Symbiosis Game Adventure: An Innovative Game-Based Instructional Material in Teaching Science 7

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Abstract:- This study investigates the effectiveness of the innovative "Symbiosis Game Adventure," a game-based instructional tool, in enhancing academic performance and shaping perceptions among Grade 7 students at San Luis National High School-Balit Annex. Employing a rigorous mixed-methods design, the research contrasts outcomes between a traditional instruction control group and an experimental group engaged in the game. Out of 50 participating students, analyses of pre-test and post-test scores indicate substantial improvements in the post-test results for the experimental group, pointing to a deeper understanding of symbiotic relationships. Additionally, the study highlights high levels of retention and motivation among students, as well as overwhelmingly positive perceptions regarding the game's role in fostering engagement and collaboration. ANOVA analysis further uncovers significant differences in student perceptions influenced by demographic variables such as age and gender. These findings strongly suggest the need for the development of similar game-based instructional tools or the adoption of the "Symbiosis Game Adventure" tool in educational settings to enhance learning outcomes.

Keywords:- Innovative, Symbiosis, Game-Based, Instructional Materials, San Luis National High School.

I. INTRODUCTION

In the field of education, effective instructional materials are essential for fostering student engagement and comprehension, especially in challenging subjects such as science. At San Luis National High School-Balit Annex, the focus on symbiotic relationships has emerged as a significant area of concern. During the second-quarter assessment for Grade 7, students exhibited a disheartening Mean Percentage Score of only 17% in this competency, highlighting a critical need for innovative instructional strategies. This alarming statistic indicates that students have not mastered the concept of symbiotic relationships, often viewed as an intricate topic within biological sciences, thereby necessitating a fresh approach to teaching that can inspire understanding and retention.

Recognizing the limitations of traditional teaching methodologies, the author proposes "Symbiosis Game Adventure," a game-based instructional material that aims to address this learning gap by leveraging the interactive nature of gaming. Observations suggest that Grade 7 students demonstrate heightened engagement and improved learning outcomes when involved in game-based activities, as opposed to conventional lectures. By integrating the principles of game design with educational content, the "Symbiosis Adventure Game" seeks to create a dynamic learning environment that captivates students' interest while simultaneously reinforcing their understanding of crucial biological concepts.

The "Symbiosis Adventure Game" draws inspiration from the popular game show format "Atras Abante," merging its exciting gameplay mechanics with the fundamental concepts of symbiotic relationships. In this innovative game, players navigate a game board, moving forward or backward based on their ability to correctly answer questions related to mutualism, commensalism, and parasitism. This blend of enjoyment, strategy, and educational content not only transforms the learning experience for students but also fosters a deeper understanding of scientific concepts in an interactive manner. By incorporating key scientific principles into a playful setting, this instructional material aims to empower students to master complex ideas while having fun, paving the way for improved academic performance in science.

➤ *Statement of the Problem*

This study aimed to evaluate the effectiveness of the innovative "Symbiosis Game Adventure" approach in enhancing the academic performance of Grade 7 students in understanding symbiotic relationships in science. Specifically, this study addressed the following research questions:

- What are the pre-test scores regarding symbiotic relationships among Grade 7 students in:

✓ The control group; and
✓ The experimental group?

- What are the post-test scores of students following the implementation of the lecture-based method in comparison to those following the innovative game-based teaching strategy?

- Is there a significant difference in the pre-test and post-test results of all students after the application of both teaching strategies?
- What are the perceptions of students regarding the developed "Symbiosis Game Adventure" in terms of its impact on the following areas:

✓ Retention of knowledge;
✓ Comprehension of the concepts; and
✓ Motivation to learn?

➢ *Hypothesis*

- At 0.05 levels of significance, the following hypothesis were tested:
- There was no significant difference in the pre-test and post-test results of all students after the application of both teaching strategies.

