



## A comparative analysis of academic performance and engagement components in a gamified flipped classroom implementation: a quasi-experimental study

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**Abstract.** *Introduction.* The effectiveness of the flipped classroom model in higher education is constrained by insufficient student engagement during the self-directed preparatory phase. One approach to addressing this limitation is the integration of gamification elements into the model's framework. *Aim.* The present research *aims* to evaluate the effectiveness of a gamified flipped classroom model (GFCM), developed on the basis of Self-Determination Theory, in comparison with a standard flipped classroom approach. The dependent variables are academic performance and four dimensions of engagement: agentic, behavioural, emotional, and cognitive. *Methodology and research methods.* The study employed a quasi-experimental pretest-posttest design, with experimental ( $n = 37$ ) and control ( $n = 37$ ) groups formed from intact classes. The intervention lasted eight weeks; the experimental group followed the GFCM, while the control group adhered to the standard flipped classroom model. Comparative analyses of academic performance data and survey responses regarding engagement indicators were conducted using independent-samples t-tests. *Results.* Statistically significant differences in favour of the experimental group were observed in academic performance and across all four dimensions of engagement ( $p < 0.05$ ). *Scientific novelty.* The *scientific novelty* lies in the development and empirical validation of a theoretically grounded, gamified flipped classroom structure, in which gamification elements are systematically integrated into the pedagogical framework rather than applied in an ad hoc manner. *Practical significance.* The proposed model can serve as a toolkit for designing instructional processes aimed at fostering sustained intrinsic student motivation and offers an alternative to superficial forms of gamification in educational practice.

**Keywords:** flipped classroom, gamification, student engagement, self-determination theory, higher education

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## Сравнительный анализ академической успеваемости и компонентов вовлеченности при геймифицированной реализации технологии «перевернутого класса»: квазиэкспериментальное исследование

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**Аннотация.** Введение. Эффективность применения модели «перевернутого класса» в высшем образовании ограничена недостаточным уровнем вовлеченности обучающихся на этапе самостоятельной предварительной подготовки. В качестве одного из способов преодоления данного ограничения рассматривается интеграция элементов геймификации в структуру модели. Цель исследования заключается в оценке эффективности разработанной на основе теории самоопределения геймифицированной модели «перевернутого класса» (GFCM) по сравнению со стандартной реализацией данной модели. В качестве зависимых переменных выступают академическая успеваемость и четыре измерения вовлеченности: деятельностное, поведенческое, эмоциональное и когнитивное. Методология, методы и методики. Исследование выполнено в дизайне квазиэксперимента с предварительным и итоговым тестированием в экспериментальной ( $n = 37$ ) и контрольной ( $n = 37$ ) группах, сформированных на основе существующих учебных коллективов. Длительность эксперимента составила восемь недель; экспериментальная группа работала по модели GFCM, контрольная – по стандартной модели «перевернутого класса». Сравнительный анализ данных академической успеваемости и результатов опроса по показателям вовлеченности проводился с использованием t-критерия Стьюдента для независимых выборок. Результаты. Установлены статистически значимые различия в пользу экспериментальной группы по показателям академической успеваемости, а также по всем четырем исследуемым аспектам вовлеченности ( $p < 0,05$ ). Научная новизна состоит в разработке и эмпирической валидации теоретически обоснованной структуры геймифицированного «перевернутого класса», в которой элементы геймификации системно интегрированы в педагогический сценарий, а не применяются ситуативно. Практическая значимость. Предложенная модель может служить инструментарием для проектирования учебного процесса, ориентированного на устойчивую внутреннюю мотивацию студентов, и представляет альтернативу декоративным формам геймификации в образовательной практике.

**Ключевые слова:** перевернутый класс, геймификация, вовлеченность студентов, теория самоопределения, высшее образование

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## Introduction

The flipped classroom, as described by S. Han [1], has emerged as a prominent pedagogical model in higher education. It reverses the traditional learning structure by shifting content delivery outside the classroom and dedicating in-class time to active, collaborative learning activities. The model's success, however, fundamentally depends on students' preparation in their own time, typically through pre-recorded lectures or assigned readings. A substantial body of research indicates that the primary obstacle to the model's effectiveness is a lack of student engagement and self-regulation during these essential pre-class activities, often resulting in unprepared students and unproductive in-class sessions. This critical challenge has been extensively documented by L. Abeysekera and P. Dawson [2], Z. Zainuddin, S. K. W. Chu, and C. J. Parera [3], as well as Z. Zainuddin and S. H. Halili [4].

