

Article

The Effect of Gimkit Gamification on Students Mastery of Ether Nomenclature and Properties in Organic Chemistry

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Abstract

This study aims to analyze the effectiveness of gamification using the Gimkit platform in improving students' understanding of ether concepts in Organic Chemistry. Ether material, including nomenclature, structure, physicochemical properties, and basic reactions, is often perceived as challenging due to its abstract nature and the need for strong conceptual understanding. Therefore, alternative learning approaches are required to enhance student engagement and learning motivation. A mixed-methods approach was employed involving 60 undergraduate pharmacy students. Participants completed two sequential learning evaluations: a conventional assessment using Google Forms and a gamified assessment conducted through Gimkit with equivalent content coverage. The results showed that students achieved higher average scores in the gamified assessment than in the conventional test. Students also reported increased motivation, active participation, and improved understanding of ether concepts. These findings indicate that Gimkit-based gamification positively affects both learning outcomes and students' learning experiences and has strong potential as an effective instructional strategy in Organic Chemistry education, particularly for ether-related material in pharmacy programs.

Keywords: Chemistry education, Ether compounds, Gamification, Gimkit, Pharmacy Students.

Abstrak

Penelitian ini bertujuan untuk menganalisis efektivitas gamifikasi menggunakan platform Gimkit dalam meningkatkan pemahaman mahasiswa terhadap konsep eter dalam Kimia Organik. Materi eter, yang mencakup tata nama, struktur, sifat fisikokimia, dan reaksi dasar, sering kali dianggap menantang karena sifatnya yang abstrak dan membutuhkan pemahaman konseptual yang kuat. Oleh karena itu, pendekatan pembelajaran alternatif diperlukan untuk meningkatkan keterlibatan dan motivasi belajar mahasiswa. Pendekatan metode campuran (mixed-methods) digunakan dengan melibatkan 60 mahasiswa sarjana farmasi. Partisipan menyelesaikan dua evaluasi pembelajaran berurutan: penilaian konvensional menggunakan Google Forms dan penilaian berbasis gamifikasi yang dilakukan melalui Gimkit dengan cakupan materi yang setara. Hasil penelitian menunjukkan bahwa mahasiswa mencapai skor rata-rata yang lebih tinggi dalam penilaian berbasis gamifikasi dibandingkan dengan tes konvensional. Mahasiswa juga melaporkan adanya peningkatan motivasi, partisipasi aktif, serta pemahaman yang lebih baik tentang konsep eter. Temuan ini menunjukkan bahwa gamifikasi berbasis Gimkit berpengaruh positif terhadap hasil belajar maupun pengalaman belajar mahasiswa, serta memiliki potensi yang kuat sebagai strategi instruksional yang efektif dalam pendidikan Kimia Organik, khususnya untuk materi terkait eter dalam program studi farmasi.

Kata Kunci: Pendidikan kimia, Senyawa eter, Gamifikasi, Gimkit, Mahasiswa farmasi.

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1. INTRODUCTION

The landscape of higher education in health sciences has undergone a major transformation in recent years. Institutions are increasingly shifting toward instructional approaches that emphasize active engagement, conceptual understanding, and the practical integration of learning technologies. Within pharmacy education, Organic Chemistry remains one of the most challenging subjects for undergraduate students, largely because it requires simultaneous mastery of structural interpretation, mechanism-based reasoning, and functional-group recognition [1]. Highlights this learning barrier, stating that organic chemistry is a language of molecules, and students often struggle not because the material is inherently difficult, but because they have not yet learned how to read it [2]. This difficulty is particularly evident when students encounter functional groups whose patterns of behaviour differ from what they intuitively expect.