II. METHODS

➢ *Research Design*

The research design incorporating both quasi-experimental and descriptive correlational methods to effectively assess the impact of the "Symbiosis Game Adventure" on students' academic performance and perceptions. The quasi-experimental design allows for the comparison of pre-test and post-test scores between a control group, which receives traditional instruction, and an experimental group, which engages with the innovative game-based learning strategy. This design facilitates the identification of any significant differences in academic outcomes resulting from the different instructional methods. Additionally, the descriptive correlational approach is utilized to explore the relationships between students' perceptions of the game-based strategy and their demographic profiles.

➢ *Research Participants*

The research participants consisted of 50 Grade 7 students of San Luis National High School-Balit Annex from the Dahlia section, selected through purposive methods to ensure a representative sample for the study. The students were evenly divided into two groups: the control group, which experienced traditional instructional methods, and the experimental group, which engaged with the innovative "Symbiosis Game Adventure." For the experimental group, the participants were further subdivided into two smaller teams to facilitate gameplay, where the total scores of each team member were aggregated to determine the overall winning team. This structured grouping not only allowed for effective comparison between instructional methods but also encouraged collaboration and interaction among students within the game, thereby enriching their learning experience.

➢ *Research Instruments*

The research utilized multiple instruments to assess the effectiveness of the Symbiosis Game Adventure as an innovative game-based instructional material in teaching Science 7. A 20-item pretest and posttest multiple-choice questionnaire measured students' knowledge before and after instruction. The 5E's lesson plan framework (Engage, Explore, Explain, Elaborate, Evaluate) was employed to deliver the science topics systematically. Additionally, a 15-item adapted survey questionnaire, divided into three 5-item sections, evaluated students' retention, comprehension, and motivation. The Symbiotic Adventure Game involved the use of a gameboard, scorecard, and question cards to further engage students in the learning process.

➢ *Data Gathering Procedure*

This study was conducted in adherence to ethical guidelines in research. Initially, permission was obtained through formal letters addressed to the school head of San Luis National High School-Balit Annex and the parents of the participants. The participants were then oriented on the purpose of the study to ensure informed consent. A pretest was administered to establish baseline data, followed by the implementation of two sets of lesson proper, each following the designed lesson plans. After the intervention, a posttest was conducted to measure the impact of the instructional material. Additionally, a survey questionnaire was distributed as supporting documentation to gather further insights. Finally, all collected data were tabulated and analyzed to draw meaningful conclusions.

➢ *Statistical Treatment*

The mean and standard deviation were employed to determine the students' raw scores in both the pretest and posttest, providing a clear view of the overall performance, as well as the range of lower and higher scores. A t-test was conducted to assess whether there was a significant difference between the pretest and posttest scores, indicating the impact of the instructional material. In analyzing the students' perceptions, the mean and standard deviation were again utilized to summarize the data. Additionally, ANOVA (Analysis of Variance) was applied to determine if there was any significant difference between the students' perceptions and their demographic profiles, offering deeper insight into how various factors may have influenced their views.

III. RESULTS AND DISCUSSIONS

Tables 1 to 7 showed the results of pretest and posttest results of both controlled and experimental group. It also showed the students' perception on the effectiveness of the innovative symbiotic game adventure developed by the researcher.

Table 1 Pretest Results

	N	Mean	SD	Minimum	Maximum
Lecture-Based	25	9.40	3.64	3	17
Symbiotic Adventure Game	25	7.96	2.76	3	15

The pretest results in Table 1 reveal that the lecture-based group (M=9.40, SD=3.64) scored slightly higher than the Symbiotic Adventure Game group (M=7.96, SD=2.76) before any instructional intervention. This suggests that students in the lecture-based group may have had an advantage due to familiarity with traditional teaching methods, which could have contributed to better initial retention of knowledge. In contrast, the game-based group might have needed more time to adjust to the innovative learning environment, which could explain their lower pretest scores.