Gamification, defined as the integration of game design elements and mechanics into non-game contexts, has been widely recognised as a potent strategy for enhancing user motivation and engagement, as highlighted by M. Kalogiannakis, S. Papadakis, and A. Zourmpakis [5]. By leveraging mechanics such as points, badges, and leaderboards, educators aim to tap into intrinsic human desires for achievement, recognition, and competition, thereby transforming mundane tasks into more enjoyable and motivating experiences.

The logical synthesis of these two concepts has led to the rise of the Gamified Flipped Classroom (GFC). Early studies have shown its potential to increase student motivation in pre-class activities. However, a critical review of the literature reveals that many GFC implementations are atheoretical and ad hoc, applying game elements superficially without a clear connection to foundational learning theories – an issue highlighted by Z. Zainuddin, S. K. W. Chu, and C. J. Perera [3]. This often results in a system that may be temporarily fun but fails to foster deep, sustained engagement. Our research addresses this critical gap by proposing and validating the *Gamified Flipped Classroom Model (GFCM)*. The distinction of a “Model” is crucial; it signifies a cohesive pedagogical system where every gamified component is intentionally designed to support the core psychological needs for *competence*, *autonomy*, and *relatedness*, as outlined in the Self-Determination Theory (SDT) by R. M. Ryan and E. L. Deci [6], which serves as a robust framework for understanding human motivation.

The intended outcome of the GFCM is the enhancement of student engagement. Modern educational theory views engagement not as a monolithic concept, but as a multidimensional construct encompassing four critical aspects: *behavioural* (effort and persistence), *emotional* (interest and positive feelings), *cognitive* (deep processing and strategic learning), and *agentic* (proactive contribution to one's learning path). This multidimensional perspective on student engagement is supported by the comprehensive frameworks developed by G. Aparicio, T. Iturralde, and A. Maseda [7], J. Reeve and C. M. Tseng [8], and W. Oliveira, J. Hamari, S. Joaquim et

al. [9]. By fulfilling students' psychological needs, the GFCM is hypothesised to foster growth across all four dimensions of engagement.

Therefore, our study aims to empirically test the effectiveness of the theory-driven GFCM. It hypothesises that by systematically supporting competence, autonomy, and relatedness, the model will lead to significantly higher levels of multidimensional student engagement and, consequently, improved academic performance when compared to a non-gamified, standard flipped classroom.

To achieve the research aim and provide a systematic evaluation of the proposed model, our study addresses the following research questions:

1. Does the implementation of the Gamified Flipped Classroom Model (GFCM) lead to statistically significantly higher academic performance compared to a standard flipped classroom?

2. Does the use of the GFCM result in statistically significantly higher scores across the four dimensions of student engagement (agentic, behavioural, emotional, and cognitive) in comparison to the standard flipped classroom model?

## Literature Review

### ***The Gamified Flipped Classroom Model (GFCM): a Conceptual Framework***

The GFCM is not merely a collection of game elements added to a flipped classroom. This model is a theory-driven, systematic pedagogical framework designed to foster holistic student engagement, directly responding to recent calls for more structural and integrated approaches to gamified learning as emphasised by Q. Yu and K. Yu [10] as well as Z. Zainuddin, S. K. W. Chu, and C. J. Perera [3]. The model's architecture is grounded in SDT, which, as formulated by R. M. Ryan and E. L. Deci [6], posits that fulfilling students' innate psychological needs for *autonomy*, *competence*, and *relatedness* is the catalyst for high-quality motivation and engagement.

Furthermore, contemporary meta-analyses and systematic reviews conducted by M. Kalogiannakis, S. Papadakis, and A. Zourmpakis [5] and L. Li, K. F. Hew, and J. Du [11] confirm that integrating these foundational mechanics systematically yields superior active learning outcomes and robust human metrics compared to standard flipped models. The GFCM operationalises this theory through four interconnected components, each engineered to satisfy one or more of these needs and, in doing so, to enhance the four dimensions of student engagement.

