Implementation of game-based integrative learning in understanding organic chemistry nomenclature among grade 11 GAS students of Talangan Integrated National High School

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Abstract

Organic Chemistry is often regarded as a challenging subject due to its abstract nature, particularly in the nomenclature of organic compounds. Many students struggle with understanding and applying the rules for naming hydrocarbons, leading to difficulties in higher-level chemistry concepts. This study investigates the implementation of game-based integrative learning through Organic Scrabble as an instructional tool to enhance the understanding of Organic Chemistry nomenclature among Grade 11 GAS students at Talangan Integrated National High School. The research employed a quasi-experimental design with a pre-test and post-test assessment to determine the effectiveness of Organic Scrabble in improving students' academic performance. A total of 25 students participated in the study, engaging in game-based learning sessions over one week. The results revealed a statistically significant improvement in post-test scores compared to pre-test scores, indicating that game-based learning positively influenced students' comprehension and retention of organic chemistry nomenclature. The interactive nature of the intervention fostered student engagement, motivation, and active participation, aligning with constructivist learning principles that emphasize hands-on and collaborative learning experiences. Findings from this study suggest that game-based integrative learning can be an effective strategy in teaching complex scientific concepts, particularly in chemistry education. The use of educational board games like Organic Scrabble not only enhances conceptual understanding but also promotes critical thinking and problem-solving skills. This study recommends that science educators explore the integration of game-based approaches to improve students' academic performance and engagement in challenging subjects like Organic Chemistry.

Keywords: Game-based learning; organic chemistry nomenclature; educational board games; constructivist learning approach; student engagement

1. Introduction

Chemistry is regarded as one of the most crucial scientific disciplines, and mastering this field necessitates advanced cognitive abilities, knowledge, and laboratory skills. Today's students struggle with many concepts, one of which is Organic Chemistry—specifically, the writing and naming of hydrocarbons. The students encountered a dilemma in grasping the concepts, especially the facts and elements of Organic Chemistry (Alias and Ibrahim, 2019). Game-based learning is being introduced to bridge the gaps in knowledge acquisition of least learned concepts (Zirawaga, Olusanya & Maduko, 2017).

Organic chemistry has become an essential aspect of daily life, with applications in nearly all fields (Yong, 1994). Although organic chemistry is included in various undergraduate curricula, such as engineering and medicine, the failure rate among students remains consistent across these programs (Triboni & Weber, 2018). Many students approach introductory organic chemistry courses with a degree of anxiety and fear (Pungente & Badger, 2003). Despite most students' efforts to learn chemistry, many do not reach their objectives due to the subject's difficulty (Markow & Lonning, 1998). As a result, most students opt to memorize subjects like organic chemistry instead of comprehending them, hoping to pass the exam. The naming of organic compounds is a key component of general chemistry and introductory organic chemistry courses. Organic compound nomenclature often begins with a branched alkane, to which substituent and/or functional groups are added incrementally. To accurately name organic chemical compounds, students should first be able to classify functional groups. Not comprehending the nomenclature of organic compounds in its entirety can result in difficulties with other aspects of organic chemistry. Games can help with this issue. To assist students in dealing with the challenges they face while learning, educational games are often utilized. (Zhang, 2017).

According to the Governance of Basic Education Act of 2011, the overarching aim of basic education is to cultivate Filipino learners by equipping them with fundamental skills in literacy and numeracy, critical thinking and learning strategies, as well as commendable values so they can grow into citizens who are caring, self-sufficient, productive, socially conscious, patriotic, and responsible. Along with this, it was deemed necessary to enhance the integration of competencies both within and across different learning areas.

In the 21st-century classroom, which is centered on students, using games in teaching exemplifies an integrative method. This strategy actively involves students in learning by merging enjoyment and competition with educational material, resulting in a more comprehensive grasp of the topic and maintaining student motivation and concentration. The teacher assumes the role of a coach and learning facilitator, assisting students with their tasks. As noted by Manuel (2015), students now engage in interdisciplinary projects that necessitate skills and knowledge from various subjects, rather than learning each subject separately. These projects involve working towards desired outcomes.