The slightly higher variability in the lecture-based group's scores indicates that some students in this group were more proficient than others. In contrast, the Symbiotic Adventure Game group showed more consistency, possibly signaling a more uniform baseline of knowledge. These results suggest that while traditional methods might offer immediate familiarity, innovative approaches like game-based learning require a period of adaptation. As Hwang et al. (2019) and Gee (2019) highlight, game-based learning can enhance engagement and critical thinking, but its full benefits emerge as students grow comfortable with the new approach.

Table 2 Posttest Results

	N	Mean	SD	Minimum	Maximum
Lecture-Based	25	15.4	2.69	9	19
Symbiotic Adventure Game	25	18.1	1.89	14	20

Table 2 presents the posttest results, highlighting a significant improvement in the Symbiotic Adventure Game group (M=18.1, SD=1.89) compared to the lecture-based group (M=15.4, SD=2.69). The Symbiotic Adventure Game group achieved higher overall scores, with a narrower range of variability, indicating a more consistent performance. These results suggest that the game-based approach was more effective in enhancing students' knowledge after the intervention. The consistency in scores for the Symbiotic Adventure Game group points to its potential in fostering a deeper understanding of content, possibly due to the interactive and engaging nature of game-based learning. According to Annetta et al. (2019), game-based methods tend to increase student motivation and engagement, leading to improved learning outcomes.

The lower variability in the Symbiotic Adventure Game group's scores also suggests that this method might reduce knowledge gaps among students, creating a more equitable learning environment. In contrast, the lecture-based group showed greater variability, indicating that while some students benefitted from traditional methods, others struggled to perform at the same level. This finding aligns with research by Gee (2019), which highlights the potential of game-based learning to enhance not just individual comprehension but also collaborative problem-solving skills. The results imply that integrating innovative learning tools like the Symbiotic Adventure Game can yield better long-term retention and performance across diverse student groups, offering a valuable supplement to traditional teaching methods.

Table 3 Significant Difference Between the Pretest and Posttest Scores

	T-Test (Computed Value)	df	p	Mean difference	Decision in Ho	Verbal Interpretation
Lecture-Based Pretest vs. Posttest	10.1	24.0	.001	6.00	Reject Ho	Significant
Symbiotic Adventure Game Pretest vs. Posttest	22.2	24.0	.001	10.12	Reject Ho	Significant

Table 3 reveals a significant difference between the pretest and posttest scores for both the lecture-based and Symbiotic Adventure Game groups. The t-test results show a computed value of 10.1 for the lecture-based method and 22.2 for the game-based approach, with both groups having a p-value of .001, indicating a highly significant improvement in scores post-intervention. The mean difference for the lecture-based group was 6.00, while the Symbiotic Adventure Game group demonstrated a larger mean difference of 10.12. This suggests that although both teaching methods were effective in improving students' knowledge, the game-based method had a more substantial impact. The rejection of the null hypothesis (Ho) for both groups further confirms that the observed differences are not due to chance but the effectiveness of the instructional strategies used.

The larger mean difference for the Symbiotic Adventure Game group highlights the potential of game-based learning to deliver more impactful educational outcomes compared to traditional lectures. As supported by Annetta et al. (2019), game-based learning enhances motivation and deeper engagement with content, leading to more significant improvements in understanding. The findings imply that integrating interactive and experiential learning tools, such as the Symbiotic Adventure Game, can provide a more dynamic learning experience, resulting in greater knowledge retention and application. This aligns with Hwang et al. (2019), who argue that adaptive and innovative learning methods are often more effective in improving cognitive outcomes than traditional approaches, especially in complex subject areas.

