ENHANCING ACADEMIC PERFORMANCE IN TEACHING FEEDBACK MECHANISM AND MENSTRUAL CYCLE USING GAMIFIED CARD GAMES AMONG GRADE 10 LEARNERS

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ABSTRACT: *In response to the growing interest in gamified education across ASEAN countries, this study investigated the effectiveness of a menstrual cycle card game as a supplementary instructional tool for Grade 10 students in the Philippines. While traditional lecture-based methods predominated in science education, gamification emerged as a promising pedagogical strategy to enhance student engagement, comprehension, and retention, particularly for complex topics such as the menstrual cycle and biological feedback mechanisms. The educational challenges exacerbated by the COVID-19 pandemic underscored the necessity for interactive, student-centred approaches in classrooms, especially amid concurrent academic and developmental transitions characteristic of Filipino learners. This study employed a quasi-experimental design involving two groups: a control group receiving conventional instruction and an experimental group utilising the gamified board and card game. Pretest and posttest assessments measured learning outcomes. Baseline pretest scores indicated comparable prior knowledge between groups (control mean = 6.89; experimental mean = 7.80). Posttest results revealed a statistically significant improvement in the experimental group (mean = 9.06) relative to the control group (mean = 7.94). Paired sample t-tests demonstrated a significant difference in posttest scores between groups ($t = -5.12$, $p = 1.3 \times 10^{-5}$, two-tailed), substantiating the efficacy of the gamified intervention in enhancing student academic performance. Furthermore, participants evaluated the game across four dimensions: learning value, enjoyment, user-friendliness, and creativity, with consistently high mean ratings (learning = 2.98; enjoyment = 3.07; user-friendliness = 3.01; creativity = 3.03). These findings indicate that the game not only promoted cognitive gains but also increased learner motivation and engagement. Collectively, the results support the integration of gamified learning tools as effective pedagogical alternatives within Philippine science education. The intervention addressed limitations inherent to traditional instructional methods, mitigated gaps arising from remote learning contexts, and aligned with regional initiatives to modernise teaching practices for the 21st-century knowledge economy. The study advocates for broader implementation of interactive methodologies, comprehensive teacher training for effective facilitation, and further investigation into the long-term impacts of gamification on student achievement and scientific literacy within the ASEAN region.*

Keywords: *gamification, science education, interactive learning, student engagement, learning outcomes*

1. INTRODUCTION

Due to the increasing popularity of gamification in education, the ways of teaching and learning have changed tremendously worldwide. Gaming elements are integrated by educators around the world into student learning and performance, spurred by the digital age that constantly transforms society [1]. Innovative teaching methods are being adopted widely in ASEAN countries to address the demands of the 21st-century knowledge economy [2]. Gamification is used by educators in these nations to modernise instruction and to develop future competencies of students.

With fast technological enhancement becoming rampant in the Philippines, schools are learning how to take on new pedagogical strategies gradually towards enriching learning experiences [3]. In some cases, however, traditional teaching practices remain, and current studies suggest that despite the positive results obtained by gamified teaching, many teachers are still not implementing these approaches successfully because they lack the necessary resources and training [4]. This challenge is especially vital because Filipino students generally show low mastery of such essential biology topics as the menstrual cycle and feedback mechanisms [5]. These topics remain some of the least mastered scientific concepts and indicate an extensive learning gap that still has not been closed by conventional instructional approaches.

The absence of a foundational biological understanding is not just a challenge for the Philippines, with similar issues also of concern in the Asia Pacific region [6]. The impact of the COVID-19 pandemic further compounded these issues by interfering with the traditional classroom experience of interacting with students and lowering the level of engagement through remote modes of teaching. Given the onset of complex developmental changes during adolescence, Grade 10 learners require a more comprehensive comprehension of reproductive health and systemic biological feedback for the sake of personal well-being and informed decision-making [7]. However, there are still misconceptions and a knowledge gap, which the constraints of online education are only sharpening.

