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The Impact of Game-based Learning and Flipped Classroom on Solfeggio Performance, Engagement, and Satisfaction

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Abstract

This study examines the impact of the game-based learning and flipped classroom (GBL+FC) model on a solfeggio course with 90 first-year music education students at a large college in China. It addresses the gap in literature regarding the combined use of game-based learning and flipped classroom models in solfeggio courses for music education, an area that has been underexplored. In the flipped classroom, students independently reviewed materials and applied their knowledge through interactive, problem-solving activities, while game-based learning incorporated team challenges, interactive assessments, and a recognition system to boost engagement. The experimental group (GBL+FC) outperformed the control group, with an average post-test score of 85.50 compared to 69.20, a statistically significant difference ($p < 0.05$). This indicates the effectiveness of the model in enhancing students' understanding and performance. Engagement was also significantly higher across all dimensions: behavioral engagement (EG: 19.50 vs. CG: 15.00), emotional engagement (EG: 19.80 vs. CG: 14.20), cognitive engagement (EG: 20.20 vs. CG: 15.10), and active engagement (EG: 20.00 vs. CG: 15.30). Additionally, satisfaction was significantly greater in the GBL+FC group (65.11) compared to the control group (43.49), with a statistically significant difference ($p < 0.05$). This suggests that students in the GBL+FC group had a notably higher level of satisfaction with the course, attributed to the interactive and motivating elements of the model. The higher post-test scores, increased engagement, and greater satisfaction in the GBL+FC group strongly support the model's effectiveness. By combining game-based learning with flipped classroom strategies, the model enhanced students' practical application of complex musical concepts, leading to improved performance and a deeper connection with the course material.

Keywords: Game-based learning, Flipped classroom, Music education, Solfeggio performance, Student engagement, Engagement

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1. INTRODUCTION

1.1 Challenges in Solfeggio course and the Need for Innovative Teaching Methods

Due to the repetitive and complex nature of solfeggio course, training often becomes monotonous, leading to several challenges for students. Research shows that students frequently face poor performance [1], low classroom participation [1], and lack of motivation [1], [2], [3]. The performance of repetitive skills is often associated with a reduction in subjective interest and engagement. [4], and individual learning can limit opportunities for interactive and enjoyable learning experiences. [6]. These challenges are even more difficult for students with weak foundations and low psychological resilience [7], as they have to overcome both musical skill barriers [8], [9] and psychological obstacles [9], [10].

To address these challenges, innovative teaching methods are needed. Game based in learning and flipped classrooms are emerging as effective strategies to potentially improve student performance. The flipped classroom model has been shown to significantly enhance learning by increasing student participation and motivation [11], [12]. Similarly, game-based in learning, which incorporates elements like rewards and competition, has been proven to engage student and create a more interactive learning environment [13], [14]. By combining both strategies-game based in learning and flipped classrooms-teacher can offer a more dynamic and motivating learning experience, addressing monotony, disengagement, and lack of motivation in solfeggio course [15], [16]. According to Seaborn, & Fels' research [15], game helps increase student interest and improves performance. Serenko [16], also found that games and online materials effectively increase student satisfaction in higher education.

1.2 The Role of Game-based Flipped Classroom in Enhancing Solfeggio Learning

Game-based flipped classroom (GBL+FC) model combines the principles of flipped learning with game elements to create an engaging and student-centered learning environment. One of its main advantages is its ability to increase student engagement. As Lian and Pan [17] point out, student engagement is crucial for knowledge retention, especially in online learning environments. In their study, Urh, Vukovic, Jereb & Pintar [18] used game elements to enhance student participation in discussions, exercises, peer sharing, supervision, and more. Game elements such as earning points, earning badges, and competing on leaderboards motivate students to actively participate in both pre-class and in-class activities [19],[20]. It was increased engagement is particularly important in solfeggio course [12], [16], where students needed to repeatedly practice and apply concepts. The excitement of competition and reward systems can reduce boredom and improve focus and commitment, as shown by Rahmani, Zaid, Abdullah, Mohamed, & Aris [21].

