UtilitasMathematica

ISSN 0315-3681 Volume 122 (2), 2025

Harry Potter-Inspired Gamification in Learning Calculus

Judith M. Aleguen
Cebu Technological University- Argao Campus
Province of Cebu, Cebu, Philippines, 6000
judith.aleguen@ctu.edu.ph

Rhey L. Dizon
University of San Carlos
Talamban, Cebu City, Cebu, Philippines, 6000
rldizon@usc.edu.ph

Abstract

This study utilized an embedded experimental mixed-methods design to investigate the use of a Harry Potter-inspired gamification strategy in a mathematics classroom. The research was conducted at a public higher institution in the Philippines, involving pre-service mathematics teachers taking Calculus 2 alongside other math subjects. Quantitative data was collected through a 15-item test questionnaire (α=0.809), demonstrating a significant difference ($p = <0.001$) between the student performance after the implementation of the gamification strategy. The thematic analysis using Collaizzi's method supported the effectiveness of the approach in improving student understanding and attitudes towards mathematics. Findings indicated that the Harry Potter-inspired gamification strategy effectively enhanced student motivation to study and engagement in Calculus. The immersive nature of the approach made the learning process enjoyable, fostering a deeper understanding and retention of mathematical principles. The incorporation of a house system, inspired by the Harry Potter series, promoted teamwork and collaboration among students. However, potential challenges were identified, including unequal participation, potential distraction, and time-consuming problem-solving activities. These drawbacks need to be addressed through carefully designed activities, inclusivity, and a balanced use of gamified elements. Based on the positive results observed, the researchers recommended the implementation of the Harry Potter-inspired gamification strategy in mathematics classrooms. The strategy enhanced student motivation, active participation, and understanding of mathematical concepts, however, teachers should design activities that ensure inclusivity and active engagement for all students while balancing challenges and providing clear instructions and feedback.

Keywords: *harry potter-inspired, gamification, mathematics classroom, calculus*

Introduction

Mathematics has long been a challenging subject for many students, particularly in higher education. Despite efforts to improve teaching strategies and learning approaches, many students still struggle to engage with and master mathematical concepts (Cohen & Soto, 2014). One emerging approach to improve student engagement and motivation is gamification - the use of game elements and mechanics to make learning more enjoyable and interactive (Deterding et al., 2011).

Gamification uses game design elements in non-game contexts to motivate and engage individuals in achieving their goals (Dicheva et al., 2015; Kapp, 2012). In recent years, gamification has gained attention in the field of education as a potential tool to increase student engagement and motivation (Hamari et al., 2014). A growing body of literature has explored the use of gamification in the classroom, examining its effects on student motivation, learning outcomes, and overall classroom experience (Landers & Landers, 2014; Domínguez et al., 2013). In recent years, there has been an increasing interest in the use of gamification in teaching mathematics in higher education (Reis & Vasconcelos, 2019). A growing number of studies have investigated the potential benefits of gamification for improving student engagement, motivation, and learning outcomes in mathematics courses (Barata et al., 2013; Huang, 2018; Tondello et al., 2016).

A study by Hamari, Koivisto, and Sarsa (2014) found that gamification elements, such as badges and leaderboards, increased student motivation in an online course. Similarly, a study by Landers and Landers (2014) found that a gamified learning management system increased student engagement and participation in an undergraduate course. The same findings in the study conducted by Huang (2021) positively impacted student motivation, engagement, and learning outcomes in various educational contexts. Dicheva et al. (2015) identified the most common gamification techniques used and their effectiveness, and Hamari et al. (2014) reviewed the empirical evidence for the effectiveness of gamification in various contexts, including education.

Other studies have examined the effects of gamification on student learning outcomes. A study by Sung, Chang, and Liu (2016) found that a gamified learning system improved student learning outcomes in a computer programming course. Additionally, a study by Kapp (2012) found that gamification can enhance knowledge retention and transfer. Moreover, some studies have also raised concerns about the potential negative effects of gamification, such as its potential to distract from learning objectives or to reinforce extrinsic rather than intrinsic motivation. For example, a study by Dicheva et al. (2015) found that while gamification improved student motivation in a programming course, it did not necessarily lead to improved learning outcomes.

In the Philippine setting, Eres (2019) found that gamification improved student engagement in a mathematics classroom, while Yap (2018) found that it positively impacted academic performance and motivation in a Philippine history classroom. Bato (2017) explored the use of gamification in higher education in the Philippines and found that it could potentially address challenges in student engagement and motivation. The results of the Philippine literature are consistent with the findings of the global literature, suggesting that gamification can positively impact student motivation, engagement, and learning outcomes in the Philippine context. However, the studies in the Philippine literature are limited in scope, focusing on specific courses and student populations. Thus, further research is needed to determine the generalizability of these findings to other contexts in the Philippines and beyond.

Research suggests that including fantasy elements in gamification design can have a positive effect on engagement, motivation, and enjoyment in mathematics learning (Lee, 2017; Dicheva et al., 2015).

For instance, Naeem and Ravaja (2017) found that immersion and flow experience had a significant positive effect on enjoyment and engagement in fantasy-themed games. Additionally, Egenfeldt-Nielsen et al. (2016) discuss the potential benefits of using video games for learning, including mathematics learning, and the use of fantasy elements in game design. Marczewski (2015) also highlights the importance of including fantasy elements in gamification design in creating motivational experiences. Overall, the literature supports the use of fantasy elements in gamification for mathematics learning to increase engagement, motivation, and enjoyment.

Several studies have also explored the use of a Harry Potter-inspired gamification approach in the classroom to teach mathematics. Hewitt (2019) and Davis and Smith (2018) both found that using a Harry Potter-inspired curriculum increased student motivation and engagement in mathematics learning. Similarly, Zdziarski et al. (2021) found that using a Harry Potter-inspired gamification approach increased student engagement and motivation, as well as improved learning outcomes. These findings are consistent with the general literature on gamification and suggest that using a Harry Potter-inspired gamification approach can be a promising way to enhance mathematics learning in the classroom.

