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The Impact of Integrating Gamification into Cooperative Learning TPS on Students' Mastery of Heterocyclic Compound Nomenclature

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ABSTRACT

This research project investigates how incorporating gamification into the cooperative learning strategy Think-Pair-Share (TPS) affects students' understanding of heterocyclic compound nomenclature, which is a difficult and frequently problematic aspect of organic chemistry. A quasi-experimental design was utilized with 60 undergraduate chemistry students in their seventh semester at the University of Zawia. Participants were randomly divided into three groups: traditional instruction (Control), TPS (Ga), and TPS with gamified flashcards (Gb). Quantitative data were obtained via a post-instruction exam and analyzed with one-way ANOVA and Tukey's HSD. The Gb group attained the highest average score (8.11), significantly surpassing both the Ga (6.40) and Control (5.25) groups (ANOVA, $F = 14.72$, $p < 0.001$). These findings were further corroborated by qualitative data collected through interviews and questionnaires, revealing that more than 85% of students in the Gb group reported increased engagement, motivation, and understanding. The study concludes that the combination of gamification and TPS leads to significant improvements in conceptual learning outcomes in chemistry, and it recommends applying this approach more widely in science education.

INTRODUCTION

University-level chemistry instructors often face considerable challenges when teaching intrinsically complex topics, as students frequently struggle to comprehend such material and demonstrate limited receptiveness to conventional instructional methods. This often leads to a decline in student interest, which negatively impacts engagement and learning outcomes (Busthomi et al., 2024). Byusa et al., (2022) reported that over 60% of students found abstract chemistry concepts difficult to understand when taught using traditional methods, contributing to persistent misconceptions and reduced academic performance. One such area is the nomenclature of chemical compounds, which is commonly taught in a passive manner that relies heavily on rote memorization. Mutma'inna et al., (2024) observed that more than half of their surveyed students lacked a conceptual understanding of compound nomenclature, indicating the limitations of conventional pedagogies. This challenge is especially pronounced in the systematic nomenclature of heterocyclic compounds, which presents a significant hurdle in undergraduate chemistry education due to its complexity and the numerous rules involved. Research has shown that students frequently fail to retain and apply these rules correctly, resulting in knowledge gaps and poor comprehension. To address these issues and enhance student understanding, it is imperative for educators to adopt innovative instructional strategies that transcend traditional methods. Teachers are not only responsible for delivering content but also for utilizing diverse and engaging pedagogical approaches to foster meaningful learning experiences tailored to the complexity of the subject matter (Wahyudi & Masuwd, 2024)

Cooperative learning is a particularly notable strategy among these; it involves students collaborating in small groups to tackle problems or take part in guided discussions. This method aids in the development of critical thinking skills and fosters active learning (Öztürk, 2023). Aspects of gamification can be added to this approach in order to make the learning environment more engaging and interactive. Ultimately, the goal is to cultivate a deeper conceptual understanding and encourage greater active engagement in mastering complex scientific subjects (Rudolf, 2022). The Think-Pair-Share (TPS) strategy, which is a successful cooperative learning technique, encourages active involvement and teamwork among students as well as critical thinking. The process begins with individual reflection by students on a question or problem posed by the teacher, allowing for personal engagement with the material. After that, students collaborate to exchange their reflections, fostering peer interaction and deeper understanding through dialogue (Al Abri & Al-Mekhlafi, 2025). In the end, students share their ideas with the class, promoting broader participation and enabling the teacher to clarify concepts and address misconceptions. This approach ensures that all students take part, even those who might hesitate to speak in larger groups, and it enhances communication, critical thinking, and peer learning. Teachers should provide unambiguous instructions, handle time efficiently, and engage actively (Nwankwo & Nnamani, 2025)