Another key advantage of GBL+FC model is its ability to boost learning motivation. Motivation, especially intrinsic motivation, plays a vital role in students' academic performance and interest in learning [22]. By incorporating game mechanics into the flipped classroom, students become more motivated to engage with course content, complete assignments, and participate actively in classroom activities. In the study by Urh, Vukovic, Jereb, & Pintar [18], game elements were integrated into higher education classrooms, resulting in increased student participation in discussions, questioning, and answering, and a heightened desire to explore classroom knowledge. The sense of achievement through rewards and competition also enhances students' enthusiasm for learning and encourages

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them to invest more time and effort into mastering the subject matter [8], [12], [14].

GBL+FC model promotes collaboration and peer interaction through goal-oriented games that encourage cooperation and communication among peers [6], [9], [13]. Deterding [19] suggested that the rules established in games help peers share learning experiences more effectively. Chin and Rickard [16] validated that games and online learning increase student participation. By incorporating team challenges and group competitions, this model creates a collaborative learning environment where students can share insights and provide feedback, sometimes more effectively than teacher-student interactions alone. Studies by Doi [5], Wang [7], and Schwarzenberg & Navon [10] support this view. These interactions not only enhance students' understanding of solfeggio but also help them develop valuable social learning and teamwork skills. The model allows for self-paced learning and free feedback, adapting to individual needs, abilities, and goals.

In solfeggio course, where learning styles and paces vary, tailored assignments and learning paths are essential. GBL+FC model ensures all students can improve by offering these personalized, self-paced opportunities. This study aims to explore the impact of GBL+FC model on academic performance, learning satisfaction, and engagement in solfeggio course, providing theoretical and practical insights for reforming solfeggio course.

RQ 1: Does the use of game-based flipped classroom (GBL+FC) approach, compared to the traditional teaching method, have a significant effect on enhancing solfeggio performance?

RQ 2. Does the use of GBL+FC approach compared to the traditional teaching method, have a significant effect on enhancing student engagement in solfeggio course?

RQ 3. Do the students who learn with GBL+FC approach show higher student satisfaction than those who learn with the traditional teaching method in solfeggio course?

2. GBL+FC Model

GBL+FC model, based on the work of Hwang, Chen, & Sung [23] and Doi's flipped classroom model [24], follows a dynamic, seven-step process to enhance learning through collaboration, feedback, and interactive learning. This model incorporates game-based learning (GBL) elements alongside flipped classroom (FC) strategies, creating a comprehensive and engaging educational framework. The model has been adapted with expert advice to include feedback and skill training steps, resulting in a seven-step teaching cycle. The seven steps of GBL+FC model are as figure 1:

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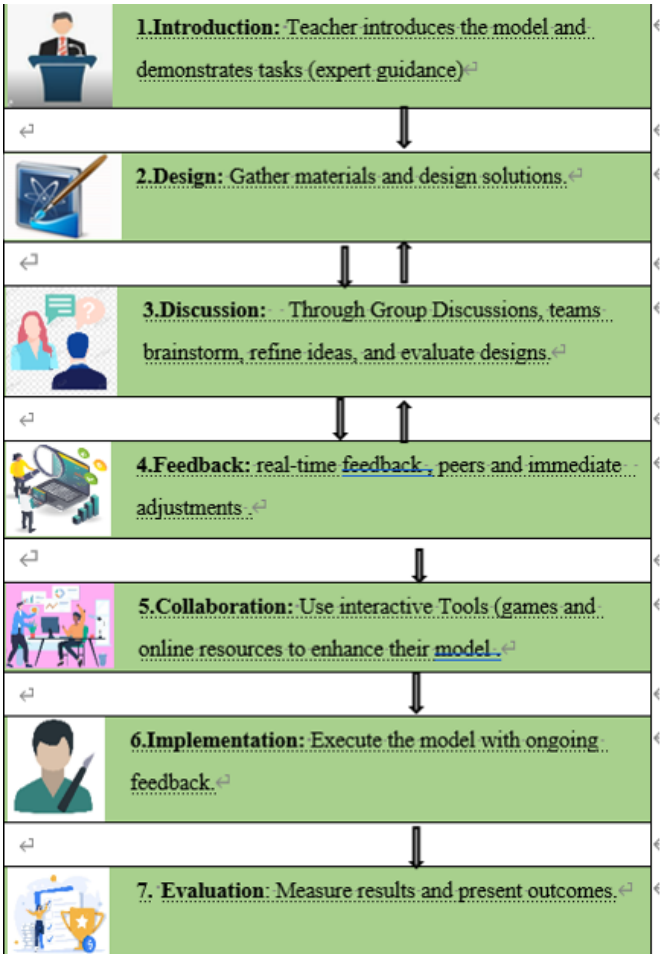