### ***Component 1: Choice-Based Learning Pathways (Fostering Autonomy)***

This component directly targets the need for autonomy, which is the feeling of volition and psychological freedom. Instead of a single, mandatory pre-class video, students are offered meaningful choices – for instance, they can learn the core concepts by watching a video lecture, reading a technical article, or listening to a podcast. Providing such choices is a cornerstone of autonomy-supportive teaching, which has been established as a strong predictor of student engagement by L. Li, K. F. Hew, and J. Du [11], as well as P. Luarn, C. C. Chen, and Y. P. Chiu [12].

Recent findings by P. Luarn, C. C. Chen, and Y. P. Chiu [12] emphasise that intrinsic learning motivation flourishes when digital learning pathways offer custo-

misable options rather than rigid tracks. Furthermore, J. Liu, S. Cao, X. Liu et al. [13] proved that shifting from traditional passive media consumption to active multi-modal selection optimises cognitive structures and empowers students to self-manage their learning pace. This act of choosing is fundamental to fostering engagement:

(1) **Agentic Engagement:** By making meaningful decisions about their learning paths, students transition from passive recipients to proactive *agents* of their own instruction, expressing personalised preferences in their conceptual trajectories in line with the findings of C. K. Y. Chan and K. K. W. Lee [14];

(2) **Emotional and Behavioural Engagement:** The freedom to choose reduces feelings of coercion and increases intrinsic interest, leading to more positive emotions (*emotional*). Students are also more likely to complete the preparatory work (*behavioural*) because they have selected a mode that aligns with their preferences;

(3) **Cognitive Engagement:** Empowered by choice, students are more inclined to select the learning mode they believe will help them understand the material most deeply, thus encouraging the use of more sophisticated learning strategies (*cognitive*).

### ***Component 2: Points and Badges System (Fostering Competence)***

This component is designed to build a sense of competence, which is the feeling of being effective in one's actions. Students earn immediate points for completing pre-class quizzes and unlock milestone badges for mastery. This system provides a constant stream of affirmative feedback, a mechanism highlighted by M. Sailer and L. Homner [15] as highly effective in gamified environments for fostering a sense of capability and progress.

Contemporary research by M. Sailer and M. Sailer [16] as well as Y. Xiao and K. F. Hew [17] demonstrates that immediate rewards and point progression act as vital instructional scaffolding that strengthens self-regulated learning (SRL) loops by making incremental learning progress visible. Additionally, W. S. Alhalafawy and M. Z. Tawfiq Zaki [18] found that structural feedback loops embedded in digital platforms significantly boost metacognitive awareness and satisfaction during asynchronous learning tasks, effectively preventing learners from experiencing cognitive overload or feeling detached as confirmed by M. Yoon, J. Hill, and D. Kim [19].

**Behavioural and Emotional Engagement:** The clear, instant feedback loop reinforces effort and persistence (*behavioural*). The accumulation of points and earning of badges create a visible record of progress, which boosts confidence and reduces learning anxiety (*emotional*). **Cognitive Engagement:** As students see a direct link between their study strategies and their scores – a form of metacognitive feedback – they are encouraged to self-regulate and think more strategically about how to learn effectively, thus deepening their cognitive processing as suggested by M. Kalliogiannakis, S. Papadakis, and A. I. Zourmpakis [5].

### ***Component 3: Team-Based Quests (Fostering Relatedness and Competence)***

During in-class sessions, students collaborate in small teams to solve complex problems framed as “quests”. This structure primarily addresses the need for relat-

edness, the feeling of being connected to others. Well-designed collaborative tasks are known to foster a strong sense of community, which has been recognised as a key driver of engagement by B. Huang, K. F. Hew, and C. K. Lo [20], R. Huang, A. D. Ritzhaupt, M. Sommer et al. [21], and B. Huang and K. F. Few [22].