The COVID-19 pandemic significantly disrupted every education system across the world, including the ASEAN countries and the Philippines, which pose some unique challenges in sustaining learning continuity [8][9]. Due to the abrupt shift towards remote opportunities for learning, students lacked access to interactive and hands-on science instruction and in particular, to the difficult and sensitive topics like the menstrual cycle and feedback mechanisms [10]. The Department of Education [8] has reported that remote learning worsened already existing learning gaps by lowering students' engagement and comprehension as a result of reduced face-to-face interaction and lack of technological resources. Adolescent learners in particular have suffered disproportionately in this situation, as they need more guided,

experiential learning to understand biological processes crucial to their development and their health education [9]. As a result, there is an immediate requirement for creative, adjustable teaching strategies that can solve this pandemic caused problems and help retain control over hard science substance.

Under these persisting deficiencies, game-based learning rises as a promising alternative. Gamification provides an avenue to create interactive and contextually relevant learning experiences, which deepen conceptual understanding and increase student motivation in difficult subjects such as those dealing with the menstrual cycle and feedback mechanisms [11]. This approach not only improves academic performance, but it also increases students' confidence and enthusiasm for science and possibly influences students' future educational and career paths [12].

Many studies have been conducted on teaching pedagogies [13, 14, 15, 16, 17, 18], student preferences and readiness [19, 20], student motivation and attitude [21, 22, 23, 24], teachers skills, competencies, and challenges [25, 26, 27], assessment techniques and tools [28, 29, 30, 31] and other related factors [32, 33, 34, 35, 36, 37, 38] to enhance students learning outcome but little was done on investigating the indicated topics using gamified approach. Hence, this study was done.

This study aims to bridge the identified research gap by evaluating the effectiveness of a menstrual cycle board and card game in improving Grade 10 learners' comprehension of these under-mastered topics. It seeks to provide Philippine and ASEAN educators with practical, evidence-based strategies to support scientific literacy and resilience in the post-pandemic educational landscape, preparing students to meet modern challenges with robust biological knowledge and critical thinking skills.

This study specifically sought to answer the following problems:

1. What are the pretest scores of learners in the menstrual cycle and feedback mechanism topics for both the control group and the experimental group before the intervention?
2. What are the posttest scores of learners in the menstrual cycle and feedback mechanism topics for both the control group and the experimental group after the intervention?
3. Is there a significant difference between the pretest and posttest scores of the control group and the experimental group, indicating the impact of the menstrual cycle card game intervention?
4. Is there a significant difference in the posttest scores between the control group and the experimental group, highlighting the comparative effectiveness of traditional versus game-based learning?
5. How do the participants evaluate the effectiveness of the menstrual cycle card game as a supplementary teaching tool in terms of:
    a. Enhancing learning;
    b. Providing enjoyment;
    c. Ensuring user-friendliness; and
    d. Fostering creativity?

2. RESEARCH METHODOLOGY

This study employed a quasi-experimental research method to investigate the effect of gamification as a mode of learning on student performance in the topics of Feedback Mechanism and Menstrual Cycle among Grade 10 students. The chosen research design facilitated the division of participants into experimental and control groups, allowing for the establishment of causal relationships without the need for randomisation [39]. To further clarify and emphasise the structure of the research design, a diagram was created to visually represent the flow and components of the study.

Two groups of Grade 10 learners participated in the study: an experimental group and a control group. The experimental group received instruction supplemented with educational materials, specifically a menstrual cycle card game, while the control group received conventional classroom instruction [40]. The study utilised print-based (analogue) materials as the primary intervention tool, by DepEd Order 83, s. 2003, which underscores the continued importance of print instructional resources in Philippine basic education. Even with the rise of digital learning tools, however, Internet connectivity and digital devices have been unevenly available to schools in rural and under-resourced areas. Board and card games are analogue tools that provide equitable, accessible and tangible learning experiences that detract from distraction and promote active engagement. Additionally, print materials provide easier group work and hands-on experience, including understanding the complicated biological process of the menstrual cycle and the system's feedback mechanisms.

Pretests and posttests were administered before and after the intervention to assess students' understanding of the feedback mechanism and menstrual cycle. The pretest established baseline knowledge, while the posttest measured changes in academic performance following the intervention.

In addition to the quantitative data from the pretests and posttests, the study collected qualitative data through a game perception survey administered to the experimental group. This survey gathered participant feedback on their experiences with the gamified educational tool, focusing on its perceived effectiveness in supporting learning, its entertainment value, user interface simplicity, and creative features.