The goal of this research is to enhance the academic performance in Organic Chemistry nomenclature among Grade-11 GAS students at Talangan Integrated National High School. Students cannot apply or see the connection to real life for certain concepts, particularly those that are abstract, such as organic chemistry nomenclature. To meet the requirements, they simply copy and paste materials or memorize the meanings of concepts found online, without fully comprehending what is described or explained in the learning resources. This study aimed to alter this perspective by employing a manipulative method like Organic Scrabble, facilitating the learners' self-discovery of knowledge through engagement in activities with their peers.

Furthermore, this study aims to assist other educators in understanding that today's generation requires appropriate teaching methods and strategies for effective learning, rather than relying solely on conventional knowledge transfer. To cater to the needs of each 21st-century learner, it is necessary to devise a variety of teaching and assessment strategies.

2. Literature review

2.1. Related Studies

Nothing in this world is constant; everything changes nearly every second of the day, and educational activities (teaching and learning) should change as well. The days when learning relied solely on chalk and books are long gone; today, everything is computerized for retrieval, transmission, storage, and manipulation. Pascual (2017) cites the research by Steedy (2008), which underscored that in order to retain students' grasp of a lesson's core concept, teachers must be creative and flexible in their approach, given the nature of today's students. To achieve success, students must embrace lifelong learning. To assist them in cultivating the skills vital for becoming successful learners necessitates a distinct teaching and learning approach. Likewise, it is a significant responsibility for teachers to establish an environment that is supportive of learners. (Ramos, 2014) According to Colgan's study (2014), as cited by Pascual (2017), learners misbehave because they disengage and lose interest once they find the subject boring. The best solution is to employ various approaches and strategies, including ICT, TV programs, books, and games. As the current curriculum is primarily focused on a student-centered approach, involving students in the learning process greatly enhances their understanding of the lesson (Manuel, 2015).It takes a lot of work to engage with 21st-century learners, as they are known as "Millennials." The consideration is less about age differences and more about cultural differences. They do not resemble the typical students of our age; their attention spans and tempers are much shorter, leading to disengagement from discussions on topics they perceive as overly abstract. Therefore, creative strategies and engaging methods are crucial for effective knowledge transfer, and teachers must help students navigate their challenges with subjects like science.

A number of studies have been carried out regarding the use of educational board games to strengthen students' learning. A study carried out by Ong and Linaugo (2019) is an example of this, in which a board game was used to link concepts related to the history of the periodic table, the placement of elements, and trends. The aim is to bolster students' understanding of the conceptual material. The effectiveness of the board game was assessed based on the students' satisfaction, acceptability, and mean gain. The game was designed to promote active learning about the position of elements, as well as their uses and significance in contemporary society. Consequently, it serves as a resource for teaching groups and classes of secondary students.

In a study, Bagadiong (2013) examined the use of low-tech games for teaching Grade 10 students about quadratic functions. The research found that games like "Go on a Hunt" and "QF Snake and Ladders" effectively improved students' Mathematics performance. Likewise, Tabago (2014) created game-based activities centered on pinoy culture using a quasi-experimental design and discovered that these activities effectively helped to illustrate physics

concepts like work, power, and energy. Furthermore, Furio (2022) carried out a study on the use of games as remedial instruction for both low- performing and high-performing students in Rational Algebraic Expression. The study found that this approach was effective in improving the performance of both groups and addressing the achievement gap. The studies underscore the promise of low-tech games for improving students' learning outcomes and academic performance.

As stated by Zirawaga, Olusanya, and Maduko (2017), Game-based learning serves to bridge knowledge gaps in relation to the topics that are least understood. Utilizing game-based learning would be particularly beneficial for assessing the student's interest and capacity to motivate themselves to learn fundamental details about organic chemistry formulae and nomenclature. Regarding this, Piaget (1962) identified three fundamental types of games: sensorimotor play, role-playing, and rule-based games. Of the various kinds of games, it was noted that those with rules are characterized by a sense of rivalry and ongoing regulation. Consequently, Piaget viewed games with rules as a valuable method for enhancing knowledge, as players must teach themselves to manage their behavior when confronted with various viewpoints on the proper way to play. According to Alejandria et al. (2023), the research by Fancisco-Mariscal et al. (2016) stated that game-based learning is the most effective teaching method. Thus, using this method or approach in teaching opens up opportunities for teachers to enhance their instructional practices.