Despite efforts to improve teaching strategies and learning approaches, many students still struggle to engage with and master mathematical concepts (Cohen & Soto, 2014). One emerging approach to improve student engagement and motivation is gamification - the use of game elements and mechanics to make learning more enjoyable and interactive (Deterding et al., 2011). (Jones & Pearce, 2018; Hewitt, 2019). More research is needed to understand how and why these gamification approaches are effective in increasing student motivation and engagement in mathematics learning. Additionally, there is a need for research that explores the potential challenges and limitations of using Harry Potter-inspired gamification in the classroom, such as potential distraction or exclusion of students who are not familiar with the Harry Potter franchise (Zdziarski et al., 2021). Overall, future research could contribute to a deeper understanding of the effectiveness and best practices of using Harry Potter-inspired gamification in the mathematics classroom.

The present study aims to investigate the effects of gamification in teaching mathematics in higher education, integrating the Harry Potter-inspired gamification approach. Specifically, this study seeks to determine whether incorporating this approach in mathematics courses can improve students' performance and understand students' perspectives on the effect of this approach on their total learning experience in learning concepts in mathematics. Lastly, to come up with implementation modules for integrating this approach in teaching mathematics among tertiary students.

Theoretical Background

Self-determination theory (SDT) is a framework that explains the psychological needs that drive intrinsic motivation, which is the motivation that comes from within oneself rather than external factors (Ryan & Deci, 2000). According to SDT, three basic psychological needs are essential for intrinsic motivation: autonomy, competence, and relatedness. Autonomy refers to the need for control over one's learning, competence refers to the need to feel capable of mastering a task, and relatedness refers to the need to feel connected to others. Gamification can potentially enhance these

psychological needs by offering choices (autonomy), feedback and recognition (competence), and social interaction and collaboration (relatedness) (Kapp, 2012).

Flow theory is a psychological framework that describes the experience of being fully immersed and engaged in an activity. Flow occurs when an individual faces a challenge that is neither easy nor difficult and matches their skill level (Csikszentmihalyi, 1990). When experiencing flow, individuals become completely absorbed in the task, lose track of time, and feel a sense of enjoyment and fulfillment. Gamification can facilitate the flow experience by providing clear goals, immediate feedback, and challenges matching the individual's skill level (Kapp, 2012).

Thus, these theories could provide a theoretical framework for understanding how gamification could enhance intrinsic motivation and lead to improved learning outcomes in mathematics education.

Hypotheses

Null Hypothesis (Ho): The is a significant difference between the pretest and posttest scores of the BSED-Mathematics students after the Harry Potter Gamified Approach is integrated.

Alternative Hypothesis (Ha): The is no significant difference between the pretest and posttest scores of the BSED-Mathematics students after the Harry Potter Gamified Approach is integrated.

Significance of the Study

The findings of this research study can be applied in a variety of contexts and linked to more significant topics to foster a very strong sense of research consumption, particularly when creating an interactive learning environment in the classroom. The results of this study opened everyone's eyes to the benefits of incorporating a Harry Potter-inspired gamification approach into the teaching of mathematics courses to maximize student engagement and participation in their learning. Additionally, the results of this study can be used as a starting point for comparison or as a guide for validating a theory when this method is applied to other fields of study.

Research Methodology

This section discusses the research design, explores the environment, describes the data sources, and explains the roles of the researcher as the study instrument. Moreover, data collection procedures are also discussed in detail in this section, along with the appropriate data analysis methods.

Research Design

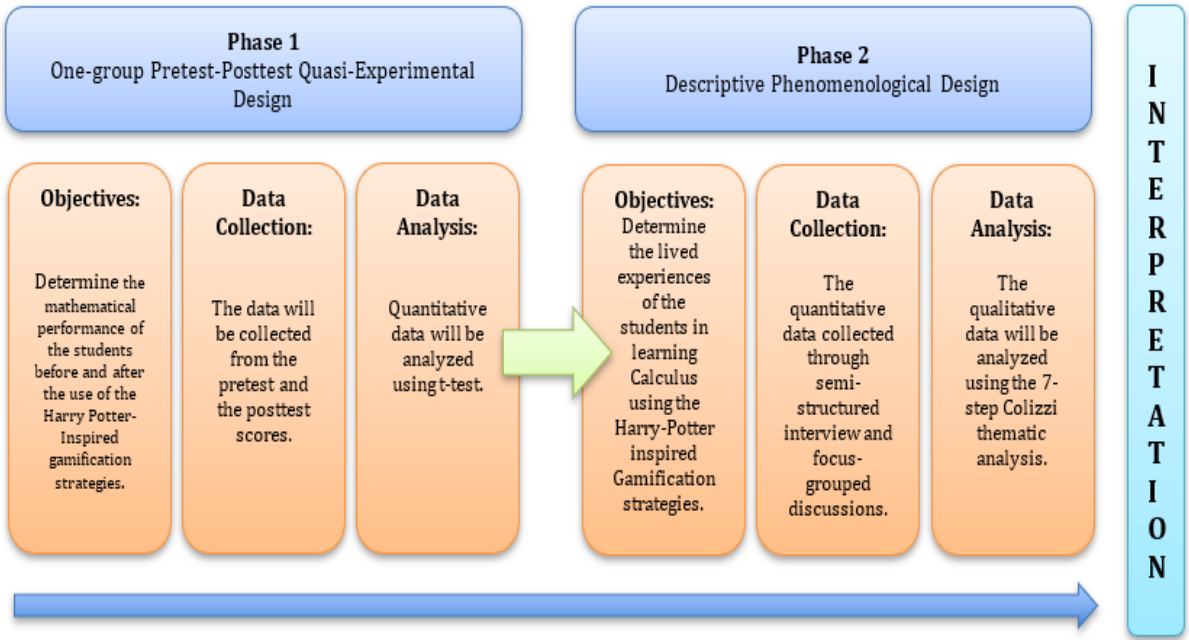
The overall aim of the study is to examine the effects of Harry Potter-inspired gamification on mathematics learning outcomes in Calculus 2, specifically in integration techniques. The research paradigm of this study is anchored on the pragmatist point of view, which allows for a flexible and practical approach to research with an emphasis on problem-solving and real-world applications. This paradigm aligns with the goal of this study, which is to investigate the practical implications of incorporating gamification elements into a mathematics course.