In recent years, U. K. Durrani, G. Al Naymat, R. Ayoubi et al. [23] proved that group-based assessment games and collective quests maintain high social accountability and active collaboration under challenging educational contexts. This shift towards interactive problem-solving bridges the gap between individual pre-class preparation and shared classroom mastery, while fulfilling students' collaborative expectations as presented by R. Li, A. Lund, and A. Nordsteien [24] and L. A. Samah, A. Ismail, and M. K. Hasan [25].

Emotional and Behavioural Engagement: Working towards a shared goal fosters positive interdependence, directly enhancing *emotional* engagement. Social accountability encourages active participation from all members (*behavioural*). Cognitive and Agentic Engagement: Quests demand that students combine knowledge and co-construct solutions (*cognitive*). As teams strategise, individuals can take on proactive roles, which is a form of *agentic* engagement.

#### **Component 4: Team Leaderboards (Fostering Relatedness and Low-Stakes Competition)**

Progress on team quests is visualised on a public, team-based leaderboard. This design choice is deliberate, as it frames competition in a positive, collaborative light, which can mitigate the potential negative effects of social comparison while amplifying in-group cohesion, an effect observed by E. Vilhunen, V. Vesterinen, M. Äijälä et al. [26].

Furthermore, recent studies by E. Vilhunen, V. Vesterinen, M. Äijälä et al. [26] and A. Husain, A. Qasem Al-Shayeb, F. Saleem Khazalah [27] indicate that when leaderboards track collective team progress rather than hyper-competitive individual metrics, they sustain situational interest and deep immersion (flow) without inducing individual performance anxiety or emotional friction among learners.

Emotional and Behavioural Engagement: The leaderboard amplifies the sense of shared purpose (relatedness), making the learning experience more exciting. This friendly competition provides an incentive for teams to stay persistent (*behavioural*). Agentic Engagement: Teams can proactively monitor their standing and make collective decisions on how to improve their performance, fostering a shared sense of agency.

In summary, the GFCM components work in concert as a single educational ecosystem. The model is designed so that the pursuit of game-like achievements is intrinsically linked to the act of meaningful learning, self-regulation, and holistic student engagement, as evidenced by G. Asiksoy and S. Canbolat [28].

Table 1 summarises the direct relationships between each component of the GFCM, the primary psychological needs it supports, and the key dimensions of engagement it is designed to influence.

Table 1  
Conceptual framework of the Gamified Flipped Classroom Model (GFCM)

| GFCM component         | Brief description                                                                                                 | Targeted Psychological Need (SDT) | Key engagement dimensions targeted         | Implementation phase         |
|------------------------|-------------------------------------------------------------------------------------------------------------------|-----------------------------------|--------------------------------------------|------------------------------|
| Choice-Based Pathways  | Students choose their preferred format for pre-class learning materials (e.g., video, article, or podcast).       | Autonomy                          | Agentic, Emotional, Behavioural, Cognitive | Individual Space (Pre-Class) |
| Points & Badges System | Students earn points for completing pre-class tasks (e.g., quizzes) and receive badges for specific achievements. | Competence                        | Behavioural, Emotional, Cognitive          | Individual Space (Pre-Class) |
| Team-Based Quests      | In the classroom, students collaborate in small groups to solve complex case studies or problems ("quests").      | Relatedness and Competence        | Emotional, Behavioural, Cognitive, Agentic | Group Space (In-Class)       |
| Team Leaderboards      | Team progress on quests is displayed in real-time on a leaderboard to foster healthy competition.                 | Relatedness and Competence        | Emotional, Behavioural, Agentic            | Group Space (In-Class)       |

Methodology, Materials and Methods

Research Design and Participants

A quasi-experimental, pretest-posttest non-equivalent control group design was adopted to evaluate the effectiveness of the instructional model. This approach allowed for a comparison between the experimental and control groups without disrupting the natural learning environment. One group served as the experimental group, receiving the GFCM treatment, while the other functioned as the control group, which utilised a conventional flipped classroom model without gamification elements. Data collection involved 74 undergraduate students in the “Learning Evaluation” course at a state university in Indonesia.