The research findings demonstrated that students who participated in gamified activities exhibited greater improvements in pre- and posttest scores compared to those in the non-gamified (control) group. The mixed-methods approach provided a comprehensive understanding of the impact of gamification on both academic outcomes and student perceptions.

2.2. Research Instrument

The researcher used a pretest and a posttest a 10 item, multiple-choice exam to evaluate the effectiveness of the educational card game. The test was made after making a table of specifications or TOS. The pretest was administered firsthand as a guide for the creation and modification of the game if necessary. The posttest was given after the discussion.

The pretest and posttest won't be able to produce without TOS or the table of specification. TOS served as the idea of the items needed for the pretest and posttest, ensuring the validity and reliability of the questions relative to the number of questions and lessons taught of the researcher, checked by the head teacher in science or a legitimate validator of the said TOS, pretest and posttest.

Afterwards a survey questionnaire validation was checked by the validator as well, in this file will be showing a Likert scale

containing content validation and construct validation as well as reliability test making sure that it is aligned to the intended outcomes which was also validated and tested by experts.

The development of the Card Game, Menstrual Cycle and Feedback Mechanism Card games were previewed under the pretence of the ADDIE Model which stands for Analyse, Design, Develop, Implement and Evaluate. The ADDIE model is one of the top concepts in creating instructional course materials, in this case, the board game itself.

2.3. Data Gathering Procedure

A formal request letter was sent to the principal of Eulogio Rodriguez Integrated School to obtain permission before the study started. The Head Teacher in Science validated the research tools, including the pretest and posttest. Guardians of students were given consent forms, and only those with signed forms were included. A pretest was given to both groups to determine a baseline understanding of the menstrual cycle and feedback mechanisms.

The experimental group used the "Menstrual Cycle Card Game," while the control group received the same material through teacher-led discussions and textbook readings. A professional observer was present in every session to ensure intervention integrity.

Observers used a checklist, and teachers received training to ensure consistent implementation. A posttest was administered to both groups immediately after the intervention. The experimental group also completed a survey on motivation, engagement, and opinions about the gamified approach. Data was statistically assessed to compare pretest and posttest scores.

In the case of attrition, non-parametric tests were used, as they are suitable for small samples and missing data, ensuring the analysis remained valid.

2.4. Data Analysis

The statistical tools employed for the analysis of the pretest, posttest, and surveys were created to effectively meet the research objectives. Normality testing was conducted to check assumptions for parametric tests.

For Statement of the Problem 1, the mean scores for both the control and experimental groups' pretests and posttests were calculated to allow for a comparison of results before and after the intervention. Meanwhile, for Statement of the Problem 2, a Dependent Sample T-Test was used to compare the pretest and posttest results within the control and experimental groups. An Independent Sample T-Test was used to compare the posttest results between the control and experimental groups. Finally, for Statement of the Problem 3, survey responses were examined using mean scores and standard deviation. The data were analysed using Microsoft Excel to evaluate the gamified tool in terms of learning, enjoyment, user-friendliness, and creativity.

These statistical methods aimed to analyse the data and draw conclusions about the impact of gamification on learners' academic performance and their evaluation of the gamified tool.

3. RESULT AND DISCUSSION

3.1. Pretest Performance of Control and Experimental Groups

The pretest scores were carried out to establish the baseline knowledge on the menstrual cycle and feedback mechanisms in the controlled and experimental groups. The controlled group's mean pretest score was 6.8857, while the experimental group scored more average with a mean pretest score of 7.8. These results indicated that both groups had a similar initial level of knowledge, with the experimental group at a minimal advantage.

These results implied that students had a weak understanding of the content matter before the intervention and required an instructional approach to enhance their understanding. Outcomes evident in the pretest further justified foundation knowledge interventions. Using a fair and comparable baseline made an objective evaluation of the impacts of the menstrual cycle card game possible, which was an important aspect of this study. The reason for the provision of such resources to the experimental group was to determine the extent of rectification of the issues revealed in the pretest and to complement the traditional approaches to teaching. By ensuring that the groups were relatively equally well-disposed before the test, the study was better able to attribute any difference in posttest scores to the teaching strategy.