This study utilized an embedded experimental mixed methods design. Mixed-method design is a type of research design that combines both quantitative and qualitative data collection and analysis (Creswell, 2014). The embedded experimental design used one data set to provide a supportive, secondary role in a study based primarily on the other (Creswell et al., 2003). In the context of this research, qualitative data (interview transcripts) are used to support the results of the quantitative data (scores).

This research involved two phases, the first of which was the collection and analysis of the student's scores to identify patterns or relationships that could answer the research question or hypothesis (Johnson & Onwuegbuzie, 2004). The second phase involves the collection and analysis of the students' lived experiences in the implementation of the Harry-Potter-inspired gamification strategy in learning Calculus, which was used to explain or further understand the results of the quantitative analysis. The interview transcripts were analyzed using thematic analysis to identify themes or patterns that can help explain the results of the quantitative analysis (Teddlie & Tashakkori, 2009). Finally, the researchers integrated the findings from both phases to provide a comprehensive explanation of the research question or hypothesis (Morgan, 2007).

Fig. 1.

The Embedded Experimental Method Framework of the Study



In the context of this study, the quantitative approach used a one-group pretest-posttest-quasi-experimental design. Participants were given a pretest before receiving the gamified instruction and a posttest after completing the instruction. The design assumes that any improvement in learning outcomes between the pre-and post-tests is due to the intervention. The qualitative phase used a descriptive phenomenological design involving the conduct of semi-structured interviews with students to gain a deeper understanding of their lived experiences with Harry Potter-inspired

gamification. Data analysis was also conducted in two stages, with the scores analyzed first, followed by the interview transcripts. The quantitative data were analyzed using descriptive and inferential statistics, while the qualitative data will be analyzed using thematic analysis to identify recurring themes and patterns in the data.

Environment

This study was conducted at Cebu Technological University-Argao Campus, one of the government-funded Higher Education Institutions (HEIs) in the Philippines, located at Ed Kintanar Street, Lamacan, Argao, Cebu, approximately 70 km from Cebu City. The Cebu Technological University-Argao Campus is one of the campuses under the Cebu Technological University (CTU) system, catering to more than 3000 students from Argao and neighboring towns southeast of Cebu province. The campus prides itself on its professional education and technical courses. The College of Teacher Education offers Elementary Education, Secondary Mathematics Education, and Technology & Livelihood Education. Most of its programs have accreditations from the Accrediting Agency of Chartered Colleges and Universities in the Philippines, Inc. (AACCUP), with its Elementary and Secondary Education having Level III Accreditation status. Furthermore, it has been a top-performing school several times in the previous Board Licensure Examinations for Professional Teachers and a top-performing school in the QS World University Ranking.

Respondents

Quantitative

The respondents of this study were pre-service mathematics teachers who were taking Calculus 2 together with other math subjects. The 26 students are identified through purposive sampling. The purposive sampling technique is used because the participants need to have a certain level of knowledge and experience in mathematics, as well as the ability to reflect on their experiences with the gamification elements (Polit & Beck, 2021). All respondents have completed at least one mathematics course in college before taking Calculus and have a strong interest in mathematics and education. The respondents are in their second year of the course Bachelor of Secondary Education major in Mathematics (BSED Mathematics) program and are aged between 20 and 25 years old.

Table 1

Distribution of Respondents

Gender	***f***	***%***
Male	*3*	*12%*
Female	*23*	*88%*
Total	*26*	*100%*

Qualitative

Of the 26 respondents, 22 agreed to participate in the semi-structured interview. Of the 22, only 16 were interviewed because data saturation was already reached.

Instrument

Quantitative

The first instrument used in this research is the researcher made a 15-item multiple choice test on the topic of Integration Techniques in Calculus 2. To test the reliability of the questionnaire, Cronbach's Alpha was calculated. Cronbach's alpha is a measure used to assess the reliability, or internal consistency, of a set of scale or test items. To interpret, George and Mallery (2003) provide the following rules of thumb:

Table 2

Cronbach Alpha Interpretation

Cronbach Alpha	Interpretation
≥0.91	Excellent
0.81-0.90	Good
0.71-0.80	Acceptable
0.61-0.70	Questionable
0.51-0.60	Poor
≤ 0.50	Unacceptable

A. Item Content Validity Index

Data were gathered from the assessment of a panel of experts in the field of Mathematics. Based on the results, all three (3) experts agreed that the questions were "excellent" in terms of clarity of directions and items, adequateness of items per category or indicator, attainment of the purpose, objectivity, and scale and evaluation rating system. On the other hand, one (1) expert gave an "excellent" rating on the presentation/organization, while two (2) experts gave a "very good" rating. Moreover, on the sustainability of items, two (2) experts gave an "excellent" rating, while the other expert gave a "very good" rating. Using the item-content validity index (I-CVI), the result showed that the items in the researcher's questionnaire were valid as they gave an **I-CVI of 1.0.** Polit, D., Beck, C., and Owen, S. (2006) emphasized that for it to have great content validity, it would be made up of items with I-CVIs of.78 or higher validity (Shi J, Mo X, Sun Z., 2012). Outstanding experts, high-quality items, strong conceptual and developmental work, and clear instructions to the experts on the underlying components and the rating task were all necessary for this.

Table 3

Item Content Validity Index

	E1	***E2***	***E3***	***No. of Agreements***	***I-CVI***
S1	5	5	5	3	1
S2	5	4	4	3	1
S3	5	4	5	3	1
S4	5	5	5	3	1
S5	5	5	5	3	1
S6	5	5	5	3	1
S7	5	5	5	3	1
AVE	***5***	***4.71***	***4.86***	***3***	***1***

B. Internal Consistency Reliability Test

Internal consistency reliability, as emphasized by Barchard, K.A. (2010), measures the same number or score each time it is administered, all other things being equal. The 15-item test questions were pilot tested on 53 second-year BSED-Mathematics students who took the test as part of this study, and the internal consistency of the data collected was evaluated using Cronbach's alpha. It has an internal consistency reliability result of 0.809, which is greater than the predetermined value and extremely close to 1.0, based on the results as shown below. As a result, the multiple-choice test developed for the research was "good" or internally consistent.