Figure 1. GBL+FC model

In the introduction phase, the teacher introduces game-based learning in flipped classroom (GBL+FC) model and demonstrates key tasks, offering expert guidance to help students set clear learning goals. The design phase follows, where teachers and students gather materials and begin creating solutions, setting the foundation for their learning journey with a game-based approach. During the discussion phase, through Group Discussions, teams brainstorm, refine ideas, and use collaborative tools (e.g., online whiteboards) to optimize designs. In the feedback phase, teachers and peers provide continuous input, helping students make immediate revisions based on collaborative feedback. This step emphasizes real-time refinement, an essential part of the flipped classroom model, where feedback is not delayed. The Collaboration phase encourages students to use games and online resources to adjust their model further. Interactive tools (Game:Dancing Line and Rhythm Master, and Chaoxing platform) and online materials promote ongoing learning and adaptation, enabling students to explore different strategies to improve their projects continuously.

During the implementation phase, students execute their projects with ongoing feedback. The use of games and websites allows for immediate adjustments, making this stage dynamic and responsive. Finally, in the evaluation phase, students measure their results, present outcomes, and reflect on their work. This reinforces the learning process, helping solidify their understanding and fostering a sense of accomplishment.

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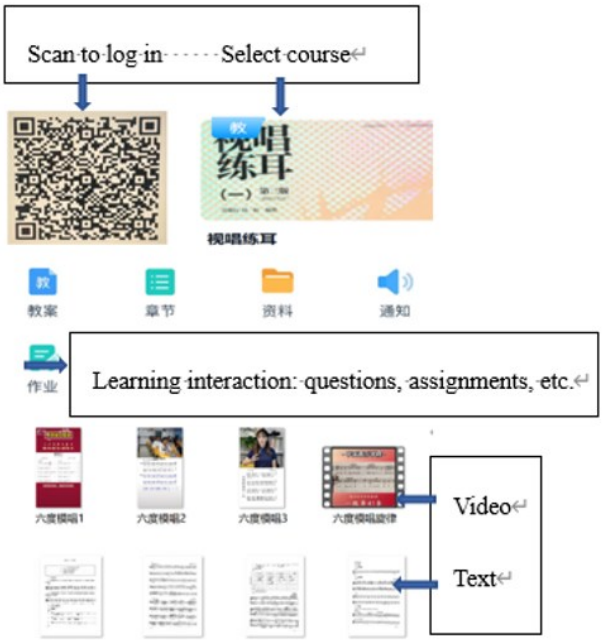

Figure 2. Chaoxing Interface

Chaoxing is a Chinese online learning platform offering courseware, videos, audio, group tasks, tests, and attendance tracking. Figure 2 is the interface of Chaoxing website. Students scan the code to access the learning interface. or student ID login. The solfeggio course includes videos, text, discussions, and assignments.

Dancing line is a rhythm-based mobile game where players control a line that moves forward, navigating obstacles and twists in sync with music. Players tap the screen to change the line's direction, avoiding obstacles while staying in rhythm with the music. The game helps improve students' musical abilities by training their sense of rhythm and timing. Figure 3 shows the login and gameplay screenshots.