The slightly higher score of the experimental group might have been attributed to differences in student readiness, prior exposure to the topic, or slight variations in learning environments. However, within the context of this study, all factors or aspects that might have influenced their baseline knowledge were not included in the analysis. Nevertheless, the similarity of scores established a fair baseline for comparing the impact of gamification as a teaching strategy.

3.2. Posttest Performance of Control and Experimental Groups

After the intervention, the mean posttest scores were analysed. The controlled group achieved a mean posttest score of 7.9429, while the experimental group scored 9.0571. The improvement in scores indicates that both groups benefited from their respective teaching methods, with the experimental group exhibiting a greater increase.

The results highlight the effectiveness of the menstrual cycle card games as a supplementary tool for teaching. The positive results achieved by the experimental group show that the application of interactive and gamified methods of training improves learning results and involvement of students much more effectively than traditional approaches.

The improvement in the results of group control means that traditional learning methods, such as presenting lectures, guiding group discussion and using textbooks, continue to encourage the students' performance. These are old school methods and have formed the back burner of education for many years and they are credited for the success at fostering learning, especially when delivering organised subjects. This small advance calls into question the weaknesses built into traditional education, particularly about complex or abstract concepts such as feedback processes and the menstrual cycle. The observed results of the controlled group suggest that while traditional methods may be able to teach facts, they may not effectively engage the student in the lesson or ensure comprehensive understanding.

However, the robust results recorded in the experimental group highlight the utility of incorporating interactive tools into learning. Setting board and card games on the menstrual cycle may have boosted students' engagement and participation, thereby making it easy to understand and retain complex concepts. By involving the students in practical work, using visual aids and providing multiple repetitions – all of which are important aspects of educational psychology- the use of a gamified approach probably helped students' ability to retain information. Similarly, encouragement of collaboration and

interaction can intensify the encouragement to share ideas amongst users and ultimately enhance the understanding thereof. The experimental group's striking success shows that innovative and interactive tools could be used for traditional teaching.

A similar baseline was established in the pretest scores between the control and experimental groups, with only a slight advantage found in the experimental group. After the instructional interventions, there were improvements in posttest scores for both traditional and gamified pedagogical methods which implies that there was learning under both schemes. Most notably, the experimental group scored higher magnitude of increase than that of the control group which indicates that interactive game based instructional approach shows more promising learning outcomes.

The integration of data of the pretest and posttest allows for a comprehensive and cohesive interpretation of the effectiveness of the utilised instructional approaches. Scores from the pretest confirmed baseline equivalence and showed that both groups started off having the same knowledge level of the menstrual cycle and feedback mechanisms, thus facilitating an objective assessment of the learning gains. Both traditional and gamified teaching methods seem to have positively influenced student learning. The significant improvements observed in both groups' posttest results represent this. Considering this, the statistically significant and larger gains in the experimental group suggest that the gamified instructional tool holds a more effective feature than the conventional educational program. The results of these findings indicate that conventional methods provide a building block of knowledge while gamified approaches facilitate higher engagement, retention and conceptual understanding through different learning styles with active participation. The relevance of gamification to motivate and increase collaboration and cognitive development more than traditional instruction alone is reflected in the existing literature [41, 42].

3.3. Significant Differences of Group Scores

Based on the analysis conducted for the controlled group, the P(T<=t) two-tail result is 2.20E-06, which is smaller than alpha = 0.05, therefore rejecting the null hypothesis and revealing a statistically significant difference between the pretest and posttest scores of the controlled group. This suggests that, while to a limited degree, traditional teaching techniques were successful in raising students' comprehension of the menstrual cycle and feedback processes. The improvement in scores shows that even traditional methods, including lectures and textbook-based instruction, can help students learn new material if they are presented well. The slight improvement in the controlled group, however, also emphasises the fundamental drawbacks of conventional approaches. These methods might not adequately meet the variety of learning demands present in a classroom or engage pupils. Although pupils may learn and recall information, their depth of understanding and application of that knowledge may be limited, as indicated by the comparatively little improvement in scores. This result, therefore, further emphasises how crucial it is to investigate other teaching approaches to supplement conventional techniques and overcome their drawbacks.