Qualitative

The second instrument was a researcher-made interview schedule to gather the students' lived experiences in learning Calculus using the Harry Potter-inspired gamification strategy. This interview guide was validated by content experts and was pilot tested on three students, so the researcher could get a good grip on the flow of the interview. The interview questions were about the students' engagement, motivation, and satisfaction with the gamification elements, as well as open-ended questions to gather more details on their lived experiences.

Data Collection

The researcher creates a table of specifications to focus on the important areas and assigns a weight to each one according to its significance. An instructional plan to design the flow of the lesson when integrating the Harry Potter-inspired gamification approach and the construct of the researcher's constructed questionnaire aligned with the table of specifications. The questionnaire was checked by experts in the field of Mathematics to ensure the internal consistency of each item before doing pilot testing. Possible revisions are made based on the recommendations and approval from the experts. Once checked, the pilot test is performed on 53 third-year BSED-Mathematics students to examine the internal consistency of the instrument. After completing the validation process and pilot testing, this study continues by administering the test questionnaire to the main participants of this study. This uses a one-group pretest-posttest design to examine the effects of Harry Potter-inspired

gamification on students' overall learning experiences in a mathematics course. The data collection procedures involve four phases.

First, the participants will complete a 15-item pretest to assess their baseline knowledge of the topic, Integration Techniques in Calculus 2. This is to establish that the participants did not receive any prior instruction about the topic.

Second, the Harry Potter-inspired gamification strategy was implemented, which involves the use of Harry Potter-inspired gamification elements in a Calculus 2 course. The gamification elements will include activities such as problem-solving challenges, puzzles, and quizzes that are themed around the Harry Potter universe. Students will be sorted into 4 houses (Gryffindor, Ravenclaw, Hufflepuff, and Slytherin). Each house will have one group leader called the "prefect". Each house prepares its house yell, wands, costume, scarves, and flag. Just like in the Harry Potter movie, each house will compete in a game called House Cups. It is a series of games where the students solve problems about Integration Techniques while also earning points, collecting potions and badges, and navigating a series of obstacles and distractions. The potions and badges have corresponding points, which could either be added or subtracted from their total scores. The house with the highest score will become the winner and receive additional points, an individual Hogwarts badge, and a House Cup badge for their flag. The rest of the houses can keep their scores in the game, but will not receive the badges. For individual activities, students will be moving through different levels depending on their total scores. The leveling includes Muggles (0-50 points), Squib (51-100 points), Wizard (101-150 points), Dumbledore's Army (151-200 points), Auror (201-250 points), and Sorcerer (251 and more).

Implementation Plan

This plan aims to combine the enchanting world of Harry Potter with the study of Mathematics, specifically focusing on the topic of Integration Techniques in Calculus by using the elements of the Harry Potter universe to create a gamified learning experience for students to explore and master the principles of integration.

Table 4

Harry -Potter Inspired Gamification Strategy Implementation Plan

Day	Objective	Activities	Materials Needed
1	-Perform integration using different techniques.	- Introduce the lesson as Hogwarts School of Integration - Display house banners and Sorting hat replica - Play Harry Potter music	- Hogwarts-inspired house banners/Flags - Sorting hat replica - Harry Potter music - Wand replicas - Integration Technique PPT

	- Identify practical problems for integration	- Conduct a sorting ceremony and assign students to Gryffindor, Ravenclaw, Hufflepuff, and Slytherin -Explain integration technique activities for each house -Display leaderboard in the classroom for scorekeeping - Facilitate interactive discussion on different integration techniques (e.g., substitution, integration by parts, partial fractions) - Conduct practice exercises and drills or mini-games to reinforce integration techniques -Allow students to work in their respective houses -Award points to each house based on their performance	- Whiteboard and markers - Question bank of integration problems with increasing difficulty -House Scarfs
2	- Solve integration problems in a team setting	- Organize house challenges with integration problems - Introduce elements like potions for extra points, port keys for hints, and snakes for minus points -Provide Harry Potter-themes problems	- Question bank of integration problems with increasing difficulty -Potions - Assistance materials (hints, feedback)
3	- Engage in a final integration challenge	-Organize a House Cup Challenge or a Tri-Wizard Cup Game -Present a difficult integration problem as the final challenge to all houses -Award extra points to the house that solves the problem correctly first - Conduct a closing session to wrap up the lesson - Announce final scores and declare the winning house and give a reward	- Question bank of integration problems with increasing difficulty -Potions - Assistance materials (hints, feedback) - House Cup -rewards

Harry Potter -Inspired Gamified Elements

This study explores the utilization of Harry Potter-inspired gamified elements teaching. The incorporation of gamification techniques, coupled with the magical realm of Harry Potter, seeks to create heightened engagement, interactive participation, and improved performance in Calculus. In this instructional strategy, students will embark on a transformative journey, where they will encounter various gamified elements inspired by the Harry Potter series. Each element is designed to create an immersive and stimulating learning environment, igniting curiosity, promoting

collaborative teamwork, and nurturing perseverance. Listed below are the different gamified elements inspired by Harry Potter.