Hypothesis

To guide the statistical analysis, the following null ( $H_0$ ) and alternative ( $H_1$ ) hypothesis were formulated:

$H_0$ : There is no statistically significant difference in academic performance and multidimensional student engagement (agentic, behavioural, emotional, and cognitive) between students taught using the Gamified Flipped Classroom Model (GFCM) and those taught using the standard flipped classroom.

$H_1$ : Students taught using the Gamified Flipped Classroom Model (GFCM) will exhibit statistically significantly higher academic performance and multidimensional student engagement (agentic, behavioural, emotional, and cognitive) compared to students taught using the standard flipped classroom.

### **Research Procedure**

The research was conducted over an eight-week period according to the following schedule:

1) **Week 1:** A pre-test was administered to both the experimental and control groups to measure their baseline knowledge and academic performance before the intervention.

2) **Weeks 2–7:** The treatment was implemented over a six-week period. The experimental group followed the learning process using the designed GFCM. Concurrently, the control group participated in learning using a standard flipped classroom method without gamification elements.

3) **Week 8:** A post-test and a student engagement questionnaire were administered to both groups to measure the change in academic performance and the level of student engagement following the treatment period.

### **Research Instruments**

To gather the necessary data, two primary instruments were utilised: an academic performance objective test and an adapted version of the Engagement Questionnaire by J. Reeve and C. M. Tseng [8]. (1) **Academic Performance Test:** This instrument was an objective test consisting of items aligned with the course's learning objectives. The same test was used as a pre-test to measure initial ability and as a post-test to measure the change in students' academic performance after the intervention. (1) **Student Engagement Questionnaire:** This instrument was an adaptation of the Engagement Questionnaires developed by J. Reeve and C. M. Tseng [8]. The questionnaire comprised 24 items designed to measure the four dimensions of engagement. It utilised a 5-point Likert scale format, with responses ranging from "Strongly Agree" (coded as 5) to "Strongly Disagree" (coded as 1). In the current study ( $N = 74$ ), the reliability of the engagement scale and its sub-dimensions was assessed. The overall scale demonstrated high internal consistency ( $\alpha = 0.924$ ). Analysis of the four sub-dimensions also showed reliable results: emotional engagement ( $\alpha = 0.671$ ), behavioural engagement ( $\alpha = 0.846$ ), cognitive engagement ( $\alpha = 0.818$ ), and agentic engagement ( $\alpha = 0.895$ ).

### **Data Analysis**

The quantitative data collected from the post-test and the engagement questionnaire were analysed using an independent samples t-test. Prior to conducting the t-tests, the assumptions for parametric statistics were verified. Normality of distributions was checked using the One-Sample Kolmogorov-Smirnov test ( $p = 0.450$  for engagement and  $p = 0.508$  for academic performance), indicating that the data followed a normal distribution. Furthermore, equality of variances was assessed using Levene's test ( $p > 0.05$  for all comparisons); specifically, the results showed  $p = 0.593$  for engagement and  $p = 0.108$  for academic performance, confirming that the homogeneity of variance assumption was met.

Results: Validating the Model's Effectiveness

This section presents the results of the quantitative data analysis to evaluate the effectiveness of the GFCM. The analysed data include student engagement scores and academic performance scores (pre-test and post-test).

Analysis of Student Academic Performance

To measure the impact of the GFCM on learning outcomes, student academic performance data were analysed.

1. Initial Analysis (Pre-test Scores)

First, an independent samples t-test was conducted on the pre-test scores to ensure that there were no significant pre-existing differences in prior knowledge between the experimental and control groups before the intervention began. The results showed no statistically significant difference between the pre-test scores of the experimental group ( $M = 65.81$ ,  $SD = 8.45$ ) and the control group ( $M = 64.73$ ,  $SD = 8.13$ ), with  $t(72) = 0.55$ ,  $p = .58$ . This indicates that both groups began with an equivalent knowledge baseline.

2. Primary Analysis (Post-test Scores)

Descriptive statistics for the pre-test and post-test scores for both groups are presented in Table 2. While both groups showed an increase in mean scores from pre-test to post-test, the magnitude of the increase appears larger for the experimental group.