Meanwhile, analysis of the experimental group showed P(T<=t) two-tail result was 7.70E-07, which was smaller than alpha = 0.05, therefore rejecting the null hypothesis and revealing a statistically significant difference between the pretest and posttest scores of the experimental group. This outcome demonstrated how well the menstrual cycle card games improved student learning. It was likely that the dynamic and interactive aspects of such technologies played a strong role in the growth of more considerate comprehension and increased student engagement. The outcome was that game-based learning materials were effectively appropriate for addressing several learning preferences, including those who were kinesthetic, visual, and auditory; thus, they were useful and readily available to various students. Games had the potential to improve learners' ability to remember concepts, if only through the practical and easily relatable presentation of abstract theories.

The paired t-test result of the posttest scores of both groups produced a P(T<=t) two-tail value of 1.3E-05, which was smaller than alpha (0.05), and the null hypothesis was rejected and interpreted as a difference in posttest scores favouring the controlled over the experimental groups (significant).

The study strongly showed that interactive tools supplanted the traditional means of teaching in the achievement of students. The outcomes served as useful information for educators to guide their instructional strategies and educational programs. The study highlighted the need for teachers to abandon old practices and introduce new and up-to-date engaging procedures that understand the contemporary standards, expectations, and requirements of students of the present day.

While traditional approaches had their advantages, the experimental group's superior performance highlighted the need for creative and interactive strategies to improve science education and promote a deeper understanding of complex topics. Finally, the analysis showed that different teaching methods significantly supported the efficacy of students' learning. The outcome attained through the gamified approach illustrated that it was possible to raise students' interest in science studies and their success through technology and interactive tool usage.

3.4 Participants' Evaluation of the Menstrual Cycle Card Game

Four unique factors were involved by participants when it came to evaluating the menstrual cycle card game: learning, enjoyment, user-friendliness, and creativity. On a general level, the mean scores of each feature were within 2.98 to 3.07, indicating significant concurrence regarding the benefits of the game.

In terms of learning, the mean score of 2.98 showed that the tool helped students get a better understanding not only of the menstrual cycle, but also of feedback systems. The high acquiescence measured the tool's ability to enhance a clearer understanding of the menstrual cycle and back-dimension processes. This work endorsed the benefits of game inclusion into education, specifically complex ideas that could be conveyed through progressive and visual means.

Research was conducted on how game-based teaching—in this case based on a developed board game—increased conceptual understanding of the menstruation cycle, markedly in matters of menstruation, pregnancy, and contraception. Using questionnaire results, a more positive response about the readiness of students to learn about the menstrual cycle was observed after the game participation [41].

Having an average rating of 3.07, the game showed that it could promote enjoyable learning experiences. The entertaining aspects of the game earned it positive marks, demonstrating that the addition of pleasurable and interactive lessons could give tremendously heightened student engagement. Adding fun to the learning process made it easier to remember things better and made it easier to approach difficult subjects with an optimistic view.

Thoughtfully, the tool had a user-friendliness rating that stood at 3.0057 and proved intentionally simple and intuitive for its operation, which meant that a wide range of learners would have access to the resource, whether they were experienced or not.

A study conducted by [10] showed that perceived ease of learning, enjoyment, and useful knowledge positively impacted learning attitudes. The gamified curriculum significantly improved learning attitude compared to conventional methods.

Lastly, in terms of creativity, the mean score of 3.0343 reflected students' appreciation of the tool's innovative and creative design. Other similar studies were conducted that utilised gamification to enhance teaching. They integrated creativity and technology. For instance, a game called "PaGamO" was utilised in a study [43]. The findings revealed that the top three reasons students played this were because it was fun, self-learning, and wanting to improve their grades. Hence, gamification proved effective in enhancing the students' learning experience, driven by intrinsic and extrinsic motivations. Furthermore, they preferred using mobile devices over tablets and computers due to convenience.

The quantitative results of this study revealed a significant improvement in students' understanding of the menstrual cycle and feedback mechanisms, particularly within the experimental group utilising the gamified instructional tool. The experimental group demonstrated a mean posttest score of 9.0571, surpassing the controlled group's mean score of 7.9429, indicating a substantial gain in knowledge. Statistical analyses, including paired t-tests, confirmed these differences as statistically significant ($p < 0.05$), underscoring the efficacy of the gamified approach. These findings align with recent research by [18], which reported significant improvements in adolescent health awareness through game-based learning interventions in the Philippines.