One such topic is the study of ethers. Although ethers are structurally simple, they present unique conceptual demands because their reactivity, polarity, and applications do not always align with students' prior understanding of oxygen-containing compounds. Solomons and Fryhle (2020), describe their significance by noting that ethers possess a unique combination of stability and reactivity that makes them essential in both laboratory synthesis and industrial applications [3]. This statement implies that understanding ethers is not merely an academic exercise, it is foundational knowledge that influences multiple domains of pharmaceutical sciences, including synthetic pathways, solvent selection, chromatographic processes, and the development of precursor intermediates for therapeutic compounds [4].

However, despite their importance, many pharmacy students demonstrate limited engagement and inconsistent comprehension when studying ethers through traditional lecture-based models. Concepts such as their nomenclature, methods of preparation, cleavage reactions, and physicochemical characteristics often remain fragmented in students' minds [5]. Contemporary research in chemical education increasingly supports the use of interactive learning platforms to address this issue. Found that students

show significantly higher comprehension levels when instructional materials incorporate interactive or game-based strategies [6]. Their findings indicate that digital learning tools can reinforce conceptual mastery by transforming passive content consumption into an active, repetitive learning experience.

In this context, platforms such as Gimkit are particularly relevant [7]. By integrating core concepts into game-based learning, students are allowed to revisit challenging material multiple times in a format that stimulates competition, motivation, and memory retention. This aligns with the broader movement in higher education toward technology-enhanced learning, which encourages the use of adaptive, fast-feedback systems to reinforce difficult scientific concepts. For pharmacy students who must eventually apply organic chemistry principles to pharmaceutical analysis, drug synthesis, and formulation science this pedagogical approach becomes especially valuable.

Therefore, the present journal is developed not only to explain the fundamental theory of ethers but also to support an engaging learning experience suitable for pharmacy students. This paper provides a comprehensive discussion covering the structure, nomenclature, physical properties, chemical reactivity, synthesis routes, and practical applications of ether compounds. Each section is organized to promote conceptual clarity while emphasizing real-world relevance within pharmaceutical contexts. Furthermore, the integration of interactive learning strategies is highlighted as a complementary tool to strengthen understanding. Through this combination of detailed theoretical explanation and modern pedagogical perspective, this journal aims to serve as an academic reference that supports both content mastery and long-term retention for students studying ethers as part of Organic Chemistry in pharmacy education.

2. METHOD

2.1 Research Design

This research adopted a mixed-methods framework integrating quantitative performance analysis with qualitative perception measurement to evaluate the instructional value of Gimkit in facilitating pharmacy students' comprehension of ether chemistry. The rationale for employing a mixed approach lies in the complexity of chemical concept

acquisition. Learning gains must be examined not only through test scores but also through learners cognitive, motivational, and affective responses [8].

A quasi-experimental one-group design was implemented. All participants completed two sequential assessments aligned with the same instructional objectives:

1. A conventional 15-item Google Forms test.
2. A 15-item Gimkit game session, embedding gamified mechanics (e.g., point systems, rapid-response cycles, competitive interaction, instant feedback).

The study compared students' performance across these two environments to determine whether gamification enhanced conceptual clarity and recall. The qualitative component, obtained through structured Likert-scale surveys, aimed to capture learners' subjective experiences, engagement levels, and perceived cognitive support provided by Gimkit.

2.2 Participants

The research involved 24 undergraduate pharmacy students enrolled in Organic Chemistry during the 2025 academic cycle. These students were selected due to the curricular importance of ether chemistry and the documented difficulties students often encounter in mastering reaction mechanisms, nomenclature, and structural interpretation.

All students received identical instructional materials before data collection. Participation was voluntary, no control group was used, and each student served as their own comparative baseline to ensure internal consistency and minimize confounding academic-ability differences.

2.3 Data Collection Procedures

2.3.1 Quantitative Data Collection

The evaluation involved two primary methods, a Google Forms assessment and a Gimkit gamified assessment. The Google Forms assessment consisted of a 15-item multiple-choice test that measured foundational knowledge of ether structures, nomenclature, classification, physical properties, and basic reactions, with the platform automatically recording the students scores. Additionally, students engaged in a 15-item Gimkit session covering the exact same learning targets as the Google Forms test, but with added gamification elements. The Gimkit system logged real-time scores, accuracy rates, and completion data, which were then exported for statistical comparison. Ultimately, both assessments were constructed to match the same difficulty level and learning scope, ensuring methodological fairness without the need to list individual questions in this report.