Gamification is a promising teaching strategy that incorporates game-like elements—such as competition, points, and levels—into educational activities to boost student motivation, engagement, and understanding (Tegon, 2024). While digital platforms like Kahoot! and Duolingo are popular, non-digital methods such as flashcards and board games remain effective in fostering interaction and conceptual learning (Simbolon, 2025). By making learning more enjoyable and meaningful, gamification helps address foundational gaps that can hinder success in advanced topics like organic synthesis and hybridization (Najah Baroud & Aljarmi, 2025). Employing such strategies early can support deeper, long-term learning. The positive effects of gamification in chemistry education have been well documented. For example, a systematic review by Satari et al., (2024) examined educational games in organic chemistry developed between 2017 and 2023, highlighting their benefits on students' conceptual understanding and knowledge retention. Similarly, Lutfi et al., (2023) demonstrated that game-based learning in chemistry could significantly enhance student motivation and academic performance. Furthermore, the work of Byusa et al., (2022) published in Heliyon, confirmed that educational games improve students' conceptual understanding and make the subject more enjoyable for them. These findings indicate that gamification holds great potential for addressing educational challenges in complex topics such as the systematic nomenclature of heterocyclic compounds. According to Nwankwo & Nnamani (2025) students who learned circle geometry using the Think-Pair-Share (TPS) method performed significantly better on a mathematics achievement test compared to those taught using Direct Instruction. According to Adzanil et al., (2025) the Think-Pair-Share (TPS) strategy significantly improved students' personal letter writing skills by fostering greater involvement, collaboration among peers, and overall writing competence. Although both gamification and collaborative learning have been widely studied and shown to be effective, they are often explored separately in educational research. The combined impact of integrating gamification into collaborative models like Think-Pair-Share (TPS) remains largely overlooked. Exploring this intersection is essential for developing more engaging and effective strategies to help students master complex scientific concepts.

This research intends to improve seventh-semester Chemistry Department students' comprehension of the systematic nomenclature of heterocyclic compounds by combining two different teaching methods. In particular, the cooperative learning strategy Think-Pair-Share (TPS) is integrated with gamified instruction during lectures to foster a more engaging and participatory learning environment. A post-test assessing learning outcomes and a questionnaire gathering students' feedback on their learning experience are used to evaluate the effectiveness of this blended approach. The overarching aim is to enhance students' understanding of this intricate subject, thus bettering educational outcomes. Enhancements of this nature can raise the overall standard of education and services, while also helping to lower costs associated with education (Firdaus et al., 2025).

METHODS

Research Design

This study aims to investigate the effect of integrating the collaborative learning strategy "Think–Pair–Share" (TPS) with flashcard-based gamified instruction on students' learning outcomes, particularly in relation to the systematic nomenclature of heterocyclic compounds. In the posh truth era, educational media can be utilized to its fullest potential in various ways, including the use of flash card media (Setyaningrum et al., 2024). To ensure the reliability and validity of the results, a control group was used. The study adopts a mixed-methods approach, combining quantitative and qualitative data to examine how various instructional strategies influence academic performance, student motivation, and engagement (Creswell, & Plano Clark, 2018). Three teaching strategies were evaluated and compared using a quasi-experimental design: traditional lecture-based instruction, the TPS collaborative learning strategy, and a combined approach that integrates TPS with gamification elements. The aim is to identify which approach most successfully improves student learning and encourages a deeper conceptual grasp of the content. The design of the study is summarized in the following structured plans(figure 1).

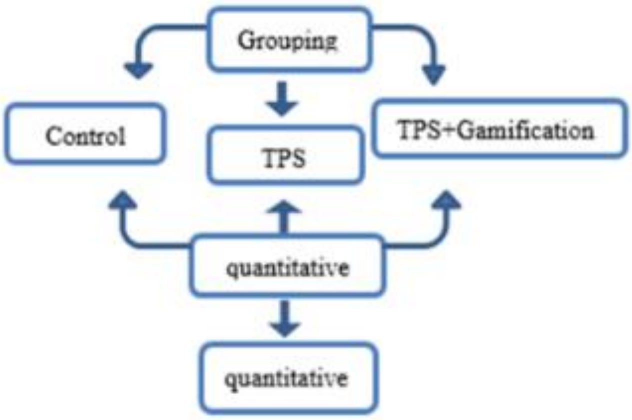


Figure 1. Flowchart outlining the structured plan of the study

Research Target

This research targeted 60 undergraduate students in their seventh semester at the Department of Chemistry, Faculty of Education, University of Zawia. These students were purposively selected based on their enrollment in an advanced chemistry course, making them an appropriate sample for evaluating the effectiveness of the instructional strategies employed. Following this, the students were randomly assigned to one of three experimental groups to ensure comparability in terms of academic background and prior knowledge of the subject matter. This combination of purposive sampling (for participant selection) and random assignment (for group allocation) was used to minimize bias and enhance the validity of the experimental design.

