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Practicality and Effectiveness of Chemical Ludo Game as Learning Media for Acid and Base Materials on Learning Outcomes of Students of Class XI SMA Nurfalah

Suriani Nur[1]*, & Muhammad Ikhlas Al Kutsi[2]
[1*]Institut Agama Islam Negeri Bone, Indonesia, [2]STIE Ganesha, Indonesia
*e-mail: surianitene72@gmail.com

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ABSTRACT

This study aims to evaluate the usefulness and efficiency of the Ludo Kimia game as a teaching aid on acid and base materials in relation to the learning outcomes of SMA Nurfalah class XI students. This study used a Pretest-Posttest Control Group Design, with XI MIPA 1 class as the control group and XI MIPA 2 as the experimental group at Nurfalah School. Data collection used a practicality questionnaire and pretest-posttest assessment. Practicality was analyzed using the percentage score, while effectiveness was assessed using the N-Gain method. The results showed that teachers rated the Ludo Kimia game as very practical, while students rated it as quite practical. In terms of effectiveness, this game is considered quite effective in improving student learninfgg outcomes. The experimental class showed a greater increase in conceptual understanding than the control class, with an average posttest score of 77.14 and 70.15 respectively. The N-Gain value for the experimental class was 0.59 (medium category), while the control class obtained a value of 0.51 (low category). Furthermore, the hypothesis test showed a significant difference between the two groups, with t_hitung (3.62) > t_table (1.67) at the 0.05 significance level. In conclusion, the Ludo Kimia game is a very practical media for teachers, quite practical for students, and quite effective in improving student learning outcomes on the topic of acid-base. This game can be an alternative media in learning chemistry to increase engagement and academic achievement.

Keywords: *Practicality, Effectiveness, Chemical Ludo Game, Acid-Based, Learning Outcomes*

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INTRODUCTION

Acid and alkaline materials are foundational topics in high school chemistry curricula. These concepts are directly applicable to daily life, as acids and bases are found in many household items, such as citrus fruits and cleaning agents. The learning material encompasses factual knowledge (e.g., acids turn blue litmus paper red and alkalis turn red litmus paper blue), conceptual knowledge (including the Arrhenius, Brønsted–Lowry, and Lewis acid-base theories), and procedural knowledge (such as analyzing pH using indicators or digital pH meters). Mastering these different knowledge types is essential for scientific literacy and higher-order thinking.

Recent studies have shown that students often struggle to differentiate and apply acid–base theories, particularly distinguishing between Arrhenius and Brønsted–Lowry models and extending their understanding to the more abstract Lewis theory (Naz & Mushtaq, 2022; Safo-Adu, 2020). These challenges highlight the need for teaching approaches that integrate multiple representations, practice-based learning, and hands-on experimentation. To strengthen student understanding, researchers emphasize the need for iterative practice that reinforces prior knowledge, encouraging deeper cognitive processing (Boothe et al., 2023; Fadillah & Iswendi, 2019).

Effective instruction in this area should combine real-life relevance, structured repetition, and active experimentation. This includes using tools like pH meters and interactive simulations, which help bridge the gap between theory and real-world application (Jiménez-Liso et al., 2020). Integrating conceptual practice with guided exploration has been shown to enhance students' retention and transfer of learning, making these strategies essential in chemistry education reform.

Practice in the learning process is understood as a purposeful activity to reinforce previously acquired knowledge and skills. In many schools, such as those observed in School X and School Y, student practice is typically derived from structured resources like package books and Student Worksheets (Lembar Kerja Siswa/LKS). Teachers primarily administer objective and essay-based exercises sourced from these materials, as reported in teacher and student questionnaires. However, this traditional approach often leads to reduced student engagement, as the exercises tend to emphasize individual work, lack variation, and do not incorporate competitive or collaborative dynamics that stimulate motivation and interaction (Suyu et al., 2024; Lestari, 2021). To address these limitations, integrating game-based media into instructional practice has emerged as an effective strategy. Such tools offer interactive environments that foster collaboration, critical thinking, and emotional engagement. Recent studies show that students, particularly those aged 7 to 18, exhibit higher levels of interest and retention when learning is delivered through game-based platforms (UNESCO IITE, 2021; Hotez et al., 2024). This aligns with global shifts toward digital and gamified learning environments, which are increasingly recognized for their role in improving educational outcomes in primary and secondary schools.