2.3.2 Qualitative Data Collection

Qualitative data were obtained using a structured 5-point Likert-scale survey administered after both assessments [9]. The scale included:

Table 1. Likert-scale.

Score	Assessment criteria
5	Strongly Agree
4	Agree
3	Neutral
2	Disagree
1	Strongly Disagree

Survey constructs evaluated:

1. Perceived conceptual clarity during Gimkit use.
2. Engagement and learning enjoyment.
3. Motivational impact of gamified learning.
4. Perceived usefulness of Gimkit as a learning tool.
5. Preference between conventional and gamified assessments.

This design intentionally avoided neutral responses to encourage decisive feedback.

3. Research Instruments

The study utilized both quantitative and qualitative instruments to evaluate student learning and experience. The quantitative instruments comprised two parallel 15-item assessments administered via Google Forms and Gimkit designed to measure students' mastery across key ether topics, including nomenclature rules, structural interpretation and classification, physical and chemical properties, fundamental reaction pathways (e.g., cleavage, synthesis), and contextual pharmaceutical applications. To maintain conciseness and meet the study's reporting scope, the specific item list for these tests is excluded from this paper. Additionally, a qualitative instrument in the form of a 12-item Likert-scale questionnaire was employed to assess four major constructs: effectiveness in conceptual understanding, engagement and interactive learning experience, motivation and interest stimulation, and usability and cognitive support. All questionnaire responses were kept anonymous to ensure honesty and reduce response bias.

4. Data Analysis Procedures

Quantitative results were analyzed using a combination of descriptive and inferential statistical methods. Specifically, descriptive statistics including mean, standard deviation, and frequency distribution described performance trends in both assessment formats, while paired-samples t-tests evaluated whether the differences between the Google Forms and Gimkit scores reached statistical significance, an appropriate measure since both assessments involved the same participants under comparable conditions. For the qualitative analysis, survey responses were examined using descriptive

percentage distributions across four Likert categories. The results were then organized into five thematic dimensions: engagement and enjoyment, conceptual clarity and understanding, motivational influence, ease of use and learning facilitation, and overall preference for future implementation. Ultimately, these themes enabled a holistic interpretation of students' perspectives regarding the integration of gamified platforms in Organic Chemistry education.

3. RESULT AND DISCUSION

3.1 Quantitative Analysis

Descriptive statistics, the three groups (Control, Ga, and Gb) are summarized in Table:1. The mean scores were 5.26 (SD = 1.76) for control, 6.47 (SD = 1.58) for Ga, and 8.11 (SD = 1.38) for Gb. These values indicate that Gc exhibited the highest average score with relatively low variability, while Ga had the lowest mean score and the greatest dispersion among the three groups.

Table 2. The mean and standard deviation of students' scores in each group.

Groups	Mean (\bar{x})	Standard Deviation (SD)
Control	5.25	1.74
Ga	6.40	1.90
Gb	8.11	1.80

A one-way analysis of variance (ANOVA) was conducted to examine whether different instructional strategies had a statistically significant effect on student performance across three groups. The mean scores for each group were as follows: control = 5.25, Group a = 6.40, and Group b = 8.15. The overall mean across all groups was 6.53. The ANOVA summary indicated a statistically significant difference in student performance between at least two of the instructional groups, with F-statistic = 14.72, p-value = 0.000007. The sammary of ANOVA result present in table 3. To further determine which specific groups differed significantly, a post-hoc test (Tukey's HSD) was employed following the ANOVA analysis. The results of this test are included in table 4.

Table 3. The result summary of ANOVA analysis.

