$, $\sigma = 0.80$). The item with the highest average was that engaging in learning activities is fun and not boring ($\mu = 4.13$, $\sigma = 0.81$). This indicates that the 5E the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game is an effective method for teaching Biology to grade 8 students. The 5E's of inquiry-based learning approach aims to provide students with knowledge and the ability to seek information, collect data, and analyze it to formulate answers. Furthermore, the incorporation of games into instruction creates a learning experience that aligns with students' learning. This not only makes the process enjoyable but also allows students to absorb content naturally through the game's structured rules. Additionally, students have opportunities to exchange ideas with their peers while engaging in the game activities, enriching the learning atmosphere with enjoyment. (Prachakul and Neuchalem, 2016) This finding is consistent with the research of Munnuai and Nasari (2023), which found that students participating in the 5E the 5E's of inquiry-based learning approach along with the use of a board game on stars in the solar system had a high level of satisfaction ($\mu = 3.92$, (σ) = 0.80). Similarly, the study by Chaiyirongsri (2014) revealed that students' satisfaction with the the 5E's of inquiry-based learning approach (5E) combined with the use of scientific games was also at a high level ($\mu = 4.13$, $\sigma = 2.35$).

Recommendations for Future Research

1. A comparative study of the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game should be conducted again, possibly changing the topics taught, to confirm the research outcomes with greater certainty.

2. Further research should examine the effects of the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game on other variables, such as learning retention or scientific process skills. These factors are essential for learning in Biology to ensure that students achieve academic success according to the standards of the International General Certificate of Secondary Education (IGCSE) curriculum.

Suggestions for Applying Research Findings

1. Given that the efficiency of the 5E's of inquiry-based learning plan combined with the "Magical Land of Nutrients" board game exceeds the established criteria, it is essential for teachers to provide feedback to students based on their performance during and after the trial activities. This will motivate students and encourage them to strive for personal development and improvement in their learning progress.

2. Since the study showed that the 5E's of inquiry-based learning approach combined with the "Magical Land of Nutrients" board game significantly increased students' development scores, teachers should encourage students to express their opinions and conduct more research during the initial activities. This can be achieved by asking a variety of questions. When students answer correctly or find information from credible and current sources, rewards such as praise or bonus points should be given to reinforce their motivation. This will help students maintain or enhance their learning development.

3. The study revealed that students showed the least satisfaction with the self-directed research activities. Therefore, while conducting learning activities, teachers should provide examples of credible sources where students can independently search for information, along with guidance and attention to all students, whether they are high-achievers, average, or struggling. This will encourage students to learn how to search for information and gain experience in self-directed learning. Since students differ as individuals, it is important to create learning experiences that address these differences, as all students desire to succeed in their learning.

4. The target group was relatively small and the duration was short. Therefore, the researches of the approach in larger groups is required.

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