The Enhanced Basic Education Act of 2013 (Republic Act no. 10533, 2013) mandated that the curriculum be sufficiently adaptable to allow and encourage schools to innovate, localize, indigenize, and improve based on their specific educational needs. A prime example of this is the Sci-Math Board Game. This game was created with the endorsement of the Department of Education, which recognized the necessity for new teaching materials aligned with key aspects of an Indigenous Peoples Education Curriculum and suggested employing the IPED Framework. Galut (2022) further proposed that employing the Sci-Math Board Game enhances students' academic performance. The rise in students' academic performance can be linked to their enthusiasm for board games. The learners' significant enhancement in academic performance can be ascribed to the intervention utilized.

Galoyo (2021) noted that in the Philippines, games are a vital component of students' daily routines. These games fulfill various roles for students, such as providing enjoyment and satisfaction, as well as teaching a new method or technique for acquiring knowledge, mastering skills, and even outdoing rivals, according to the majority of players. In the study on Digital Game-Based Learning, Van Eck (2006), as cited by Galoyo (2021), discovered that both non-digital and digital games have consistently improved learning outcomes and reduced instructional time. These games utilize both virtual and physical materials to meet particular educational needs, such as data manipulation. Physical interactions involve tangible objects, symbolic representation, and direct encounters. Incorporating educational board games into classroom activities not only provides students with the opportunity to revisit information, but also fosters a participatory and planning-oriented atmosphere that enhances their activity levels and cooperation. Moreover, it underscores the value of the periodic table of games and its impact on students' academic advancement (Ong & Linaugo, 2019).

According to Francisco-Mariscal et al. (2016), game-based learning is the most effective teaching approach. Therefore, employing this method in the classroom allows teachers to improve their pedagogical practices. Games serve as a valuable educational tool, allowing people to build their knowledge in a fun and challenging setting (Triboni & Weber, 2018; Bayir, 2014). Numerous research works have demonstrated that games play an important role in learning (Barzilai & Blau, 2014).

According to Capps (2008), incorporating games into chemistry lessons enhances students' involvement in the class. Numerous educational chemistry games are recommended in the literature, covering topics like the periodic table, atomic electronic structure, chemical kinetics, stereo-chemistry, reaction rate theory, nomenclature, and functional groups (Welsh, 2003).

Specifically, there are diverse educational games related to organic chemistry designed to address issues in the teaching-learning context. Every game aims to aid students in cultivating a conceptual grasp of organic chemistry subjects via play. By means of interaction, these educational games provide an amusing way to grasp the intricate concepts of organic chemistry. Ein Beispiel ist ein Vorschlag von Welsh (2003) für ein Kartenspiel, mit dem die Namen und der Aufbau organischer funktioneller Gruppen gelernt werden können. Other games address organic chemistry subjects like esters (Angelin & Ramstorm, 2010). Alkyl halides (Gogal, Heuett, & Jabber, 2017).

According to Li (2018), game-based learning is an instructional strategy that employs games or game-like activities to motivate and engage learners, thereby promoting learning outcomes. As noted by Leaño and Belgica (2023), Aldrich (2014) and Taylor (2014), both of whom are cited, define it as any circumstance where the learning process is integrated into an experience that possesses game-like qualities. Tylor (2014) defines it as a teaching and learning approach that employs game design, mechanics, and content to engage students in profound learning experiences. Teachers can foster a more vibrant and captivating learning atmosphere that encourages active learning and increased student involvement by incorporating game-based lessons.

Many studies have demonstrated that both digital games and traditional "low-tech" game-based learning can

positively impact the classroom, serving as effective means to boost student motivation and engagement. Huan, Liang, and Chou (2017) discovered in their critical review that digital game-based learning (DGBL) positively influences students' learning outcomes in STEM subjects. According to the study, digital games were especially useful for enhancing students' knowledge acquisition and retention. Satrio (2021) conducted another study that discovered the digital online competitive game e-Crowd war to be effective in boosting students' interest and performance in high school economics. According to Jorda and Santos (2015), digital games have also been shown to effectively improve students' comprehension of and learning about challenging subjects such as trigonometry. According to Department of Education (2015), employing board games as a teaching tool promotes student involvement in activities and educational tasks that enhance their academic performance and provide a rewarding learning experience.