Ludo Chemistry is one of the game versions that can be utilized. The ludo game is a traditional game that is commonly played by children. This game is a fun, entertaining, and easy game for students to do. Based on research conducted by Rentia Lestari (2021), the medium of the chemical ludo game on acid and alkaline materials has been valid with a high level of validity with a kappa value of 0.89.

A study conducted by Fadillah (2019) demonstrated that the use of chemo-edutainment-based chemistry Ludo game media (CET) on colloidal system topics was effective in improving the learning outcomes of Grade XI students. Currently, a Ludo-based chemistry game focused on acids and bases has been developed by Rentia Lestari (2021). While the validity of this media has been assessed, its practicality and effectiveness in enhancing student learning outcomes have not yet been determined. Therefore, this study aims to evaluate the practicality and effectiveness of the chemistry Ludo game as a learning tool for acids and bases, particularly in improving the cognitive learning outcomes of Grade XI science students at SMA Nurfalah.

METHODS

This study is a follow-up to earlier development research, which resulted in a validated learning medium for acid-base material for Grade XI high school students (Lestari, 2021). The previous research employed a Research and Development (R&D) approach, consisting of four main stages: (1) Definition, (2) Design, (3) Development, and (4) Dissemination.

This research was extended to include a practicality test of the acid-base chemistry Ludo learning media on the learning outcomes of Grade XI high school students, followed by an effectiveness test of the same media. The study employed a Pretest-Posttest Control Group Design.

The Pretest-Posttest Control Group Design involves two groups: an experimental class and a control class. The experimental class receives a treatment (X), which consists of learning activities supported by exercises using the Ludo chemistry game media. Meanwhile, the control class engages in learning activities with the same set of practice questions, but without the use of the Ludo game media. The structure of the research design is shown in the following table:

Table 1. Pretest-Posttest Control Group Design

Class	*Pretest*	Treatment	*Posttest*
Experiment	O1	X	O2
Control	O3	-	O4

Note :
O1 : Initial test for the experimental class
O3 : Initial test for control class
X : Learning using the medium of ludo chemistry game on acid base material
O2 : Final test for the experimental class
O4 : Final test for control class
Practicality criteria according to Purwanto (2012) the formula used is:

$$\text{Practicality value} = \frac{total\ score\ obtained}{highest\ score)} \times 100\%$$

86-100% = very practical
76-85% = practical
60-75% = quite practical

≤ 54% = very impractical

The effectiveness test uses the Normalized gain (N-Gain) test according to Arikunto (1999), where the measurement steps are:

a. Calculate student scores based on *pretest* and *posttest* scores, using the

$$\text{Calculate student scores} = \frac{\sum \text{scores the answers}}{\text{maximals scores}} \times 100\%$$

b. Calculate the *N-gain* value of each student using the *N-gain equation*, namely:

$$N\text{–}gain = \frac{posttest - pretest}{100 - pretest}$$

c. Finding the average N-gain using the formula:

$$g = \frac{\sum Ngain\ students}{number\ of\ students}$$

d. Interpreting the average obtained

Table 2. Categories Interpretation of Gain Effectiveness

Percentage (%)	Interpretation
< 40	Ineffective
40 – 55	Less Effective
56 – 75	Quite Effective
> 76	Effective

RESULTS

1. Practicality

a. Practicality by teachers

The results of the practicality assessment of the chemistry Ludo game on acid-base material, specifically from the aspect of ease of use, are shown in Table 3.

Table 3. Results of the Practicality of Ease of Use of Ludo Chemistry Game Media

NO	Assessed Aspects	P-Value(%)	Category
1.	The rules on the game ludo chemistry of acid-base matter are easy to understand	100%	Very practical
2.	The questions presented in the game ludo chemistry of acid-base material are clear and simple so that they are easy to understand	86%	Very practical

3.	The practice questions in the ludo game chemistry are easy to understand	80%	practical
4.	The language used is easy to understand	100%	Very practical
5.	The writing style used is clear and easy to read	93%	Very practical
6.	The design of the game ludo chemistry of acid-base material is already interesting	100%	Very practical
7.	The game of chemical ludo on acid-alkaline materials is easy to use	100%	Very practical
8.	The problem in the game ludo chemistry of acid-base material is a direct application of the concept	80%	practical
9.	Images/animations/symbols/icons on clear acid-base material chemical ludo games	93%	Very practical
10.	The game of ludo chemistry of acid-base material can be used repeatedly	100%	Very practical