Source	Sun of Squares	Df	Mean square	F	p-value
Between groups	85.30	2	42.65	14.72	0.000007
Within groups	165.10	57	2.90		

Total	250.40	59
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As the p-value was well below the standard alpha level of 0.05, the null hypothesis was rejected, confirming that not all group means are equal.

Table 4. Tukey HSD Post-Hoc Test Results.

Comparison	Mean difference	p-value	95%CL (Lower, upper)	Significant ?
Control vs Ga	1.15	0.0914	(-0.15,2.45)	No
Control vs Gb	2.29	00000	(1.60, 4.20)	Yes
Ga vs Gb	1.72	0.0054	(0.45, 3.05)	Yes

The findings demonstrate that instructional strategy plays a significant role in student academic performance. There is no significant difference between the Control and Ga groups (p = 0.0914). There is a significant difference between Control and Gb, and also between Ga and Gb. This suggests that Group Gb outperforms both Control and Ga, while the improvement from Control to Ga is not statistically significant at the 0.05 level.

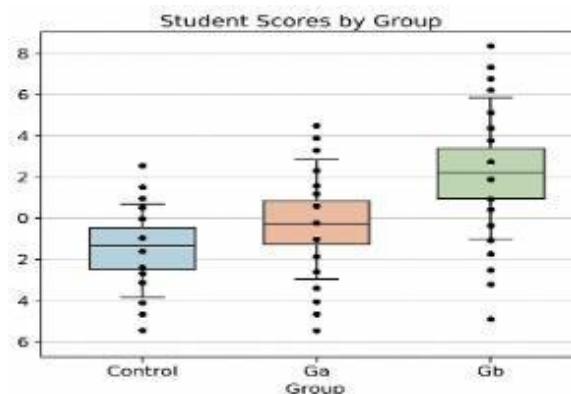


Figure 1. Boxplots to compare student performance among various experimental groups.

Boxplot was employed to visually summarize student performance across the experimental groups, emphasizing important distributional characteristics like the median, interquartile range (IQR), and possible outliers. The comparison shows a distinct advancement in performance from the Control => Ga => Gb. Group Gb is distinguished by its superior median score and a broader dispersion of elevated values, signifying a more robust central tendency as well as enhanced performance in the upper range. The observed pattern indicates that the intervention or variable applied to group Gb may have significantly improved student outcomes.

The present research examined how various teaching methods affected students' academic performance, employing a one-way ANOVA and Tukey's HSD post-hoc analysis. The outcomes demonstrated a statistically significant impact of instructional strategy on student

performance, as indicated by the ANOVA results ($F = 14.72$, $p < 0.001$). This finding suggests that at least one teaching method resulted in outcomes that were significantly different from those of other methods. The mean scores for each group indicated a distinct upward trend: Control group students had an average score of 5.25, Group Ga students averaged 6.40, and Group Gb recorded the highest mean at 8.15. The mean value across all groups was 6.53. The results indicate a performance increase from Control to Ga to Gb.

These differences were further clarified by the Tukey HSD post-hoc test. No significant difference was noted between the Control and Ga groups ($p = 0.0914$), but both Control vs Gb and Ga vs Gb comparisons revealed statistically significant differences ($p < 0.001$ and $p = 0.0054$, respectively). The results imply that the instructional method used in Group Gb significantly and positively influenced student outcomes, surpassing both the traditional method (Control) and the Ga intervention. The results suggest that although Ga may be an improvement over traditional teaching, it was not different enough to reach statistical significance. Conversely, the teaching approach used in Gb seems to have offered a stronger advancement to student learning and performance. Additionally, the distribution and uniformity of elevated scores in the Gb group bolster the method's efficacy. By doing this, the group average is raised and a more consistent advancement among students is shown this is essential for inclusive educational success. The results highlight how crucial it is to choose instructional strategies based on evidence in educational contexts. The Gb strategy's statistically significant enhancement suggests it may serve as a useful model for wider application. Further studies should examine which specific aspects of the Gb strategy contributed to its effectiveness, as well as whether these results can be reproduced across various subjects, grade levels, or populations.