Even though digital games are very popular, low-tech games are still regarded as effective instructional tools because they make use of materials and resources that are available locally. Like the Organic Scrabble, they can be used without an internet connection or electricity. They can be easily adapted to suit any learning objective and can be played both indoors and outdoors.

This study aimed to assess how effective educational board games are for reinforcing chemistry learning, especially in the naming and formula writing of various organic compounds, in light of all the statements mentioned above. As a result, this research will attribute importance and significance to the following recipients. The findings of this study will offer science educators fresh and pertinent pedagogical insights to contemplate the use of educational board games in order to enhance the enjoyment, creativity, and engagement of their classes.The research will help students develop an interest in scientific concepts, especially in the naming and chemical formula writing of organic compounds. Future researchers will find relevant details and additional empirical evidence regarding the effectiveness of educational board games as a tool for reinforcing chemistry learning, particularly with respect to writing and naming organic compound formulas.

2.2. Theoretical framework

The principle behind the Chinese maxim "I hear and I forget, I see and I remember, I do and I understand" is acknowledged in this study. This clarified that the most effective way for students to acquire a deeper understanding of a particular subject is through active involvement in the learning process. To maximize learning, the learner must adopt an active rather than a passive role.

The research is based on the work of a prominent Constructivist, Jean Piaget. It highlights the role of learners as individuals who actively investigate their surroundings to build their knowledge while developing their understanding through hands-on participation. A learner with developed cognitive abilities must actively assimilate the knowledge. Instructors should assume the role of facilitators rather than teachers, as per the constructivist approach. A teacher provides an informative lecture that addresses the subject matter, while a facilitator aids the learner in reaching their own understanding of the content. In the former case, the learner is passive, while in the latter case, the learner actively engages in the learning process. The focus shifts away from the teacher and the material, and onto the student from the instructor and the content and towards the learner (Gamoran, Secada, & Marrett, 1998).

Piaget (1962) developed the constructivism theory, which stated that individuals gain knowledge by integrating their experiences and thoughts. According to Piaget, the individual is central to the process of constructing and acquiring knowledge; therefore, constructivism serves as a foundational concept for radical constructivism. The assumption that games enhance cognitive and higher-order thinking skills served as the motivation for their use. It is frequently utilized to expedite the learning process as well. As reported by Alabbasi (2018), Sandford et al. (2006) observed that teachers believe games foster student involvement, interaction, and engagement in the classroom.

A game-based learning approach was developed by educators around the globe as a promising way to actualize Piaget's ideas in his theory of constructivism. Making board games is a good method for encouraging students to think about playing board games. Kessner and Siyahhan (2021) discovered that the design of board games within a meaningful context motivated students in both design creation and system thinking, in light of the recent surge in interest in designing tools for learning about educational board games (Ramesh and Sadashiv, 2019). Furthermore, employing board games in chemistry— particularly in relation to various chemistry concepts—holds potential. According to William (2020), games in chemistry assist students in practicing the application of and becoming familiar with chemical concepts. The student took pleasure in playing the game, perceived it as easy to play, and regarded it as a beneficial learning experience. According to Huang (2019), board games significantly boost student engagement, flow experiences, and learning outcomes. Furthermore, the focus of constructivist learning is linked to a high level of acceptance among students (Languita et al., 2023). Therefore, it is vital for the future of education and learning that educational board games are innovated. One contemporary pedagogical resource that can be utilized to tackle issues related to the quality of

chemistry education is board games (Ramesh and Sadashiv, 2019).

This study also focused on students' cognitive abilities and their performance during actual classroom interactions. While some students appear to have a natural enthusiasm for learning, many require or anticipate that their teachers will motivate, challenge, and energize them. As noted by Erickson (1978, p.), "effective learning in the classroom depends on the teacher's ability to maintain the interest that brought the students to the course in the first place." 3). No matter how motivated your students are when they enter the classroom, the events that unfold there will change their motivation for better or worse.