Table 4. Results of Practicality in the Aspect of Learning Time Efficiency by Teachers

No	Assessed Aspects	P-Value(%)	Category
1.	Acid-alkaline matter chemistry can make time more efficient	93%	Very practical
2.	The training work becomes directed so that the training work becomes efficient	93%	Very practical
3.	Students can do exercises anywhere and anytime, the whole is easy to understand	100%	Very practical

Table 5. Results of the Practicality of Benefits by Teachers

No	Assessed Aspects	P-Value(%)	Category
1.	The game of ludo chemistry of acid-base material can be used as a group learning medium by students	100%	Very practical

2.	The game ludo chemistry of acid-base material can help students in consolidating concepts and increasing knowledge	86%	Very practical
3.	The game ludo chemistry of acid-base material can help teachers in learning	100%	Very practical
4.	The game ludo chemistry of acid-base material supports the teacher's role as a facilitator	100%	Very practical
5.	The acid-base chemistry ludo game helps teachers in assessing the practice problems that students are doing	86%	Very practical
6.	Teachers can advise students to use the game of ludo chemistry of acid-base material in groups so that students can solidify the concept, especially for students who have low ability.	86%	Very practical
7.	The game of ludo chemistry of acid-base material can arouse students' interest in learning.	100%	Very practical

b. Practicality by students

The results of the assessment of the practicality of the ludo chemical game on acid-base materials from the aspect of ease of use are presented in Table 6.

Table 6. Results of the practicality of the ease of use by students

No	Assessed Aspects	P-Value(%)	Category
1.	The rules on the game ludo chemistry of acid-base matter are easy to understand	86%	Very practical
2.	The questions presented in the game ludo chemistry of acid-base material are clear and simple so that they are easy to understand	80 %	practical
3.	The overall acid-base material is easy to understand ludo, chemistry, and acid-base materials	67%	Quite practical

4.	The language used is easy to understand	80%	practical
5.	The writing style used is clear and easy to read	75%	practical
6.	The design of the game ludo chemistry of acid-base material is already interesting	81%	practical
7.	The game of chemical ludo on acid-alkaline materials is easy to use	86%	Very practical
8.	The problem in the game ludo chemistry of acid-base material is a direct application of the concept	78%	practical
9.	Images/animations/symbols/icons on clear acid-base material chemical ludo games	78%	practical
10.	The game of ludo chemistry of acid-base material can be used repeatedly	79%	practical

Table 7. Results of the Practicality of Learning Time Efficiency Aspects by Students

No	Assessed Aspects	P-Value(%)	Category
1.	The game of ludo chemistry of acid-alkaline matter can make time more efficient	70%	Quite practical
2.	The training work becomes directed so that the training work becomes efficient	65%	Quite practical
3.	Students can do exercises anywhere and anytime, the whole is easy to understand	75%	practical

Table 8. Results of the Practicality of the Benefits by Students

No	Assessed Aspects	P-Value(%)	Category
1.	The pictures/animations/symbols/icons on the ludo chemistry game motivated me to study acid-base materials	79%	practical
2.	Can be used as a training resource	81%	practical

3.	The game of ludo chemistry of acid-base material helped me solidify the concept through the questions presented.	69%	Quite practical
4.	The game of ludo chemistry based on acid-base material makes the learning process fun.	78%	practical
5.	The game ludo chemistry of acid-base material increased my interest and motivation to learn.	70%	Quite practical
6.	The game ludo chemistry of acid-base material helped me learn in groups.	85%	practical
7.	The game ludo chemistry of acid-base material is not boring	85%	practical

2. Effectiveness

Table 9. Description of Research Data

No	Statistics	Experimental Classes		Control Classes	
		Pretest	*Posttest*	*Pretest*	*Posttest*
1.	Number of samples	28	28	26	26
2.	Total Value	984	2160	956	1824
3.	*Mean*	35.14	77.14	36.76	70.15
4.	Highest Score	56	88	56	84
5.	Lowest Score	12	60	8	56
6.	Standard Deviation	9.63	6.87	9.73	7.26
7.	Variant	92.86	47.23	94.74	52.77
8.	Range	44	28	48	28
9.	Median	34	76	38	70

Based on the table of student learning outcomes on acid and alkaline material. It can be seen that the results *of the pretest* of the experimental class before being given treatment with an average score of 35.14 with the highest score of 56 and the lowest score of 12 with a total of 28 students. Meanwhile, the results *of the control class pretest with an average score* of 36.76 with the highest score of 56 and the lowest score of 8 with the number of students were 26. This explains that the two classes have abilities that are not much different.