3.2 Qualitative Analysis

Following the administration and evaluation of the post-test across the three instructional groups, the results indicated that the third group (Gb), which was exposed to the TPS Gamification method, demonstrated the highest academic achievement, with a mean score of 8.15. To further explore students' perceptions and experiences with the instructional approach under investigation, a qualitative questionnaire was developed using Google Forms and subsequently distributed to all participants. The purpose of this instrument was to elicit in-depth feedback and to triangulate the quantitative findings with qualitative data, thereby providing a more comprehensive understanding of the pedagogical impact. The questionnaire sought to capture students' attitudes, engagement levels, and perceived effectiveness of the teaching method. The items included in the questionnaire were as follows table 5.

Tabel 5. The mean and standard deviation of students' scores in each group.

Question	Yes	No
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	(%)	(%)
I enjoyed participating in lessons that used the TPS + Gamification method.	85	15
The TPS strategy helped me understand the lesson content more deeply.	70	30
Flashcards Gamified element increased my motivation to learn.	90	10
I felt more engaged during the lesson compared to traditional teaching methods.	100	0
Discussing ideas with my peers helped me improve my understanding.	100	0
The activities were fun and made the learning process more enjoyable.	100	0
I felt comfortable sharing my thoughts during the "pair" and "share" phases.	90	10
The combination of TPS and gamification helped me remember the content better.	80	20
I was more active in class when gamified learning was used.	85	15
I would like to use this method in other subjects as well.	90	10
The gamified tasks helped me stay focused during class.	75	25
I was more confident to speak and participate during TPS+ gamification activities.	75	25
Working in pairs or small groups made learning feel less stressful.	75	25
Competing in a friendly way made the lessons more exciting.	90	10
I felt a sense of achievement when I earned points or rewards.	70	30
This method helped me understand difficult concepts more easily.	90	10
I felt that my contributions were valued during class.	85	15
The structure of TPS+gamification is more effective than TPS alone	75	25
This method is ineffective for teaching complex topics in organic chemistry.	5	95
I felt that there are no differences in this method.	15	85

The percentages represent students' responses to each questionnaire item, which were formatted as (Yes\No) questions.

The feedback data provides a comprehensive overview of students' views regarding the implementation of the combined Think-Pair-Share (TPS) and gamification strategy in the classroom. In general, the findings reveal a highly positive response to this instructional approach, particularly in relation to student engagement, motivation, participation, and overall learning effectiveness.

1. Engagement and Enjoyment

A large percentage of students reported that they enjoyed the lessons (85%) and found the activities enjoyable (100%), indicating that this method successfully increased their interest in the subject. All students (100%) felt more engaged compared to traditional teaching

methods, which strongly supports the effectiveness of this approach in capturing and sustaining attention. In addition, 90% stated that the gamified flashcard activities enhanced their motivation, reinforcing the idea that competitive and reward-based elements can positively influence student engagement.

2. Peer Interaction and Classroom Atmosphere

Most students agreed that peer discussions helped improve their understanding (100%) and that working in pairs or small groups reduced learning-related stress (75%). This highlights the collaborative strength of the TPS model, which encourages active and social learning. During the pair and share stages, 90% felt confident expressing their ideas, suggesting that the structure creates a supportive and non-threatening environment. Furthermore, 85% believed their input was valued, which is essential for building a positive classroom climate.

3. Learning and Retention

Approximately 80% of students felt that combining TPS with gamification improved their ability to remember content, while 70–90% indicated that it helped them understand the lesson material, especially difficult topics. These results demonstrate the cognitive benefits of the approach, as structured interaction through TPS combined with engaging game elements appears to strengthen comprehension and long-term retention.

4. Participation and Confidence

The approach encouraged higher levels of student participation (85%) and increased confidence in speaking and classroom involvement (75%). This is particularly important in science learning contexts, where students often struggle with self-confidence. Learners also appreciated the element of friendly competition (90%) and the sense of achievement gained from collecting points and rewards (90%).