Research Data

This study utilized both quantitative and qualitative methods for data collection (Baroud et al., 2024)). Students' academic performance was measured through a post-instruction exam, which provided quantitative data. The exam consisted of 10 carefully designed questions aimed at assessing students' competence in the accurate application of nomenclature rules and their ability to identify compounds suitable for quantitative analysis. Alongside the quantitative evaluation, a qualitative questionnaire was distributed via Google Forms and complemented by live interviews to gather students' views on the teaching method being examined—specifically, the combination of collaborative learning (Think–Pair–Share) with flashcards as gamification elements (figure2). To maintain students' interest in learning, it is crucial to create tasks that correspond with their preferences. Enhancing student engagement and improving learning outcomes can be significantly achieved by integrating gamification elements throughout all educational stages (Alouzi, 2024)

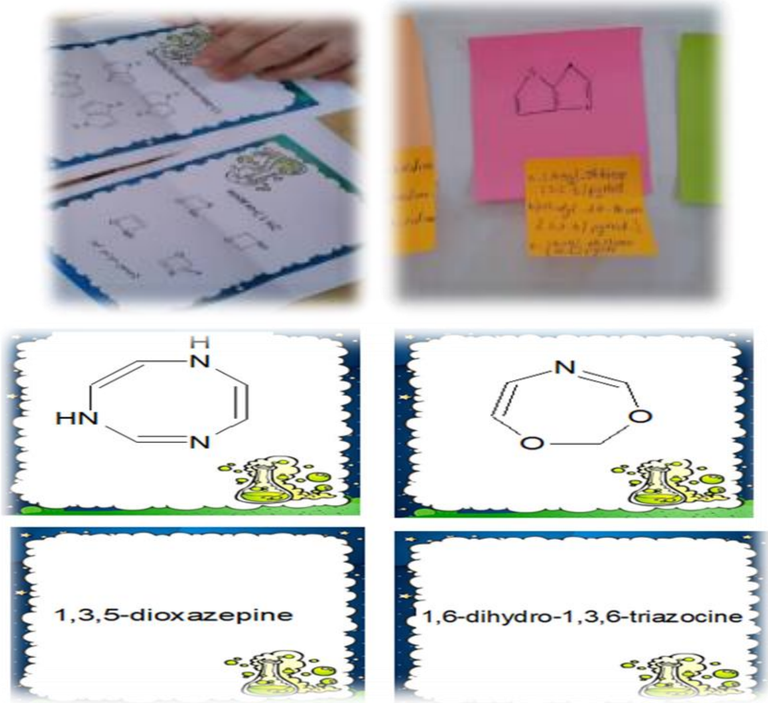


Figure 2. Examples of flashcards used in (TPS & gamification)

Research Instruments

Post-Instructional Exam: The post-instructional exam served as the principal quantitative tool in this study. This examination consisted of 10 meticulously crafted questions that assessed the students' capability to:

- Utilize the systematic nomenclature approach to determine the scientific names of heterocyclic compounds.
- Choose the appropriate compound to ensure accurate results in a quantitative analysis task associated with the study.

The exam acted as a direct gauge of students' academic performance and their grasp of essential course concepts.

Supplementary Instrument: A qualitative questionnaire and live interviews served as complementary tools to collect insights into students' experiences and perceptions of the effectiveness of an instructional approach that combined gamification elements with the Think–

Pair–Share (TPS) collaborative learning strategy. The questionnaire included Yes/No items designed to assess students' attitudes toward the method, their engagement level, perceived improvement in subject understanding, and overall satisfaction with the learning experience. Furthermore, in-person interviews were carried out with a structured questioning format that utilized the five-point Likert scale. This method enabled the gathering of straightforward and easily interpretable responses, thus improving the analysis of students' qualitative feedback.