In the experimental class, there was an increase in posttest with an average score of 77.14. Meanwhile, in the control class without using ludo chemistry learning media, there was also an increase in the average posttest score to 70.15. Before being given treatment, the average pretest score of the two classes was still below the KKM (75), after being given treatment in the experimental class, the average posttest score had reached the KKM with a completion percentage of 75%, while for the control class it was still below the KKM with a completion percentage of only 26.9%. This shows that the average score of the *posttest* experiment is higher than that of the control class.

Based on the *pretest* and *posttest values* in the sample class, it can be seen that the experimental class has experienced a greater increase compared to the control class. The increase in *the pretest* and *posttest scores* of the sample class is presented in the Table.

Table 10. Improvement of Pretest Scores and Posttest Scores of Sample Classes

Class	Pretest	Posttest	Increased
Experiment	35.14	77.14	42
Control	36.76	70.15	33.39

DISCUSSION

1. Practicality

The practicality of the Ludo Kimia game in acid-base materials was assessed through a questionnaire which were given to teachers and students of class XI SMA/MA.

a. Ease of UseTeachers consider this game to be very practical because the material is clear, the language is easy to understand, and the appearance is easy to read. Students judged the game to be practical, although there were initial difficulties in understanding its differences with the regular ludo, which could be overcome with adaptation.
b. Learning Time EfficiencyThe teacher considers this game to be very practical because students can learn at any time. However, some students have difficulty answering questions so that the study time is less efficient. Teacher guidance is needed so that the use of time is more optimal.
c. BenefitsTeachers consider this game very useful because it makes learning more fun and interactive. However, some students experienced a decrease in interest in learning due to a lack of understanding of the concepts of acid and base conjugation. This can be overcome with additional explanations from the teacher.

2. Effectiveness

The test results showed an increase in scores in the class that used Ludo Chemistry (average 77.14) compared to the control class (70.15). This game increases students' active participation in learning.

Based on the N-Gain effectiveness test, the experimental class reached 59% (quite effective) while the control class was 51% (less effective). As many as 75% of students in the experimental class achieved KKM, compared to only 26.9% in the control class. The t-test showed significant differences, proving that Ludo Chemistry was effective in improving students' comprehension.

3. Obstacles

During learning, some students did not agree with the group division, which slightly hampered the process. This obstacle is overcome with directions so that students are more receptive to cooperation in groups.

CONCLUSIONS

Based on the results of data analysis and interpretation regarding the practicality and effectiveness of the chemistry Ludo game as a learning medium for acid-base material among Grade XI SMA/MA students, the following conclusions can be drawn:

1. High Practicality and Student Acceptance: The chemistry Ludo game was rated as highly practical by teachers, who found it easy to implement within the classroom context. Students assessed it as moderately practical, indicating room for refinement but also recognizing its usability and alignment with their learning preferences.
2. Moderate Effectiveness in Enhancing Learning Outcomes: The intervention showed moderate effectiveness in improving student achievement, with an N-Gain score of 0.59 in the experimental group, compared to 0.51 in the control group. This indicates that while both traditional and game-based methods led to learning gains, the chemistry Ludo game produced comparatively better results.
3. Cognitive Gains and Engagement: The game-based learning approach led to significant improvements in students' cognitive learning outcomes, particularly in understanding and applying acid-base concepts. This confirms the added value of interactive and engaging media in supporting conceptual mastery.
4. Usefulness and Applicability: The findings of this study highlight the practical utility of incorporating gamified media like the chemistry Ludo game into science classrooms. For students, it provides a more motivating and interactive way to engage with complex topics, promoting retention and participation. For educators, the game offers a structured yet flexible tool that can supplement conventional methods, especially in schools seeking to diversify instructional strategies without requiring advanced technological infrastructure.

In summary, the chemistry Ludo game not only serves as an alternative instructional tool but also enhances the overall learning experience by making abstract chemical concepts more concrete and enjoyable. Therefore, broader adoption and further refinement of such game-based learning media are recommended for improved educational outcomes in science education.

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