Table 5
List of Gamified Elements

Gamified Elements	Application
Sorting Ceremony	The Sorting Ceremony creates a sense of excitement and engagement as students are randomly assigned to different houses. It fosters a sense of belonging, encourages team spirit, and establishes friendly competition among the houses. This element helps in building a collaborative environment and a sense of identity within each house, which can enhance teamwork and motivation throughout the lesson.
House Challenges	House Challenges promote collaboration and problem-solving skills within each house. By working together, students can tackle integration problems and earn points for their houses. The incorporation of elements like potions adds an extra layer of motivation as students collect them while solving problems to gain additional points. The competitive nature of the challenges encourages students to actively participate, apply their knowledge, and strive for excellence in integration techniques.
Interactive Discussion	Interactive discussions facilitate active learning and a deeper understanding of integration techniques. Through discussions, students can ask questions, share their insights, and engage in problem-solving activities. The use of the whiteboard and markers allows for visual representation, aiding comprehension and retention. By awarding points to their house for participation, correct responses, and potion collection, the element motivates students to contribute, reinforcing their understanding of the integration techniques actively.
Practice Exercises and Drills/Mini Games	Practice exercises and drills provide opportunities for students to apply the integration techniques learned. The inclusion of mini-games adds an element of excitement and competition, motivating students to practice and improve their skills. By incorporating time limits and challenging problem sets, this element enhances critical thinking and problem-solving abilities. The allocation of points based on performance and potion collection reinforces the importance of practice and rewards students for their effort and progress.
Final Challenge (House Cup Games)	The Final Challenge presents a high-stakes integration problem that requires teamwork and strategic thinking to solve. It creates a thrilling end to the lesson, fostering a sense of achievement and accomplishment. This adds an element of competition and urgency, as houses race to solve the problem correctly first. By awarding extra points and recognizing the successful completion of the

	challenge, students are motivated to apply their knowledge, showcase their skills, and demonstrate their understanding of integration techniques.
Leaderboard and Rewards	The Leaderboard serves as a visual representation of each house's progress, creating a sense of healthy competition and motivation. It encourages students to strive for excellence and actively participate in activities to earn points for their house. By announcing the final scores and declaring the winning house, this element acknowledges and celebrates the efforts of students. Providing rewards or privileges further reinforces a sense of accomplishment and fosters a positive learning environment. Additionally, the collection of potions as a measure of achievement adds an exciting element to the leaderboard, motivating students to collect as many as possible to gain extra points and recognition.

Third, the participants completed a posttest to evaluate the effectiveness of the strategy used on the students' performance in learning Integration Techniques.

Lastly, the researcher conducted semi-structured interviews to gather qualitative data on the students' lived experiences with the Harry Potter-inspired gamification in the mathematics classroom. All data collection procedures were conducted following ethical guidelines, and informed consent was obtained from all participants.

Data Analysis

In terms of the student's performance in the pretest and posttest, the Wilcoxon Signed Rank Test was used to compare the mean scores because the data were found to be non-normal using the Kolmogorov test of normality. The effect size of the intervention was calculated using Cohen's d, which is a statistical measure used to indicate the standardized difference between two means (Cohen, 1988). A larger Cohen's d value indicates a greater difference between the means of the two groups and, thus, a stronger effect size.

For the qualitative data, the researchers will use Colaizzi's approach, which comprises seven data analysis steps (Morrow, Rodriguez, & King, 2015) as familiarization, identifying significant statements, formulating meanings, clustering themes, developing a detailed description, producing structure, and verification. The participants' transcripts were analyzed for significant meanings. Meanings were formulated, and the themes were extracted. The fundamental structure of the phenomenon was identified and described. Finally, as part of the validation process, the researchers contacted the participants again and showed the themes extracted to see if they were consistent with the participants' actual experiences.

The embedded mixed-method analysis, where the quantitative data is analyzed first, and the result will then be used to inform the subsequent qualitative data analysis. Both data will be given equal weight and priority in the interpretation and answering of the research questions.

Limitations

This study on incorporating Harry Potter-inspired gamification strategy into a mathematics course has several limitations that should be considered when interpreting the results. First, the study uses a one-group pretest-posttest design, which lacks a control group for comparison. While this design allows for the assessment of changes in the dependent variables over time, it does not account for potential confounding factors or alternative explanations for the observed effects.

Second, the study relies on self-reported data from participants, such as the interview response, which may be subject to response bias or social desirability bias. Participants may have provided socially desirable responses to impress the researchers, leading to an overestimation of the effects of gamification on student engagement, motivation, and learning outcomes.

Third, the study is limited to a single mathematics course and a specific group of students, which may limit the generalizability of the findings to other courses or student populations. The study's findings should be interpreted with caution and not generalized to other contexts without further research.
Finally, the study's results may be influenced by the specific gamification elements used in the mathematics course. Different types of gamification elements or different levels of implementation may yield different results. Therefore, the results of this study should be considered in the context of the Harry Potter-inspired gamification strategy used in the course.

These limitations should be taken into account when interpreting the results of the study, and future research should address these limitations to strengthen the findings and improve the generalizability of the results.

Research Rigor

In this research study, the researcher shall adhere to Guba and Lincoln's (1989) criteria of trustworthiness to maintain the rigors of the study, which comprised the concepts of credibility, transferability, dependability, and confirmability as cited from the study of Anney, V. (2014). The researcher must use member checking, a technique that entails asking a research informant to confirm the transcription of an interview to focus on their responses and have a thorough comprehension of the assertions supplied, to establish credibility.

Meanwhile, the study employs the purposive sampling technique to create specified samples with the inclusion of restricted pre-service teachers who are taking Calculus together with other math subjects. Dependability, on the other hand, is attained by developing detailed procedures used in the data collection and data analysis processes to gather the necessary responses to answer the objectives of the study. Finally, confirmability is ensured by paying attention to reflexivity during the data collection and analysis processes to reduce researcher bias and ensure impartiality when the data accurately reflect the responses of the respondents.

Ethical Consideration

The researchers will adhere to all ethical protocols while carrying out the study. Ethical approval shall be sought from the Ethical Review Committee of the researcher’s affiliated institution. The participants' informed consent, which specifies their awareness of the study's purpose, their

agreement to participate, and their opportunity to stop if they are uncomfortable with the questions, will be considered before the actual gathering of data. Furthermore, during the data collection, analysis, and publication of the study findings, the participants' anonymity and confidentiality will be preserved by not disclosing their names and identities. The privacy and confidentiality of the interview setting will be carefully controlled during the interview process, data processing, and dissemination of the findings.

Results and Discussion

This study would like to assess the effectiveness of the Harry Potter-Inspired Gamification approach in teaching the Calculus 2 course among second-year BSED-Mathematics students using the researchers' made test questionnaire. The data were presented, analyzed, and interpreted to answer the statement of the problem of this study.