2.3. Conceptual Framework

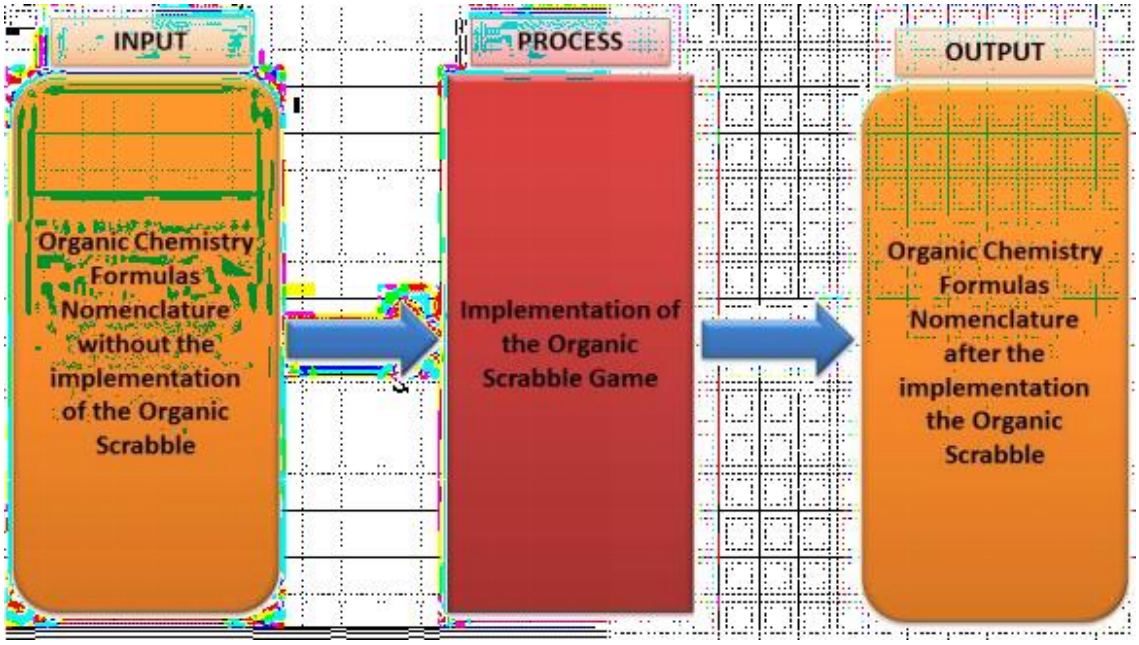
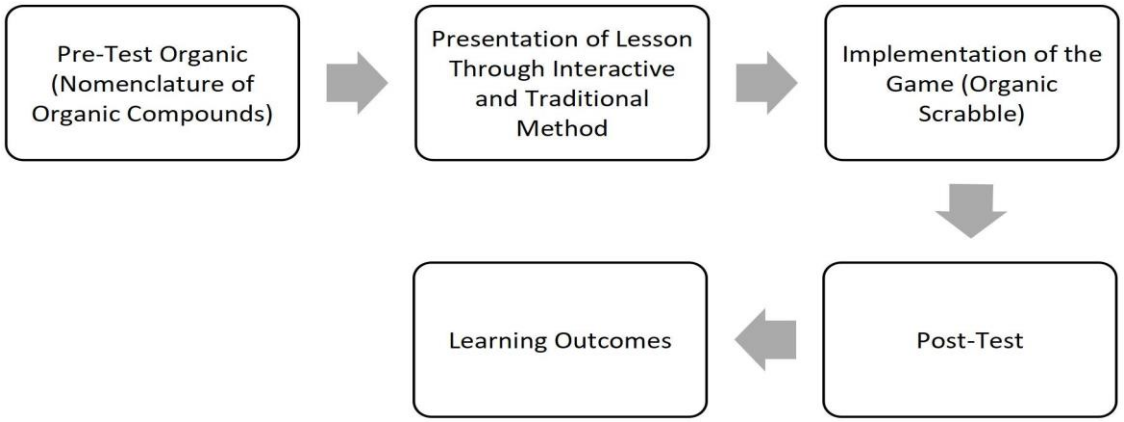