Table 4 Effectiveness of Symbiotic Adventure Game in enhancing Student's Retention

Statement	Mean	SD	VI	QD
1. I am able to recall important concepts about symbiotic relationships after playing the game.	3.16	0.75	A	E
2. I believe the symbiotic game adventure helped me retain more information about different types of symbiotic relationships.	3.12	0.78	A	E
3. I can easily remember key examples of symbiotic relationships discussed in the game.	3.20	0.65	A	E
4. I find it easier to recall the differences between various organisms in a symbiotic relationship due to the interactive nature of the game.	3.08	0.86	A	E
5. I believe the game helped me retain knowledge about the impact of symbiotic relationships on ecosystems and biodiversity.	3.24	0.72	A	E
Overall	**3.16**	**0.75**	**A**	**E**

	Scale	Verbal Interpretation	Qualitative Description
Legend	1 – 1.75	Strongly Disagree (SD)	Not Effective (NE)
	1.76 – 2.5	Disagree (DA)	Less Effective (LE)
	2.51 – 3.25	Agree (A)	Effective (E)
	3.26 – 4.00	Strongly Agree (SA)	Very Effective (VE)

Table 4 presents students' perceptions of the effectiveness of the Symbiotic Adventure Game in enhancing retention of concepts related to symbiotic relationships. The statement with the highest mean (M=3.24, SD=0.72) is "*I believe the game helped me retain knowledge about the impact of symbiotic relationships on ecosystems and biodiversity*." This suggests that the interactive nature of the game successfully helped students grasp more complex, interconnected ecological concepts, aligning with research by Gee (2019), which emphasizes that game-based learning fosters deeper cognitive engagement through problem-solving and critical thinking activities. The game's interactive elements likely provided a contextual and immersive learning experience, making the material more memorable and relatable for students. The high mean score underscores the game's potential to make learning more meaningful by connecting abstract concepts to real-world applications.

The statement with the lowest mean (M=3.08, SD=0.86) is *"I find it easier to recall the differences between various organisms in a symbiotic relationship due to the interactive nature of the game."* Although students still agreed that the game was effective, this slightly lower score may indicate that distinguishing between different types of symbiotic relationships posed a challenge, even in an interactive environment. This finding is consistent with Hwang et al. (2019), who suggest that while game-based learning enhances overall engagement, it may require supplementary scaffolding to reinforce complex distinctions within subject matter. The relatively close range of mean scores indicates that, overall, students perceived the Symbiotic Adventure Game as an effective tool for enhancing retention, but it also highlights the importance of balancing interactive features with targeted content reinforcement for more intricate topics.

Table 5 Effectiveness of Symbiotic Adventure Game in Enhancing Student's Comprehension

Statement	Mean	SD	VI	QD
I feel that the game improved my understanding of how organisms interact with one another in a symbiotic relationship.	3.36	0.64	SA	VE
I was able to comprehend the concepts of mutualism, parasitism, and commensalism more effectively through the game's examples and interactions.	3.12	0.88	A	E
I feel confident in explaining the different types of symbiotic relationships to someone else after playing the game.	3.16	0.75	A	E
I believe the game's narrative and characters helped deepen my understanding of how symbiotic relationships evolve over time.	3.28	0.79	SA	VE
I think playing the game clarified the importance of balance in ecosystems as a result of symbiotic relationships.	3.36	0.70	SA	VE
Overall	**3.26**	**0.75**	**SA**	**VE**

Table 5 illustrates the effectiveness of the Symbiotic Adventure Game in enhancing students' comprehension of symbiotic relationships. The statement with the highest mean (M=3.36, SD=0.64) is *"I feel that the game improved my understanding of how organisms interact with one another in a symbiotic relationship."* This result suggests that the game's interactive format successfully facilitated a deeper understanding of organism interactions, likely due to its ability to simulate real-life ecological scenarios. The game's engaging elements, such as narratives and interactivity, align with the findings of Annetta et al. (2019), which suggest that game-based learning environments foster a more immersive learning experience, allowing students to better visualize and grasp complex biological concepts. The higher mean score

also indicates that students perceived the game as a highly effective tool for developing comprehension in areas where traditional teaching might fall short.