A. Students' Performance in Mathematics during the Pretest and Posttest

The table below showed the relationship between the pretest and posttest results of the 26 BSED-Mathematics students enrolled in the Calculus 2 course. The researchers used the pretest-posttest design to evaluate the performance if their scores had changed before and after the Harry Potter-Inspired Gamification approach was implemented in the classroom. Based on the descriptive statistical analysis, it was determined that there was an improvement in student performance between the pretest ***(x = 6.8846; ò = 1.94580)*** and posttest ***(x = 14.4615; ò = 0.94787)*** results. The students' mean score is higher in their post-test with a smaller standard deviation indicating that the post-test scores are most clustered around the mean.

Table 6

Students' Performance in Mathematics during the Pretest and Posttest

	N	***Minimum***	***Maximum***	***Mean***	***Std. Deviation***
Pretest	26	1	10	6.8846	1.94580
Posttest	26	12	15	14.4615	.94787

B. Test of Significant Difference

To test the effectiveness of the use of the Harry Potter-Inspired gamification in a mathematics classroom, the researchers conducted a pretest and posttest to assess the performance of 26 BSED-Mathematics students who were currently taking the course Calculus 2 using the researchers' made test if there were any changes in the scores after the Harry Potter Gamified approach was integrated into the classroom. Both test scores were tested for normality using both Kolmogorov-Smirnov and Shapiro-Wilk tests. The results shown in the table below indicated that the data were not normal since the p-values were less than the alpha of ***0.05***. This further implies the use of a nonparametric test in finding the significant difference, specifically the Wilcoxon Signed Rank Test. The Wilcoxon

signed-rank test was a non-parametric statistical test used to compare paired data or to test the difference between two related samples.

Table 7
Tests of Normality Results

	Kolmogorov-Smirnov			*Shapiro-Wilk*		
	Statistics	*df*	*Sig.*	*Statistics*	*df*	*Sig.*
Pretest	.178	26	0.033	0.908	26	0.024
Posttest	.407	26	<0.001	0.628	26	<0.001

Based on the data, there was an improvement in student performance between the pretest ***(x = 6.88; = 1.91)*** and posttest ***(x = 14.46; = 0.93)*** outcomes, with a p-value of < 0.001. This means that there was a significant difference in the scores of the students between the pretest and posttest. In addition, all students scored higher in the posttest, as evident in positive ranks for all 26 respondents. Thus, this suggested that the Harry Potter-inspired gamifies strategy was beneficial in increasing second-year BSED-Mathematics students' performance in understanding their Calculus 2 lesson, specifically the topic on integration techniques. This result supported a study by Guerrero A. et al. (2020), which found that using the Harry Potter approach in mathematics classes for students in their first year of compulsory secondary education improves students' attitudes toward the teaching and learning processes.

Table 8
Significant Difference Between Scores

		RANKS			***TEST STATISTICS***	
		N	*Mean Rank*	*Sum of Ranks*	*Z*	*Sig.*
PRETEST-POSTTEST	*Negative Ranks*	0	0	0	-4.475	<0.001
	Positive Ranks	26	13.50	351.00		
	Ties	0				
	Total	26				

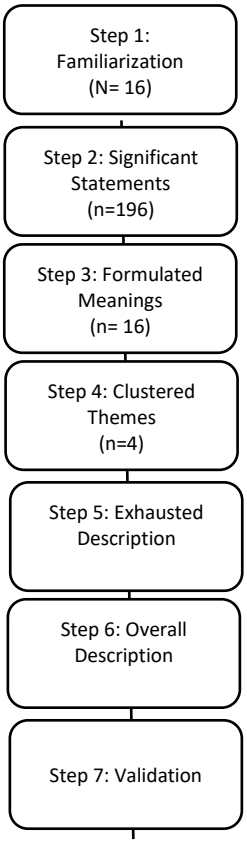
C. Lived Experiences of Second-year BSED-Mathematics Students

To understand the experiences of the students, an interview is conducted with selected second-year BSED-Mathematics students. Using a random sampling technique, a sample of students is identified

to be part of the interview. The interview ends as soon as data saturation is reached. The interview captures how the students see the Harry Potter-inspired gamification approach as a tool that helps them in learning concepts in Calculus 2. Below is the summary of the Collaizi's thematic analysis conducted by the researchers.

Fig. 2

Thematic Analysis



Gamification has been shown to be a powerful tool for engaging students and motivating them to participate in the education process actively (Kapp, 2012). Below are the responses recorded and themes developed from the lived experiences of the students as they actively engaged in their learning.

Table 9

Summary of Themes

Themes	Categories	Sample Statements
Theme 1: Embracing the	Engagement	"It is a very interesting and enjoyable game with lessons and learnings."

Wizarding World of Fun		"It was fun yet nerve-wracking when it comes to house cup games." "All I can say is that this is a brilliant idea and method to make the topic interesting while also learning." "My motivation during the game is the desire to win and to move our status into a wizard since it has a lot of perks, but it's not just about the perks; the game is engaging and fun."
Theme 2: Unleashing Your Inner Wizard	Motivation	"Before Harry Potter-inspired gamification strategy, it was usual math class. However, the game motivated us to study more." "I enjoyed the strategy implemented by the professor as aside from feeling that we are real wizards, it increases our confidence and the competition within ourselves to be better than we used to and be one of the "sorcerers" of Hogwarts." "For me, it helps me in a way that I can understand easier the lesson, and as a competitive person in terms of games, I study a lot so that I can win." "The game was made to motivate us to study more effectively because we want to win so badly. We think beyond mathematics, we think of possible challenges we are going to face. We are thinking of a new strategy to make our solving short and easy. We made a way to understand the things that need to be understood."
Theme 3: Collaborating as Hogwarts Housemates	Teamwork	"It was effective in fostering camaraderie within a group. Additionally, I was impressed by how it can enhance teamwork and cooperation but not compromise the individual effort of learners at the same time." "It helped me learn math concepts through collaboration." "Based on my experience, this gamification strategy let me use lots of skills, not just about the cognitive department. This also encourages me to develop teamwork and good communication with my group mates."