Figure 1

The major aim of this study is to find out the effects of the implementation of the organic scrabble as a learning resource material in studying and understanding the nomenclature the organic chemistry formulas. To conceptualize the relationship of the different processes involved in the study, the research paradigm was conceptualized as presented. The input consists of the student's performance that predated the implementation of the organic scrabble by giving them a 20-item diagnostic test. For the process, the students will now play organic scrabble as the learning resource to aid in understanding the nomenclature of organic chemistry. For the output, the students will be given a 20-item post-test and analyze their scores.

3. Methodology



The researcher implemented various measures to guarantee ethical consideration and cooperation from the respondents. Initially, permission was requested from the School's Principal. After the approval was obtained, formal permission was sought from both the Head Teacher of the Science Department and the Senior High School Coordinator to carry out the study. The researcher carried out the pretest after receiving approval from the School Head. To assess how effective Organic Scrabble was for helping students understand Organic Chemistry concepts—specifically, the Naming of Organic Compounds—a teacher-made test was administered to a sample of 25 students both before and after the period covered by this study. The respondents received clear and straightforward guidance on how to respond to the 25-item test, in which they were allotted a specific duration of one hour to finish. Throughout this process, the researcher meticulously gathered the test questions and answer sheets, attaining an impressive retrieval rate of 100%. The results were thoroughly verified, documented, and prepared for statistical analysis.

The researcher carefully designed game-based lessons on writing and naming organic chemistry compounds to align with the most essential learning competencies for introducing organic chemistry in this area. To prevent disruption of their classes in various subjects and to provide sufficient time for students to thoroughly engage with and understand the content, it was decided that the game-based lessons would be implemented over the course of one week during their break time.

After the game-based lessons were used, a post-test was conducted to assess the change in students' performance. This assessment was a useful means of gauging the influence and efficacy of the game-based lessons on the student's learning outcomes. The objective of the post-test was to evaluate how much students had advanced after their involvement with the stimulating and interactive game-based learning. This evaluation yielded important information about how effective this teaching method is. The test was conducted personally by the researcher. The gathered data was tallied, tabulated, analyzed, and interpreted using the following procedures.

The data collected from the pretest and post-test were analyzed using mean and standard deviation, while a t-test for independent learning was employed to determine the significant difference between the two. Moreover, the validity of the created game-based lessons was characterized using the weighted mean. Furthermore, a t-test for dependent samples was used to assess the significant difference in students' performance between the pretest and post-test.

4. Findings and Discussion

This presents, analyzes, and interprets the data gathered as a result of determining the effect of the implementation of Organic Scrabble on the Academic Performance of Grade-11 GAS Students of the Talangan Integrated National High School.

Table 1. Pre-Test and Post-Test Scores of the Grade-11 GAS Students

	Name	Pre-Test	Posttest
1	Student 1	9	13
2	Student 2	9	12
3	Student 3	10	13
4	Student 4	7	5
5	Student 5	9	16

6	Student 6	8	13
7	Student 7	10	12
8	Student 8	4	11
9	Student 9	11	15
10	Student 10	5	11
11	Student 11	11	13
12	Student 12	8	11
13	Student 13	7	6
14	Student 14	10	12
15	Student 15	10	11
16	Student 16	6	9
17	Student 17	11	15
18	Student 18	8	12
19	Student 19	9	12
20	Student 20	11	16
21	Student 21	6	5
22	Student 22	2	12
23	Student 23	7	10
24	Student 24	8	12
25	Student 25	10	11

The pre-test and post-test result were the most indispensable factors in measuring the effectiveness of using ORGANIC SCRABBLE in increasing the academic performance of Grade 11 GAS students in studying Organic Chemistry Nomenclature.