Table 2  
Descriptive statistics of academic performance scores

| Test type | Group        | N  | Mean (M) | Std. Deviation (SD) |
|-----------|--------------|----|----------|---------------------|
| Pre-test  | Experimental | 37 | 65.81    | 8.45                |
|           | Control      | 37 | 64.73    | 8.13                |
| Post-test | Experimental | 37 | 84.32    | 6.51                |
|           | Control      | 37 | 76.22    | 7.30                |

The analysis of post-test scores revealed that the experimental group ( $M = 84.32$ ,  $SD = 6.51$ ) outperformed the control group ( $M = 76.22$ ,  $SD = 7.30$ ), with  $t(72) = 5.03$ ,  $p < .001$ ,  $d = 1.18$ . This indicates that the GFCM had a large effect on improving students' academic performance.

Analysis of Student Engagement

1. Descriptive Statistics of Student Engagement

The descriptive statistics, including the mean ( $M$ ) and standard deviation ( $SD$ ) for student engagement scores in both groups, are presented in Table 3 below. The data show that the experimental group consistently reported higher mean scores across all dimensions of engagement – Emotional, Behavioural, Cognitive, and Agentic – as well as in the overall engagement score, compared to the control group.

2. Results of the Independent Samples t-test

The analysis indicated that the overall engagement score for the experimental group ( $M = 4.36$ ,  $SD = 0.45$ ) was significantly higher than that of the control group

( $M = 3.66$ ,  $SD = 0.52$ ),  $t(72) = 6.16$ ,  $p < .001$ ,  $d = 1.44$ . This represents a very large effect size, confirming the substantial impact of the GFCM on student engagement.

Further analysis on each dimension of engagement also revealed significant differences with large effect sizes:

Emotional Engagement:  $t(72) = 6.03$ ,  $p < .001$ ,  $d = 1.42$

Behavioural Engagement:  $t(72) = 5.66$ ,  $p < .001$ ,  $d = 1.33$

Cognitive Engagement:  $t(72) = 4.90$ ,  $p < .001$ ,  $d = 1.15$

Agentic Engagement:  $t(72) = 5.74$ ,  $p < .001$ ,  $d = 1.35$

A  $p$ -value of less than .05 (in this case,  $p < .001$ ) combined with these high Cohen's  $d$  values indicates that the observed differences are not only statistically significant but also have high practical significance in an educational setting.

Table 3

### Descriptive statistics of student engagement scores

| Engagement dimension   | Group        | N  | Mean (M) | Std. Deviation (SD) | Cohen's d |
|------------------------|--------------|----|----------|---------------------|-----------|
| Emotional Engagement   | Experimental | 37 | 4.41     | 0.49                | 1.42      |
|                        | Control      | 37 | 3.63     | 0.58                |           |
| Behavioural Engagement | Experimental | 37 | 4.38     | 0.44                | 1.33      |
|                        | Control      | 37 | 3.73     | 0.51                |           |
| Cognitive Engagement   | Experimental | 37 | 4.28     | 0.48                | 1.15      |
|                        | Control      | 37 | 3.69     | 0.53                |           |
| Agentic Engagement     | Experimental | 37 | 4.35     | 0.52                | 1.35      |
|                        | Control      | 37 | 3.58     | 0.62                |           |
| Overall Engagement     | Experimental | 37 | 4.36     | 0.45                | 1.44      |
|                        | Control      | 37 | 3.66     | 0.52                |           |

Note: scores are based on a 1–5 Likert scale.

### Summary of Findings

A comprehensive analysis of the quantitative data provides strong evidence supporting the effectiveness of the GFCM. The primary findings of this study are: (1) Improved Academic Performance: Students who learned using the GFCM demonstrated significantly higher academic performance compared to those in the conventional flipped classroom model. (2) Enhanced Student Engagement: The GFCM was proven to significantly increase all dimensions of student engagement (emotional, behavioural, cognitive, and agentic).

Collectively, these results indicate that the strategic integration of gamification elements into a flipped classroom framework is an effective pedagogical approach for improving both student engagement and learning outcomes.

## Discussions

### ***Interpretation of Key Findings***

The findings of this study provide clear and consistent evidence: the GFCM was significantly more effective than the conventional flipped classroom model in enhancing both student engagement and their academic performance. The experimental group not only reported substantially higher levels of engagement across all dimensions (emotional, behavioural, cognitive, and agentic) but also achieved significantly higher post-test scores, despite both groups starting from an equivalent baseline of prior knowledge.