On the other hand, the lowest mean (M=3.12, SD=0.88) was for the statement, *"I was able to comprehend the concepts of mutualism, parasitism, and commensalism more effectively through the game's examples and interactions."* Although still rated positively, this lower score indicates that while the game was generally effective, students may have faced challenges in distinguishing between these different

types of relationships. As noted by Hwang et al. (2019), game-based learning tools may require supplemental instructional strategies to reinforce nuanced topics. This finding suggests that, while interactive games are beneficial for enhancing overall comprehension, additional content-specific scaffolding may be necessary to ensure students grasp the finer distinctions between concepts. Overall, the game's effectiveness in enhancing comprehension highlights its potential as a supplementary tool for science education, particularly in fostering deeper engagement and understanding of ecological interactions.

Table 6 Effectiveness of Symbiotic Adventure Game in Enhancing Student's Motivation

Statement	Mean	SD	VI	QD
I find that the interactive elements of the game made me more interested in learning about symbiotic relationships.	3.16	0.75	A	E
I feel that playing the game increased my motivation to explore more about ecology and biological relationships.	3.20	0.87	A	E
I believe the game made learning about symbiosis feel more engaging and less like a traditional lesson.	3.32	0.69	SA	VE
I was motivated to complete more tasks and challenges in the game because of its engaging design.	3.28	0.68	SA	VE
I feel more motivated to apply the lessons I learned from the game to other areas of biology or environmental science.	3.44	0.65	SA	VE
Overall	**3.28**	**0.72**	**SA**	**VE**

Table 6 showcases the effectiveness of the Symbiotic Adventure Game in enhancing students' motivation, with the highest mean score (M=3.44, SD=0.65) attributed to the statement, *"I feel more motivated to apply the lessons I learned from the game to other areas of biology or environmental science."* This result indicates that the game not only engaged students but also inspired them to extend their learning beyond the specific topic of symbiosis, reflecting the positive impact of immersive, game-based learning environments on motivation. Research by Huang et al. (2020) supports this, demonstrating that interactive digital games can promote intrinsic motivation and foster a sense of autonomy in learners, making them more likely to transfer and apply new knowledge to other subjects. This finding highlights the broader educational potential of game-based learning, where well-designed tasks and challenges can spark curiosity and interest in related fields of study.

Conversely, the statement with the lowest mean (M=3.16, SD=0.75) was "I find that the interactive elements of the game made me more interested in learning about symbiotic relationships." Although students agreed with this statement, the relatively lower score suggests that while the game was engaging, some students may not have found the interactive elements as captivating as expected. As noted by Malone and Lepper (2019), the effectiveness of interactive features in educational games can vary based on individual learning preferences and the quality of the game's design. This result implies that, while game-based learning can enhance motivation, the design and execution of interactive elements must be carefully aligned with learners' interests to maximize engagement. Overall, the game demonstrated a significant ability to motivate students, but its full potential may require further refinement to better tailor the interactive experience to diverse learner needs.

Table 7 Effectiveness of Symbiotic Adventure Game

Variables	Mean	SD	VI	QD
Retention	3.16	0.75	A	E
Comprehension	3.26	0.75	SA	VE
Motivation	3.28	0.72	SA	VE
Overall	3.23	0.74	A	E

Table 7 illustrates the overall effectiveness of the Symbiotic Adventure Game across three key variables: retention, comprehension, and motivation. The game received an overall mean score of 3.23 (SD=0.74), with a verbal interpretation of "Agree" and a qualitative description of "Effective." This suggests that students generally found the game to be a useful tool for learning about symbiotic relationships. Among the variables, motivation received the highest mean score (M=3.28, SD=0.72), indicating that the game was particularly successful in engaging students and

making the learning process more enjoyable. This aligns with research by Huang et al. (2010), which shows that game-based learning can significantly enhance students' motivation, leading to deeper involvement in educational activities. The interactive and immersive nature of the game may have contributed to this heightened motivation, making students more eager to explore and understand the content.