It can be gleaned in the table the academic performance of the GAS 11 Learners before and after the implementation of the Organic Scrabble. During the Pre-test, there is a mean value of 8.24 and 2.332 for the standard deviation with 11 and 2 points as the highest and lowest scores respectively. For the Post-test, an increase of 3.28 is observed for the mean value for it gained 11.52, and an increase in the standard deviation of 2.888 is also observed as well as in the value for the highest score which is 16, and the lowest score which is 6. These indicate the positive impact of using the Organic Scrabble in understanding the nomenclature in organic chemistry. With the used of t-paired sample means, a value of -6.18 for the T-critical was computed while the T-computed is equivalent to 2.26. since the T-critical is much lower compared to the value of T-computed this indicates the significant difference between the two means. While the P-value of 0.00 which is lower than the alpha value of 0.05 makes it more clearer the significant difference among the scores gained with the use of Organic Scrabble and without the use of Organic Scrabble.

Hence, this value backing the statement that the use of Organic Scrabble helped the GAS 11 learners in the understanding of the nomenclature in Organic Chemistry. Examining how well the learners performed and from the positive difference between the mean, it is can be said that the use of Organic Scrabble affects the academic performance of the GAS 11 learners.

Table 2.

TEST	**n**	**GAIN**			**tV**	**t-tab**	**PV**	**Decision**
		HS & LS	**Mean**	**SD**				
Pre Test	25	11 & 2	8.24	2.332	-6.18	2.06	0.00	Significant
Post Test	25	16 & 5	11.52	2.888				

In a similar vein, Manuel (2015) stated that student involvement in the learning process leads to improved lesson comprehension, as this is now the primary focus of our curriculum—emphasizing a student-centered approach. As cited by Ramos (2014), assisting students in cultivating the skills necessary for successful learning demands an alternative approach to teaching and learning. Likewise, it is a significant responsibility for teachers to establish an environment that is supportive of learners.

5. Conclusion

The research sought to establish whether the supplemental tool developed for learning how to write and name organic compounds is effective. The research showed that the educational board game would enhance students' academic performance on specific topics in Organic Chemistry, such as writing and naming organic compounds. Following the intervention, researchers identified a statistically significant change in the pretest and post-test scores of the Grade 11 GAS students, as there was an improvement in the students' post-test scores compared to their pre-test scores. According to Piaget's theory, children mainly explore their world through play, and the games they engage in reflect the

advancement of their cognitive development. Thus, game-based learning—particularly through the use of an educational board game—has a more significant impact on their engagement in class and bolsters their cognitive development.

The game evoked feelings of excitement, joy, and nervousness among the students. Furthermore, the educational board game was made intense by a twist introduced by the researcher, which will increase players' eagerness to win the game involving organic chemistry lessons. The researcher noted that with this game, students socialize, enhance their communication skills, and enjoy themselves while learning throughout. It is quite favourable that the educational board game can supplement understanding of writing and naming organic compounds, as it is extremely successful and could replace traditional teaching methods, despite its limited use in the past. Furthermore, this approach has proven to be a helpful and innovative way to learn while having fun, especially in light of the widespread issues present in educational environments in the Philippines, particularly regarding science education. Consequently, educational board games assist students in utilizing them as supplementary tools for learning and familiarizing themselves with concepts in enjoyable ways. Although they are time- consuming, the knowledge gained while having fun with these games makes it worthwhile.

From the conclusion drawn, the following were recommended:

* The lesson designed for Organic Chemistry that uses the game Organic Scrabble could be improved by adding different game elements and including materials that are localized and contextualized. This can assist in engaging and motivating students to learn, thereby enhancing their performance. The games utilized in each classroom can be regularly adjusted to cater to the needs of various learners and cultivate the targeted competencies. Science educators may utilize to further validate Game-Based Learning (GBL) as a means to enhance their students' academic performance and attain higher levels of achievement.

* An addition of skills (Scientists/ Chemists) can be added for a diverse choice of skill selections as well as for the game to be accessible to a wider range of audience.

* Future research on the development of game-based lessons is encourage to reinforce in teaching various fields of science and across different disciplines at grade levels.