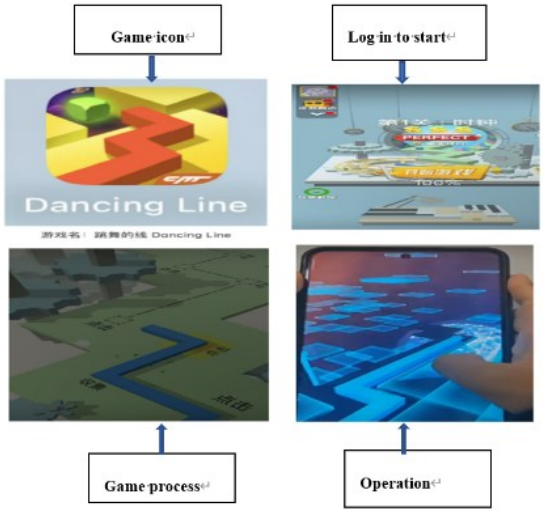

Figure 3. Screenshots from the Dancing Line Game

Figure 4. Screenshots from Rhythm Master Game

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Rhythm master game is a rhythm-based music game where players tap, swipe, or hold the screen in time with the notes that appear. The notes and actions are closely aligned with the music's rhythm, requiring precise timing. The game features various songs in different genres, helping players improve their reaction speed and sense of rhythm. This game effectively trains students' musical rhythm skills. Figure 4 shows the login and gameplay screenshots.

3. RESEARCH METHODS

3.1 Participants

This study has two phases. The first phase develops GBL+FC model for solfeggio course. The second phase is a quasi-experimental study comparing an experimental group (GBL+FC) with a control group (traditional teaching). The participants in the two phases of the study are as follows:

Phase 1: Five experts with at least five years of experience in relevant fields. Their expertise encompassed sight-singing and ear training, musicology, music education, vocal performance, and pedagogy. These experts were selected for their specialized knowledge, which provided crucial insights into the study design and implementation.

Phase 2: The participants were ninety first-year，aged 19-22 music education students (45 male, 45 female) from Guilin Normal College, China. These students were randomly selected using whole cluster random sampling, with two classes of students chosen for the study. The participants were randomly divided into two groups: the experimental group, which received instruction using the gamified flipped classroom model, and the control group, which was taught using traditional teaching methods. Each group consisted of 45 students.

3.2 Research Procedures

The study was conducted over eight weeks, with two lessons per week. The experimental group followed GBL+FC model, while the control group followed traditional classroom instruction as figure 5.

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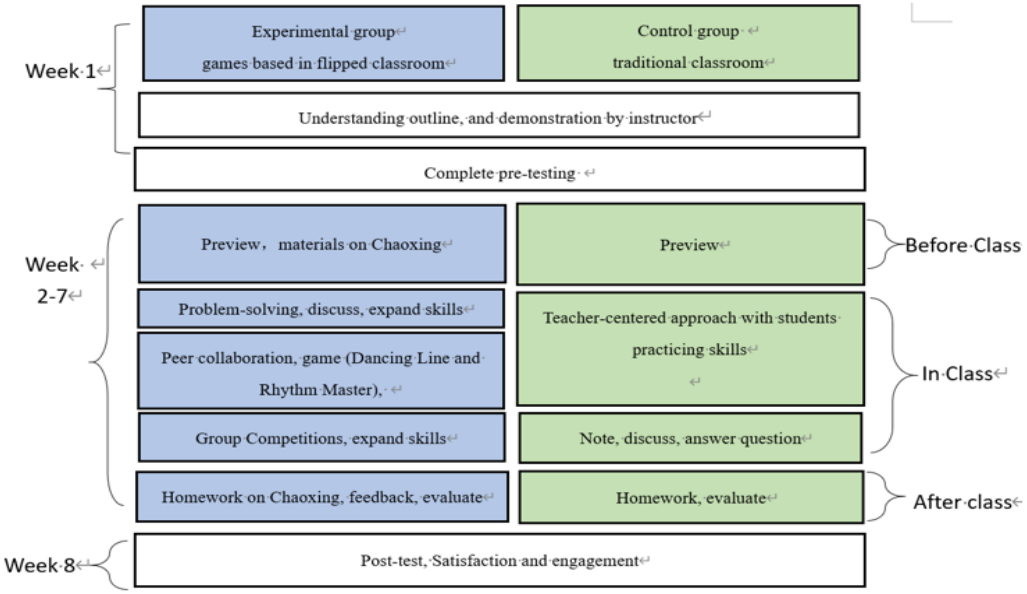

Figure 5. Experimental Process Design

Figure 5 outlines the comparison between the game-based flipped classroom and the traditional classroom approach, following a seven-step teaching method.

In the experimental Group (Weeks 1-7), students review materials on Chaoxing before class. During class, they engage in problem-solving, discussions, collaborate with peers, and play games like Dancing line and Rhythm master. After class, students complete homework and receive feedback through Chaoxing. In the control Group (Weeks 1-7), students review materials before class. During class, they practice skills, ask questions, and receive feedback from the teacher. After class, students complete homework and receive evaluations from the teacher.