Data Analysis

Quantitative analysis:

The quantitative data derived from the post-instructional examination were subjected to analysis through both descriptive and inferential statistical techniques. The overall performance of students in each group was summarized using descriptive statistics. Inferential statistical methods, including One-Way Analysis of Variance (ANOVA), were used to assess whether the differences in academic performance between the groups were statistically significant. The mean scores of the three experimental groups were compared using this statistical test to determine whether the instructional strategies had a differential impact on student learning outcomes.

Qualitative analysis:

The results of the questionnaire were analyzed using a descriptive analysis that utilized percentages. The students' responses were emailed to the researcher, who then extracted and categorized the data.The items in the questionnaire were organized into various categories that represent different facets of the students' experience with the Think-Pair-Share (TPS) strategy combined with Gamification, as detailed below:

1. Engagement and Enjoyment: This part evaluates how much students were actively engaged and whether they found the method enjoyable.
2. Peer Interaction and Classroom Atmosphere: This aspect centers on the caliber of student interactions and the general classroom environment.
3. Learning and Retention: This factor assesses the cognitive effects of the instructional approach, especially regarding students' capacity to comprehend and remember difficult material.
4. Participation and Confidence: This part looks at the effect of the method on students' readiness to take part and their self-assurance in engaging in classroom activities.
5. Future Use and Method: This category assesses students' interest in using the method for other subjects, reflecting its perceived versatility and attractiveness.
6. Critical and Contrasting: This section comprises the minority of responses that raised doubts about the method's effectiveness, especially for complex subjects like organic chemistry.

Each response's percentage ("Yes"/"No") was calculated from the total participant count (20 students), and these results were utilized to pinpoint major trends and views concerning the effectiveness of the teaching strategy employed.

Live interview: Subsequently after the post-test, face-to-face interviews were conducted with students in the (TPS & Gamification) group (Gb). The timing was chosen deliberately to prompt immediate, genuine responses about their experiences with the instructional approach. To gain more nuanced and comprehensive insights into their perceptions and attitudes, a structured set of items based on a five-point Likert scale was employed.

RESULTS AND DISCUSSION

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 1. 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

One-Way Analysis of Variance (ANOVA): 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 sammury of ANOVA result present in table 2. 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 3.

Table2. 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			

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 3: 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.

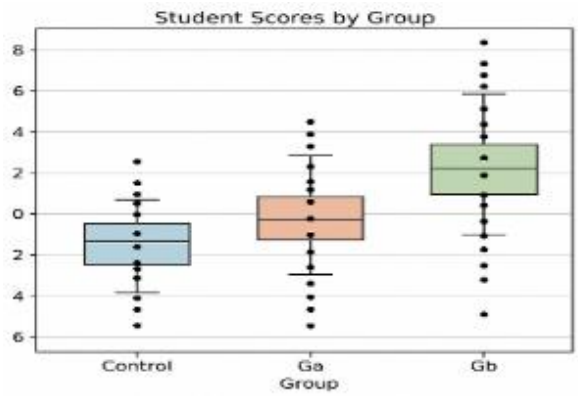


Figure 3. Boxplots to compare student performance among various experimental groups

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.

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 4. Distribution of Student Responses (Yes/No) to the Online Questionnaire Items

Question	%Yes	% No
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+ gamifacation 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 fell 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 offers a thorough insight into students' perceptions of the integrated Think-Pair-Share (TPS) and gamification approach applied in class. Overall, the results suggest a very favorable reaction to this teaching method in terms of engagement, motivation, participation, and effectiveness in learning.

1. **Engagement and Enjoyment:** A significant proportion of students indicated that they enjoyed the lessons (85%) and considered the activities fun (100%), implying that the approach greatly boosted their enthusiasm for the subject. 100% felt a greater level of engagement than with conventional methods, providing strong evidence for the efficacy of this approach in attracting and holding student attention. Likewise, 90% reported that the gamification aspect of flashcards increased their motivation, supporting the notion that competitive or reward-based learning components can improve student engagement.
2. **Peer Interaction and Classroom Atmosphere:** The majority of students concurred that engaging in discussions with peers enhanced comprehension (100%) and that collaboration

in pairs or small groups alleviated stress (75%). This illustrates the collaborative advantage of the TPS structure, which fosters active and social learning. During the "pair" and "share" phases, 90% felt comfortable sharing, demonstrating that the structure promotes a safe environment for student expression. An impressive 85% believed their contributions were appreciated in class, a key factor in fostering a supportive learning culture.