5. Future Use and Method Preference

A high proportion of students (90%) expressed interest in applying this method to other subjects, indicating its broad appeal and adaptability. Additionally, 75% felt that the combined approach was more effective than using TPS alone, supporting the idea that integrating gamification with cooperative learning produces a stronger overall impact.

6. Critical and Contrasting Views

Only a small number of students (5%) perceived the method as ineffective for teaching complex organic chemistry topics, while 15% felt it offered no clear advantage over conventional approaches. These limited responses suggest that although the strategy is highly effective for most learners, it may not be equally suitable for all students or all subject matter.

The findings highlight that the TPS combined with gamification produces a notably positive impact on students' learning experiences. This strategy encourages active participation, deeper understanding, increased motivation, and collaborative learning, all of which are key components of effective education. Although a small number of students

reported slight reservations, these responses may stem from a preference for more independent or teacher-centered instruction, particularly among learners who have difficulty with self-regulation or who perceive game-based elements as distracting. Variations in motivation levels, prior knowledge, and individual learning styles also influence student responses, underscoring the importance of employing a range of instructional methods. Overall, the strong level of support suggests that this approach holds significant potential for broader implementation in science education as well as other disciplines.

A face-to-face interview was carried out immediately after the post-test to obtain students' firsthand impressions of the method, with particular attention given to their facial expressions in order to evaluate the authenticity of their reactions to the effectiveness of the approach. A five-point Likert scale was applied to most of the items, and the results are displayed in the charts below:

Q1: Prior experience with organic chemistry nomenclature



Figure 2. Five-point Likert scale % for Q1.

Q2: How helpful was the instructional method in improving your understanding of heterocyclic nomenclature?



Figure 3. Five-point Likert scale % for Q2.

Q3: The competitive elements (flashcard games) made the sessions more enjoyable and effective.

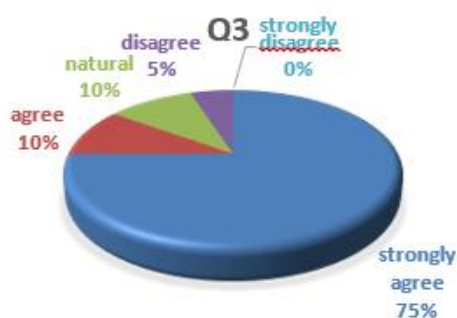


Figure 4. Five-point Likert scale % for Q3.

Q4: How clearly were the concepts explained using this method?

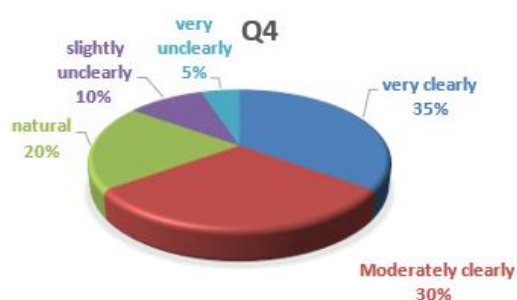


Figure 5. Five-point Likert scale % for Q4.

Q5: I was encouraged to actively participate in class activities and discussions.

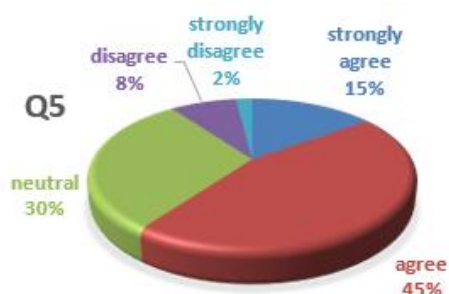


Figure 6. Five-point Likert scale % for Q5.

Q6: Which part of the method was most helpful for your understanding?



Figure 7. Students' perspectives on the most valuable component.