Qualitative evaluations further corroborated these quantitative outcomes. Students rated the menstrual cycle card game highly across four dimensions: learning ($M = 2.9829$), enjoyment ($M = 3.0743$), user-friendliness ($M = 3.0057$), and creativity ($M = 3.0343$). Based on such positive assessments, the game did contribute not only to comprehension of complex biological concepts but also to improved student engagement and motivation. This is consistent with the results of several recent studies [44, 45] that have shown game-based learning improves cognitive, social, emotional, motivational and engagement outcomes for education environments. This study integrally brings together the quantitative and the qualitative perspectives to understand the impact of gamified learning tools on student performance and engagement. A combination of statistical evidence and student-reported experiences in the context of game-based interventions supports the potential to improve science education and presents a strong rationale for implementing them more broadly into curricula.

This study produces several practical implications for classroom practice. From the use of the card game, one can deduce that interactive and gamified learning tools can significantly improve students' understanding and engagement with an otherwise abstract and difficult topic like the menstrual cycle and feedback mechanisms to enhance science instruction [46]. Accordingly, implemented alongside traditional teaching strategies, such strategies can meet different learning preferences and enhance student motivation and collaboration [47]. Furthermore, the user friendliness of the game lends itself to be feasible in various classroom settings with minimal teacher preparation and resource support [48]. Therefore, these findings suggest that including gamified activities regularly can not only help master complex content but can further provide a more enjoyable and supportive learning environment and thereby alleviate anxiety while further deepening cognitive engagement [49]. This study provides overall evidence supporting the pedagogical shift towards more student-centred and experiential approaches that are in line with contemporary educational best practices and have the potential to improve not only academic performance but also students' attitude towards science learning [3].

4. CONCLUSIONS

From the study findings, the following conclusions are drawn.

1. The rate of improvement was high regarding the menstrual cycle card game compared to the controlled group in terms of performance after the posttest. The menstrual cycle card game enriched conventional teaching methods by adding interactive, creative formats that engaged players to evoke recall and retention of the menstrual cycle and feedback information through fun and effective means.
2. The high marks for enjoyment indicate the game did a good job getting students interested in learning and taking a more pleasure-seeking perspective on learning. The students' possible growing interest and participation may have had a positive effect on their learning outcomes and proved the necessity of fun and interactive ways of teaching.
3. High user-friendliness as measured among Grade 10 learners, indicated how easily it was navigated and was accessible.
4. The game demonstrated how gamification is a good way to increase the accessibility and clarity of abstract biological concepts using its original method of teaching biology topics.
5. The results of the study show that education policies should include ways to incorporate new teaching tools. Evidence that interactive, gamified resources can augment existing curricula, improve student learning and result in better outcomes in science education is provided by the success of the menstrual cycle card game.

5. RECOMMENDATION

The researcher comes up with the following recommendations after concluding the study.

1. It is encouraged that schools and educators find room for these innovative instructional strategies, for example, the menstrual cycle card game, in Grade 10 biology lessons focusing on more complex topics like the menstrual cycle and feedback mechanisms. Pretest and posttest assessments should be used as measures of implementation progress, which should be done at least once per quarter.
2. Structured training should be conducted for teachers to guarantee effective implementation of the menstrual cycle card game. In addition, these sessions should include at least one practical workshop per term, targeting the areas of game facilitation, classroom integration and alignment with assessment.
3. In order to develop this menstrual cycle card game, developers and educators can make it more

customizable by adding features like adjustable difficulty levels, language options or visual aids. These modifications should be piloted in different classrooms, and the data on their performance and engagement with the students will be used to improve them.

4. School administrators should make student-centred learning mandatory by mandating two interactive or gamified tools per grading period. Assessing instructional effectiveness should use regular monitoring using such things as classroom observations and learner feedback.
5. Longitudinal studies of retention of learning and conceptual understanding over time should be carried out on students using gamified learning tools by researchers. Follow-up assessments should be administered at least three and six months after the intervention.

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