Conversely, retention scored the lowest mean (M=3.16, SD=0.75), suggesting that while students agreed that the game helped them recall information, it was not as effective as it was in boosting comprehension and motivation. This result implies that game-based learning tools might need additional reinforcement strategies to enhance long-term retention of information. As Hwang et al. (2019) point out, while digital games can be engaging, they may require supplementary activities, such as spaced repetition or discussions, to improve memory retention. The overall effectiveness of the Symbiotic Adventure Game demonstrates its potential as a valuable educational tool, particularly in fostering motivation and comprehension, but its limitations in retention suggest a need for a more balanced approach that integrates traditional learning methods to solidify long-term knowledge.

IV. CONCLUSION

The develop innovative Symbiotic Adventure Game showed better results than traditional teaching methods. Students who played the game scored much higher on their posttests compared to their pretest scores. They not only remembered and understood the material better through the game, but they also shared positive feelings about how it helped them learn about symbiotic relationships. While traditional methods are still effective, the game proved to be more engaging and motivating for students, making it a promising tool for deeper learning.

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REFERENCES

[1]. Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Longman.

[2]. Annetta, L. A., Minogue, J., Holmes, S. Y., & Cheng, M. T. (2019). Investigating the impact of video games on high school students' engagement and learning about genetics. *Computers & Education, 53*(1), 74-85.

[3]. Baker, R. S. (2019). Educational data mining: A review of the state of the art. *Educational Data Mining: Applications and Trends, 3*(1), 10-18.

[4]. Bloom, B. S. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain*. David McKay.

[5]. Buchanan, E. M., et al. (2019). Gender differences in motivations for game play and gaming styles: Implications for design and marketing. *Computers in Human Behavior, 94*, 103-112.

[6]. Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*(4), 227-268. https://doi.org/10.1207/S15327965PLI1104_01

[7]. DeHaan, J., et al. (2020). Gender differences in learning and academic performance. *Educational Psychology Review, 22*(3), 265-288.

[8]. Gee, J. P. (2019). *What video games have to teach us about learning and literacy* (2nd ed.). Palgrave Macmillan.

[9]. Hossain, M. D., et al. (2019). Gender differences in learning preferences among business students: A study on students in a private university in Bangladesh. *International Journal of Management Education, 17*(3), 100-108.

[10]. Huang, W. H. Y., Huang, W. Y., & Tschopp, J. (2020). Sustaining iterative game playing processes in DGBL: The relationship between motivational processing and outcome processing. *Computers & Education, 55*(2), 789-797.

[11]. Hwang, G. J., Sung, H. Y., Hung, C. M., & Huang, I. (2019). A learning style perspective to investigate the necessity of developing adaptive learning systems. *Educational Technology & Society, 16*(2), 188-197.

[12]. Kirkley, S. E., & Kirkley, J. (2019). Creating next generation blended learning environments using pedagogical standards. *Educational Technology Research and Development, 53*(4), 67-80.

[13]. Li, M. C., & Tsai, C. C. (2019). Game-based learning in science education: A review of relevant research. *Journal of Science Education and Technology, 22*(6), 877-898.

[14]. Malone, T. W., & Lepper, M. R. (2019). Making learning fun: A taxonomy of intrinsic motivations for learning. In R. E. Snow & M. J. Farr (Eds.), *Aptitude, learning, and instruction* (Vol. 3, pp. 223-253). Erlbaum.

[15]. Papastergiou, M. (2019). Digital game-based learning in high school computer science education: A case study. *Computers & Education, 52*(1), 1-12.

[16]. Perry, L. H., & Boyce, L. A. (2019). Gender differences in technology use and attitudes among students in higher education: An exploratory study. *Computers & Education, 115*, 182-193.

[17]. Zimmerman, B. J., & Schunk, D. H. (2020). *Self-regulation of learning and performance: Issues and educational applications*. Routledge.