The preliminary results (Q1) show that students' prior experience with organic chemistry nomenclature varies, which aligns with the heterogeneity typically seen in undergraduate chemistry classrooms. Even with this difference, the outcomes from Q2 and Q4 evidently show that the teaching approach led to a considerable enhancement in students' grasp of heterocyclic nomenclature and in the clarity of concept communication. These results align with earlier research emphasizing the effectiveness of interactive and learner-centered methods in chemistry education [10, 11]. The favorable reaction to competitive and game-based components, especially the implementation of flashcard games (Q3), strengthens the case for integrating gamification into science teaching. Elements like these not only enhanced enjoyment but also fostered cognitive engagement and knowledge retention, as evidenced by the research of Lutfi *et al.*, (2023) and Tegon, (2024) has been consistently highlighted in literature [12, 13]. That when gamification is effectively organized and corresponds with educational goals, it can convert abstract material into forms that are easier to engage with and remember. Furthermore, the Think-Pair-Share strategy seemed to be crucial for fostering student involvement and interaction (Q5). After the sessions, a live interview was conducted that offered qualitative validation. Students' facial expressions and verbal feedback confirmed the responses given on the Likert scale. This is consistent with the findings of Al Abri & Al-Mekhlafi, (2025) and Adzani *et al.*, (2025), who discovered that TPS promotes deeper involvement and creates a collaborative learning environment conducive to critical thinking and peer learning [14, 15]. The responses of students to Q6, which pinpointed the most beneficial elements of the teaching strategy, underscore the importance of combining different active learning methods. Visual aids, peer discussions, and interactive exercises proved to be especially helpful, highlighting the necessity for multimodal teaching methods in chemistry education.

The results of Silva *et al.*, (2022) and Xodabande *et al.*, (2022) corroborate this observation, as they showed that an integration of visual, verbal, and kinesthetic learning modes improves conceptual understanding and memory retention

[16, 17]. To sum up, incorporating gamification and TPS into the chemistry curriculum showed quantifiable benefits for students' understanding, engagement, and overall learning experience [18]. The results indicate that this type of hybrid teaching model provides a hopeful structure for instructing difficult scientific subjects and could be beneficially implemented in educational settings to address deficiencies in student readiness and involvement. However, several limitations should be noted. The improvements observed may be partly due to the novelty effect, as increased motivation could stem from exposure to a new method rather than its actual effectiveness. The small sample size ($n = 60$) and short intervention period limit the generalizability of the results. Group dynamics and instructor influence may introduce bias, and self-reported data can be affected by social desirability. Future studies should use larger, more diverse samples and assess long-term impacts through extended and longitudinal designs.

4. CONCLUSION

This research investigated how students' comprehension of heterocyclic compound nomenclature was affected by the combination of gamification and the Think-Pair-Share (TPS) strategy. The results indicated that students in the gamified TPS group (Gb) had a significantly higher score (mean = 8.11) compared to those in the TPS-only (Ga = 6.40) and traditional instruction (Control = 5.25) groups. Qualitative data further suggested that the Gb group exhibited heightened engagement, motivation, and conceptual retention. The results back the constructivist learning theory, emphasizing how a combination of cooperative learning and gamification promotes deeper understanding via active, student-centered involvement. Introducing gamification into TPS provides a useful method for teaching complicated subjects. Instruments such as flashcards, point systems, and peer collaboration can enhance performance and foster a classroom atmosphere that is more interactive and supportive. This hybrid model shows potential for broader application in STEM education. Training programs can assist educators in applying these methods across different subjects and levels. Students' perspectives and opinions about chemistry directly influence their ability to solve problems, engage in the field, experience satisfaction, and perform academically. To attract outstanding students to professional chemistry programs, we need to provide a stimulating learning. Future research should evaluate long-term retention, investigate digital versus non-digital gamification tools, and analyze cognitive and emotional reactions to gamified learning. Students' perspectives and opinions about chemistry directly influence their ability to solve problems, engage in the field, experience satisfaction, and perform academically. To attract outstanding students to professional

chemistry programs, we need to provide a stimulating learning.

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