		"Through this game, our bonding seems stronger, and the trust we have for each other is undeniable." "I was very much satisfied with this strategy because it promotes collaboration and camaraderie among my fellow learners."
Theme 4: Facing the Hurdles	Challenges	"Not all members can participate or can solve the problem because they depend on their teammate who can answer the problem solving faster." "Some games divert students' attention away from the true educational objective, which could mean that the intended results of the teaching-learning process are not achieved." "But the disadvantage of this is that it favors those who are capable of solving calculus problems, and for us, slow learners tend to do anything yet still not good." "It can also lose the interest of the slow learner student, making him/her just rely on the fast learner group mate." "The disadvantage of this strategy is that other games/obstacles are time-consuming." "It's sometimes physically and mentally draining." "Based on my observation, the skilled members tend to learn more concepts and tend to improve more, while those who need some scaffoldings are left behind and end up not meeting the objectives. To address this, the games should be by the group, yet each member should receive the same number of tasks."

Theme 1: Embracing the Wizarding World of Fun

The results of this study showed that introducing a Harry Potter-inspired gamification approach in a Calculus classroom had enhanced student engagement significantly, parallel to the study of Sabala (2018), Smith et al. (2020), Karamert & Vardar (2021), and Flores et. al (2022). By integrating elements from the magical world of Harry Potter into the teaching and learning process, such as sorting students into houses, using potions to get extra points, participating in house cup games, and embarking on quests, students said that it had *"improved their engagement with the lesson"* and *"made their learning experience more interactive and fun".*

The researchers attributed this to the fact that the gamified class was more fun and engaging and that students felt a sense of excitement and personal connection to the material. This could also be because by leveraging the popularity and familiarity of the Harry Potter series, students were likely to feel a sense of excitement and personal connection, which can fuel their enthusiasm for learning Calculus.

Theme 2: Unleashing Your Inner Wizard

This immersive approach not only made the learning process more enjoyable but also facilitated a deeper understanding and retention of calculus principles since students were more motivated to study harder and strive to win games. The students stated that they feel a sense of excitement, personal investment, and a desire to succeed in the gamified activities. The prospect of earning points through the game can create a sense of accomplishment and drive students to push themselves further. Furthermore, gamification introduces an element of competition and rewards, which can foster a sense of achievement and drive students to strive for excellence. The Harry Potter-inspired gamification approach provided students with a clear goal to work towards, such as winning house competitions that instill a sense of purpose and direction, giving students a tangible reason to study harder and apply themselves more diligently. The element of competition, whether it's between individuals or houses, further fuels motivation as students strive to outperform their peers and earn recognition.

Furthermore, this gamification approach enhanced students' intrinsic motivation by making the learning experience enjoyable and immersive. When students find learning calculus to be fun and engaging, they are more likely to feel motivated to dedicate their time and energy to studying. The connection to the Harry Potter universe adds an element of novelty and excitement, making the learning process more appealing and enticing.

Theme 3: Collaborating as Hogwarts Housemates

The house system, inspired by the Harry Potter series, divides students into different houses within the classroom, fostering teamwork and collaboration. Students within the same housework together, supporting each other in academic activities and forming strong relationships. Inter-house competitions promote healthy competition, encouraging students to collaborate and strategize to earn points for their respective houses. The house system instilled shared accountability, as each member's contributions impacted the overall performance of the house. Through points and rewards, individual and collective achievements were recognized, motivating students to continue collaborating and striving for excellence. The house system created a sense of community, enhanced engagement, and developed valuable skills such as communication and problem-solving. This agrees with the result of the study by Guerrero et. al (2020) that the collaborative method, developed by means of the Harry Potter theme in the subject of mathematics, causes a better attitude of the student towards the teaching and learning process.

Theme 4: Facing the Hurdles

Despite the positive views of the students on the application of a Harry Potter-inspired gamification strategy, they have also identified several challenges that they have encountered. Some students

identified that limited familiarity with the Harry Potter series and the wizarding world could hinder their engagement, as they cannot fully connect with the theme. Additionally, some students struggle to see the direct link between the Harry Potter theme and the mathematics concepts, perceiving it as mere superficial decoration rather than a meaningful integration. These varying levels of enthusiasm and engagement with the theme among students may lead to unequal participation and motivation within the gamified classroom.

In addition, even if Harry Potter-inspired gamification can be a great way to engage students in mathematics, they had also identified some potential drawbacks, which were: (1) not all students were able to participate equally because, in a group setting, students who were better at mathematics end up doing all of the work, while those who were struggling were left behind, (2) it can lead to frustration and a feeling of disenfranchisement due to the complexity of the game which can be distracting if students were too focused on the game that can lead to a loss of learning, and (3) some students find gamified activities to be too challenging or stressful, time-consuming because they spend most of their time in solving problems.

The qualitative results of this study, where the use of the gamification strategy increased the students' engagement and motivation, explained the increase in their mathematical performance. This is also reflected in the study of Ariffin et.al. (2022), who assert that it is highly recommended to implement gamification activities in teaching and learning because it shows a significant relationship between all factors with the students' assessment score, and the increment in students' motivation to study and participate in class activities contributes to their performance in the subject taught. Gamification-based teaching practices, like the one used in this study, have a positive impact on student achievement and students' attitudes toward lessons, as stated in the same result from the study of Yildirim (2017).

The need to introduce gamified practices in the field of teacher training allows teachers to apply this methodology in a relevant way in their professional development (Gonzalez A. et.al., 2022), helping the student to learn mathematics interactively and interestingly and to deliver mathematical material easily (Udjaja, Y., et.al., 2018). Additionally, a high percentage of teachers think this kind of activity has positive effects on students' development, improving their affective domain toward mathematics and required skills for mathematical competency (López P. et.al., 2021).