This result aligns directly with the comprehensive meta-analysis conducted by Q. Yu and K. Yu [10], which concluded that gamified flipped classrooms significantly outperform traditional flipped structures in optimising students' learning outcomes. Similarly, this finding is consistent with the comparative study of U. K. Durrani, G. Al Naymat, R. M. Ayoubi et al. [23], who reported that integrating gamified layers within active business education structures yields superior academic efficiency and performance compared to non-gamified setups.

This result is particularly significant because it isolates the key variable: the strategic integration of gamification elements. Since both groups in our study utilised a flipped classroom approach, the significant difference in outcomes implies that the gamified layer – including choice-based paths, a points system, and team-based missions – was the primary driver of the observed improvements. This suggests that it is not merely flipping the classroom that proves effective, but rather *how* students are motivated and supported within that inverted structure, a pedagogical perspective strongly advocated by Z. Zainuddin, S. K. W. Chu, and C. J. Perera [3] in their recent work on gamified design frameworks.

### ***The Interrelationship Between Engagement and Academic Performance***

The most powerful finding of this study is the mutually reinforcing relationship between engagement and performance. The data do not just show that the experimental group was more engaged *and* performed better; they suggest that *increased engagement acted as the primary mechanism driving the improvement in academic performance*.

From Behavioural and Agentic Engagement to Learning: The high scores in behavioural and agentic engagement within the GFCM group indicate that students not only completed pre-class assignments but did so more proactively and consistently.

This finding strongly supports the work of G. Asiksoy and S. Canbolat [28], who observed that structured gamification mechanics successfully stimulate proactive pre-class behavioural engagement. By experiencing autonomy (through choice-based paths) and initiative (agentic engagement), students arrived in class better prepared. This superior preparation allowed them to participate in in-class activities (team-based missions) at a deeper level, transforming face-to-face sessions into opportunities for application and mastery, rather than mere clarification, echoing

the active learning pathways identified by R. Li, A. Lund, and A. Nordsteien [24] and L. A. Samah, A. Ismail, and M. K. Hasan [25].

From Cognitive and Emotional Engagement to Deeper Understanding: The high level of cognitive engagement suggests that GFCM students were employing deeper processing strategies. Interestingly, this finding presents a nuanced contrast to the meta-analytic findings of L. Li, K. F. Hew, and J. Du [11], who reported that while gamification enhances student intrinsic motivation, it often has a minimal or non-significant impact on students' perceived competency. In contrast to their findings, our empirical study demonstrated that the structured points and badges system, combined with team missions, significantly boosted cognitive engagement and felt competency. This difference may stem from our model's integration of immediate, structural feedback loops during asynchronous learning, which, as W. S. Alhalafawy and M. Z. Tawfiq Zaki [18] noted, enhances metacognitive awareness and satisfaction.

Furthermore, this is consistent with the work of Y. Xiao and K. F. Hew [17], who showed that personalised gamification features actively drive behavioural and cognitive outcomes by making learning progress tangible. Emotionally, the positive and collaborative learning environment, fostered by team missions, reduced anxiety and built a positive connection to the subject matter and their peers. When students feel capable (competent) and emotionally connected, they are more willing to invest mentally and tackle challenging material, which ultimately leads to better understanding and higher post-test scores.

#### ***Connection to Self-Determination Theory (SDT)***

The remarkable effectiveness of the GFCM can be precisely explained through the lens of Self-Determination Theory (SDT). The empirical findings of this study provide a concrete validation of how fulfilling the three basic psychological needs directly translates into superior learning outcomes, validating the foundational constructs of R. M. Ryan and E. L. Deci [6].

**Fulfillment of Autonomy:** The “Choice-Based Paths” component directly addresses the need for autonomy. This was evidenced by the significantly higher agentic engagement scores in the experimental group. By giving students control, the model empowered them to become architects of their own learning experience. This directly aligns with the insights of P. Luarn, C. C. Chen, and Y. P. Chiu [12], who observed that digital learning environments that offer flexible choice-based pathways significantly support student autonomy, thereby driving higher intrinsic motivation.