3. **Learning and Retention**: 80% felt that the integration of TPS and gamification enhanced their content recall, while 70–90% indicated it was beneficial for grasping lesson material, particularly challenging concepts. The cognitive advantages of this approach are demonstrated by these figures: the combination of structured discussion (TPS) with stimulating, game-like reinforcement seems to improve both understanding and memory retention.
4. **Participation and Confidence**: The method prompted a greater degree of involvement (85%) and fostered a feeling of increased confidence in students regarding speaking and taking part (75%). This is especially beneficial for science education, where student confidence is frequently lacking. Students valued the friendly competition (90%) and the sense of accomplishment associated with earning points and rewards (90%).
5. **Future Use and Method**: Preference 90% indicated interest in using this method for other subjects, demonstrating the wide transferability and attractiveness of TPS + Gamification. A 75% majority believed that the combination was more effective than TPS alone, confirming the synergistic effect of combining game elements with cooperative learning.
6. **Critical and Contrasting**: Views Only 5% thought the method was ineffective for teaching complex organic chemistry concepts, while 15% believed there was no difference from traditional methods. The small percentages indicate that although the strategy is very effective for most, it may not meet the needs of all learners or be suitable for every topic.

The results emphasize that the TPS + Gamification method has a strong positive effect on students' learning experiences. This approach cultivates active involvement, enhanced comprehension, motivation, and teamwork in learning all essential elements for successful education. Even though a few students expressed minor concerns, This may be attributed to some students may prefer individualized or instructor-led guidance, especially if they struggle with self-regulation or find gamified elements distracting. Differences in motivation, prior knowledge, and learning styles also affect how students respond, highlighting the need for diverse teaching approaches.
the predominant backing indicates that this approach could be highly promising for wider use in science education and other fields.

A face-to-face interview was conducted immediately following the post-test to capture students' direct feedback on the method, with an emphasis on their facial expressions to assess the genuineness of their reactions to the approach's effectiveness. five-point Likert scale was utilized for the majority of the questions, where presented in charts below:

Q1: Prior experience with organic chemistry nomenclature

Figure 4. Five-point Likert scale % for Q1

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

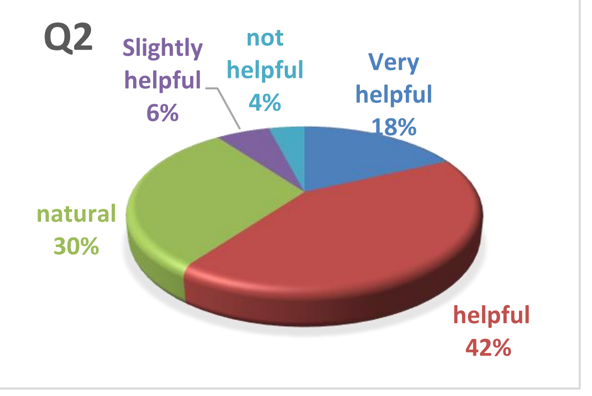
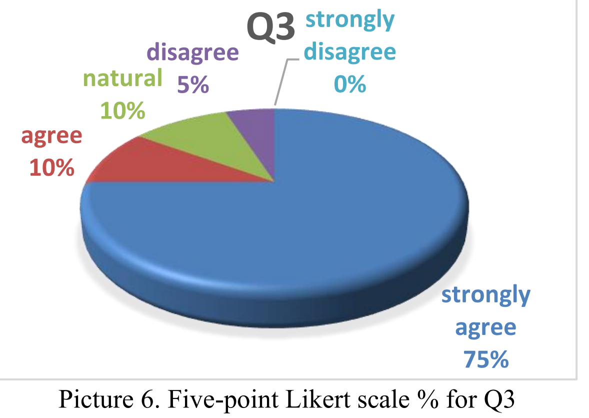