Conclusion

Using the Harry Potter-inspired gamification strategy in a calculus classroom had the potential to significantly enhance students' motivation to study harder and succeed in the games, and improve their performance in Mathematics. By tapping into the excitement and engagement that both the competition and the Harry Potter series bring, students can find joy in the learning process and be driven to put in extra effort to achieve success. When motivation was increased, students were more likely to study diligently, actively participate, and ultimately excel in their Calculus course. Also, it was important to note that while gamification can be a powerful motivator, the underlying educational content and learning objectives should remain the central focus. The gamified elements should complement and support the objectives of the course rather than overshadowing it. A well-

designed gamification approach should strike a balance between fun and educational value, ensuring that students are motivated to study harder while still grasping the fundamental concepts and skills of calculus.

Recommendation

Based on the positive results observed, both in the students' performance and in their lived experience, the researchers recommended implementing the Harry Potter-inspired gamification strategy in mathematics classrooms. The engaging and immersive nature of the strategy enhanced student motivation, active participation, and understanding of mathematical concepts. By incorporating gamified elements and leveraging the appeal of the Harry Potter series, students become more invested in their learning, leading to increased effort and a deeper grasp of mathematical principles.

To address the students' concerns regarding the use of the strategy, teachers needed to design activities carefully, ensuring inclusivity and active participation for all students. Games should be brief, captivating, and used in moderation. It was also essential to assign diverse roles and incorporate cooperative, competitive, and individual game formats. Balancing challenges and difficulties was important, along with providing clear instructions and feedback, and recognizing students' participation and effort through rewards was encouraged. Taking into account the student's age, maturity level, specific mathematical concepts, available time, and resources was necessary for the effective implementation of this strategy.

References

Barchard, K.A., (2010). Internal Consistency Reliability. Encyclopedia of Research Design. Retrieved from https://doi.org/10.4135/9781412961288

Carr, P. R., & Strock, B. (2014). Gamification in Education: A Review of the Literature. International Journal of Game-Based Learning, 4(4), 50-67. https://doi.org/10.4018/ijgbl.2014100104

Chen, M.-F. (2019). The effect of gamification on learning mathematics: A meta-analysis. Journal of Educational Technology & Society, 22(3), 249-261. https://www.jstor.org/stable/26923913

Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approach. Sage Publications. https://us.sagepub.com/en-us/nam/research-design/book236067

Davis, K., & Smith, R. (2018). Creating Hogwarts in the Classroom: Engaging students in math through a Harry Potter-inspired curriculum. The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 91(1), 16-22. https://doi.org/10.1080/00098655.2017.1402605

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in Education: A Systematic Mapping Study. Journal of Educational Technology & Society, 18(3), 75-88. https://www.jstor.org/stable/24574676

Egenfeldt-Nielsen, S., Smith, J. H., & Tosca, S. P. (2016). Understanding video games: The essential introduction. Routledge.

Gliem, J. and Gliem, R., (2003). Calculating, Interpreting, and Reporting Cronbach's Alpha Reliability The coefficient for Likert-Type Scales. Retrieved from https://rb.gy/epefs

Guerrero, A., et al. (2020). "Collaborative Learning Based on Harry Potter for Learning Geometric Figures in the Subject of Mathematics" Mathematics 8, no. 3: 369. https://doi.org/10.3390/math8030369

Hewitt, K. M. (2019). A Hogwarts-inspired approach to teaching mathematics. Mathematics Teacher: Learning and Teaching PK-12, 112(1), 42-47. https://doi.org/10.5951/mathteacher.112.1.0042

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. Educational Researcher, 33(7), 14-26. https://doi.org/10.3102/0013189X033007014

Jones, C., & Pearce, N. (2018). Exploring the use of gamification in the teaching of mathematics: A systematic literature review. Journal of Computer Assisted Learning, 34(4), 387-412. https://doi.org/10.1111/jcal.12261

Kapp, K. M. (2012). The Gamification of Learning and Instruction: Game-Based Methods and Strategies for Training and Education. John Wiley & Sons.

Kumar, P., & Yadav, B. (2021). Effects of Gamification on Engagement and Motivation in higher education: A systematic review. Education and Information Technologies, 26, 2943-2965. https://doi.org/10.1007/s10639-021-10760-7

Liu, M.-C., & Peng, W. (2021). Impact of Game-based Learning on mathematics achievement: A systematic review and meta-analysis. Journal of Educational Psychology, 113(6), 1121-1140. https://doi.org/10.1037/edu0000537

Marczewski, A. (2015). Even ninja monkeys like to play: Gamification, game thinking & motivational design. CreateSpace Independent Publishing Platform.

Morgan, D. L. (2007). Paradigms lost and pragmatism regained: Mixed-methods designs as tools for driving theory-building. In A. Tashakkori & C. Teddlie (Eds.), Handbook of mixed methods in social and behavioral research (pp. 19-37). Sage Publications. https://us.sagepub.com/en-us/nam/handbook-of-mixed-methods-in-social-behavioral-research/book225596

Naeem, U., & Ravaja, N. (2017). Immersive gameplay: The effect of immersion and flow experience on positive gaming outcomes. Cyberpsychology, Behavior, and Social Networking, 20(4), 244-32250. https://doi.org/10.1089/cyber.2016.0471

Polit, D.F. and Beck, C.T. (2021) Nursing Research: Generating and Assessing Evidence for Nursing Practice. 10th Edition, Wolters Kluwer Health, Philadelphia, 784. Retrieved from https://rb.gy/bjv84

Prensky, M. (2001). Digital game-based learning. McGraw-Hill.

Shi J, Mo X, Sun Z. [Content validity index in scale development]. Zhong Nan Da Xue Xue Bao Yi Xue Ban. 2012 Feb;37(2):152-5. Chinese. doi: 10.3969/j.issn.1672-7347.2012.02.007. PMID: 22561427.

Teddlie, C., & Tashakkori, A. (2009). Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences. Sage Publications. https://us.sagepub.com/en-us/nam/foundations-of-mixed-methods-research/book230138

Zdziarski, E. L., Gogineni, S. B., & Babu, S. V. (2021). Harry Potter and the Classroom of Math: Using gamification to increase engagement in elementary mathematics. In K. Graziano (Ed.), Proceedings of Society for Information Technology & Teacher Education International Conference (pp. 939-944). Association for the Advancement of Computing in Education (AACE).