**Fulfillment of Competence:** The need for competence was effectively fulfilled through the “Points & Badges System” and success in “Team-Based Missions”. Instant feedback from points provided a continuous sense of accomplishment, while success in team missions offered proof of mastery. This aligns with M. Sailer and M. Sailer [16], who highlighted that in-class gamified activities serve as crucial scaffolds for self-regulated learning and the development of competence. Students who feel competent are more persistent in their efforts and more likely to use higher-or-

der thinking strategies, as also reported by M. Kalogiannakis, S. Papadakis, and A. Zourmpakis [5].

**Fulfillment of Relatedness:** The “Team-Based Missions” component was the primary driver for relatedness. By working together towards a common goal, students built social bonds and a sense of belonging. This is highly consistent with the findings of E. Vilhunen, V. Vesterinen, M. Äijälä et al. [26], who reported that cooperative gamified designs (such as team quests and team-based feedback) promote high situational engagement and emotional safety, preventing individual performance anxiety. Furthermore, this supports the works of B. Huang, K. H. Hew, and C. K. Lo [20], R. Huang, J. M. Spector, and J. Yang [29], and B. Huang and K. F. Hew [22], which emphasise that collaborative, game-based learning environments cultivate strong social accountability and relatedness.

## Conclusion

Based on the analysis and discussion presented, this study concludes that the Gamified Flipped Classroom Model (GFCM) is significantly superior in enhancing both student engagement and academic performance when compared to a conventional flipped classroom model. This finding provides a definitive answer to the research problem posed. The success of this model is rooted in its ability to effectively fulfill the three basic psychological needs of students, as described by SDT. The provision of autonomy through flexible learning paths encouraged students to become active agents in their own education (agentic engagement). The sense of competence achieved through instantaneous feedback (points and badges) and success in team missions triggered greater persistence and deeper cognitive effort (behavioural and cognitive engagement). Finally, the cultivation of social relatedness through team-based missions created a positive and supportive learning environment (emotional engagement). The enhancement of these four engagement dimensions collectively created a positive cycle of intrinsic motivation. This cycle served as the primary driving mechanism for the achievement of higher academic performance, as evidenced by the experimental group’s post-test scores significantly surpassing those of the control group. Therefore, this research not only demonstrates *that* the GFCM works but also explains *why* it works. The integration of gamification elements, when grounded in solid psychological theory, is not merely a decorative addition. Instead, it is a strategic pedagogical intervention capable of transforming a learning environment into one that is more motivational, participatory, and ultimately, more effective in producing competent graduates.

**Practical Implications:** For educators and curriculum designers, the message from this research is clear: well-designed gamification, rooted in motivational theory, is an exceptionally powerful pedagogical tool. Adopting a model like the GFCM could be an effective strategy for addressing common problems of low student engagement and varied learning outcomes within the flipped classroom context.

**Limitations:** It is important to acknowledge the limitations of this study. The use of a quasi-experimental design with intact classes, while common in educa-

tional research, limits the ability to make absolute causal claims. Furthermore, the context of a single course at one institution warrants caution when generalising the findings. The eight-week duration of the study may also not have been sufficient to observe the full long-term effects. Additionally, the study did not explicitly control for the potential novelty effect. It is possible that the significantly higher engagement in the experimental group was partially influenced by the unfamiliar and novel nature of the gamified format, rather than the intrinsic motivational features of the GFCM alone. Finally, while the overall engagement instrument demonstrated high internal consistency, the emotional engagement sub-dimension yielded a lower Cronbach's alpha of 0.671. Although values above 0.60 are often considered acceptable in exploratory pedagogical research, findings specifically related to this dimension should be interpreted with caution.

**Future Research Directions:** Future research should aim to replicate these findings using a *true experimental design* with randomisation. *Longitudinal studies* that span a full semester or more would provide insight into the sustainability of the GFCM's effects. Finally, supplementing quantitative data with *qualitative research* (such as interviews or focus groups) could provide a richer understanding of how students subjectively experience autonomy, competence, and relatedness within the GFCM environment.

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