Figure 5. Five-point Likert scale % for Q2

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



Picture 6. Five-point Likert scale % for Q3

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

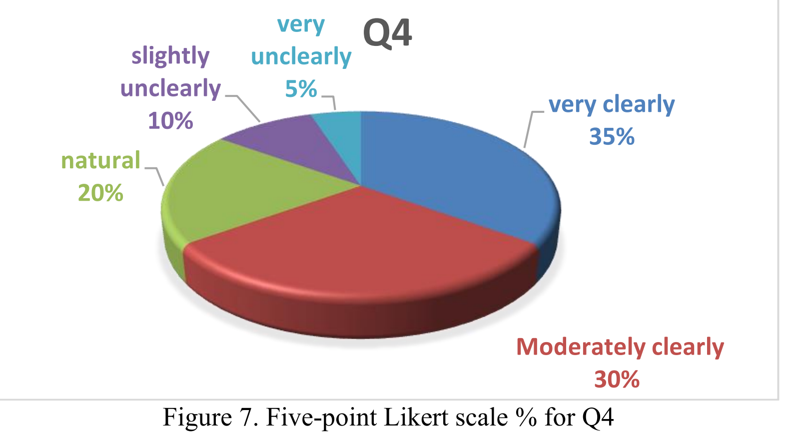


Figure 7. Five-point Likert scale % for Q4

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

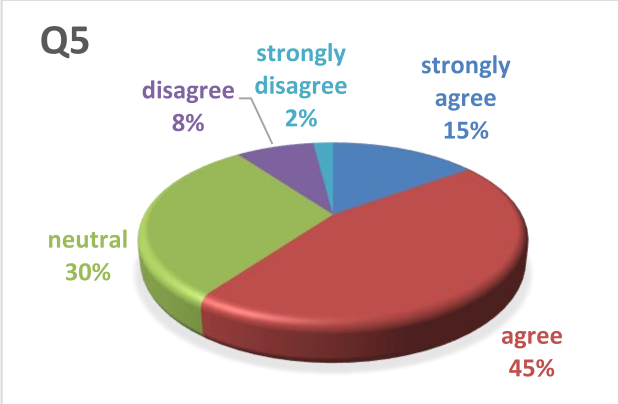


Figure 8. Five-point Likert scale % for Q5

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

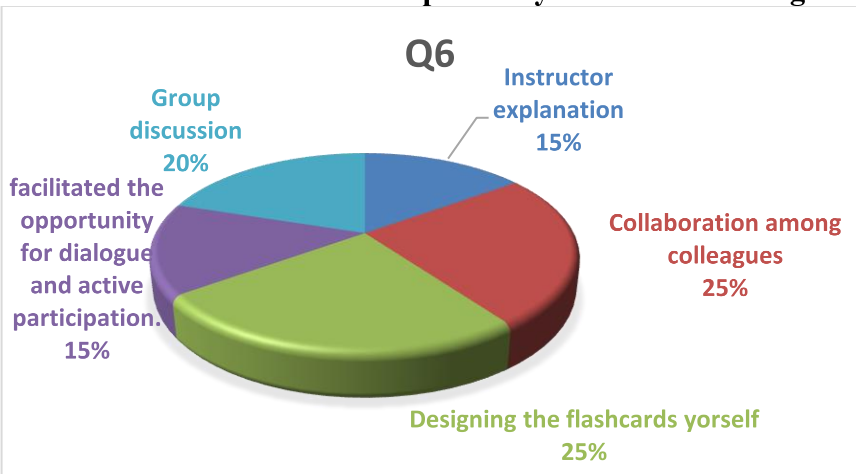


Figure 9. Students' perspectives on the most valuable component

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 (Byusa et al., 2022; Satari et al., 2024). 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 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 Adzanil et al., (2025), who discovered that TPS promotes deeper involvement and creates a collaborative learning environment conducive to critical thinking and peer learning.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. To sum up, incorporating gamification and TPS into the chemistry curriculum showed quantifiable benefits for students' understanding, engagement, and overall learning experience.(Abubakari et al., 2023). 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.

CONCLUSION AND RECOMMENDATIONS

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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