Therefore, the introduction of Organic Scrabble as an aid in increasing the academic performance of Grade 11 students (GAS) of Talangan Integrated National High School is said to be helpful and has a positive impact in understanding the nomenclature process in Organic Chemistry. So therefore, it is safe to say that, there is significant difference between the academic performance of learners with and without the aid of the Organic Scrabble.

References

Alejandria, L. L., Bajenting, J. M., Pacatan, M.A. L. D., & Diquito, T.J.A. (2023). The Use of Educational Board Game as a Supplemental Tool in Learning Periodic Table of Elements among High School Students. Amarican Journal of Education and Technology, 2(1), 60-67, https://doi.org/10.54536/ajet.v2i1.1292

Barredo, KJ. DA., "Development on the Academic Performance in ScienceUsing Strategic Intervention Material", Muntinlupa City, 2011

DepEd Order No. 32, s. 2015, Department of Education. Adopting the Indigenous People Education Curriculum Framework; 2015

Erickson, G.S. (2017). Descriptive Research Design In New Methods of Market Research and Analysis.

Edward Elgar Publishing., 51-77. https://doi.org/10.4337/9781786432698.00009

Huang, W. H., Liang, S. H., & Chou, C.Y. (2017). The Effectiveness of Digital Game-Based Learning in STEM Education: A Meta-Analysis. International Journal of Educational Technology in Higher Education, 14(1),22.

Franco-Mariscal, A.J., Oliva-Martinez, J.M., Blanco-Lopez, A., & Espana-Ramos, E. (2016). A Game-Based Approach to Learning the Idea of Chemical Elements and their Periodic Classification. Journal of Chemical Education, 93(7), 1173-1190. https://doi.org/10.1021/acs.jcchemed.5b00846

Galoyo, F. (2021). Difficulties Encountered by Calaca Senior High School Learners in Science Subjects: An Input to Game Based Learning Strategics (GBLS). International Journal of Research in Engineering, Science and Management, 4(8), 83-87.

Galut, M. N. A. (2022). Effectiveness of Sci-Math Board Game for Elementary Science and Mathematics. Asian Journal of Education and Social Studies. 28(3), 19-35. DOI: 10.9734/AJESS/2022/v28i330677

Jorda, Editha R., Delos Santos, Omega. (2015). Effects of Computer-Based Learning on the Performance in Trigonometry of the ESEP High School Students. Asia

Li, Y., Huang, D., He, W., Wu, Y. (2018). A Systematic Review of Game-Based Learning Research. In H. Xiong,M

Lin, Y. L., Huang, S.W., & Chang, C. C. (2019). The Impacts of a Marine Science Board Game on Motivation, Interest, and Achievements in Marine Science Learning. Journal of Baltic Science Education, 18(6), 892-923.

Languita, J.M., Ligtas, J. B., Baron, D.C., & Diquito, T. J. A. (2023). Preferred Style of Teaching and Learning by College Students in the New Normal. American Journal of Multidisciplinary Research and Innovation, 2(1), 74-82. https://doi.org/10.54536/ajmri.v2i1.1209

Malhota, N.K., Agarwal, J., Peterson, M. (1996). Methodological Issues in Cross Cultural Marketing Research: A State-of-the-Art Review. International Marketing Review. 13, 7-43. https://doi.org/10.1108/02651339610131379

Montejo, B.J., & Fernandez, G.A. (2021). Chemical Battleship: Discovering and Learning the Periodic Table Playing a Didactic and Strategic Board Game. Journal of Chemical Education, 98(3), 907- 914. https://doi.org/10.1021/acs.jchemed.0c00553

Pascual, E. A. (2021). The Gen-Math machines: Way to increase academic performance of senior high school learners. *International Journal of Research Publications.* https://doi.org/10.47119/ijrp1008911120212428

Piaget, J. (1962). Play, Dreams, and Imitation in Childhood. New York, NY: Norton Republic Act No. 10533. Enhnaced Basic Education Act.

Taylor, T.L., (2014). Teaching and Learning with Games. The International Encyclopedia of Digital Communication and Society, 1-7.

Zirawaga, V.S., Olusanya, A.I., & Maduku, T. (2017). Gaming in Education: Using Games as a Support Tool to Teach History. Journal of Education and Practice. 8(15), 55-64