Week 8: Both groups complete post-tests and satisfaction surveys to evaluate learning outcomes.

Figure 6. Game-based Flipped Classroom in Action

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Figure 6 illustrates the GBL+FC model process. Students preview the video lecture via Chaoxing before class. During class, teachers and students engage in teaching and learning activities. Students participate in games. After class, they take part in assessments.

3.3. Instruments

In the first phase, the assessment tool developed by Fidan and Tuncel (2019) was used to validate GBL+FC model. Experts evaluated the model quantitatively using a five-point Likert scale, with qualitative comments thematically analyzed. The teacher survey focused on their attitudes towards using GBL+FC model in solfeggio, how to implement it, and other related details. The interview included five open-ended questions, and the answers were organized for analysis.

After completing the questionnaires and interviews for both students and teachers, five experts were invited to assess the validity of the instruments in an objective, thorough, and impartial manner.

Solfeggio test was based on the standardized test paper commonly used in the school.

Table 1. Pre-test and Post-test Reliability (KR-20 Values)

Aspect （Question）	Pre-test KR-20 Value	Post-test KR-20 Value
Dictation (Tone)（1-5）	0.84	0.85
Dictation (Chord)（6-10）	0.82	0.83
Dictation (melody)（10-15）	0.83	0.81
Dictation (rhythm)（16）	0.83	0.83
Read music and solfeggio（17）	0.83	0.82
Total questions	0.72	0.76

Table 1 shows the KR-20 values for the pre-test and post-test across various aspects: dictation (tone), dictation (chord), dictation (melody), dictation (rhythm), and music reading and solfeggio, as well as the total KR-20 values for all questions. The KR-20 values for the pre-test and post-test are generally high, indicating good reliability. For example, the values for dictation (tone) were 0.84 in the pre-test and 0.85 in the post-test, while the values for dictation (melody) slightly decreased from 0.83 to 0.81. Overall, the total KR-20 values increased from 0.72 in the pre-test to 0.76 in the post-test, suggesting improved reliability of the test after the intervention.

For the second phase, two groups of students participated in the experiment and were assessed using three tests: the post-test of performance, the engagement questionnaire, and the satisfaction questionnaire. The purpose of the evaluation was explained to ensure objective and truthful responses.

The engagement questionnaire was adapted from Dixson's "Online Student Engagement Scale (OSE)" to assess participation in music courses, covering the components of behavioral, cognitive, emotional, and active learning engagement.

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Table 2. Questionnaire Reliability of Engagement

Dimensions (question)	Cronbach's Alpha
Behavioral engagement (1-4)	0.95
cognitive engagement (5-8)	0.93
emotional engagement (9-14)	0.93
Active engagement (15-20)	0.93
Total questions	0.93

Table 2 shows the Cronbach's Alpha values for different dimensions of engagement: 0.95 for behavioral engagement, 0.93 for cognitive engagement, 0.93 for emotional engagement, 0.93 for active engagement, and 0.93 for the total questions, indicating high reliability of the questionnaire.

The satisfaction measurement in this study is based on an adapted scale from Eom, Wen, & Ashill [27], and includes three dimensions: course content, teaching methods, and communication and feedback.

Table 3. Questionnaire Reliability of Satisfaction

Dimensions(question)	Cronbach's Alpha
Course content (1-3)	0.93
Teaching methods (4-7)	0.94
Communication and feedback (8-10)	0.95
Total questions	0.94

Table 3 shows the Cronbach's Alpha values for different dimensions of satisfaction: 0.93 for course content, 0.94 for teaching methods, 0.95 for communication and feedback, and 0.94 for the total questions. These values indicate that the questionnaire is highly reliable in measuring satisfaction across these dimensions. In a word，the self-assessment and questionnaire used by the students were validated to be both effective and reliable. During the experiment, students were required to complete pre-tests and post-tests under the guidance of the researcher. The tests were provided in paper format, and students were asked to complete them within a designated time frame.

3.4. Data Analysis

Data analysis was conducted using MANOVA to compare the pre- and post-test data of the two groups, aiming to determine whether GBL+FC model significantly improved student performance, engagement, and satisfaction.

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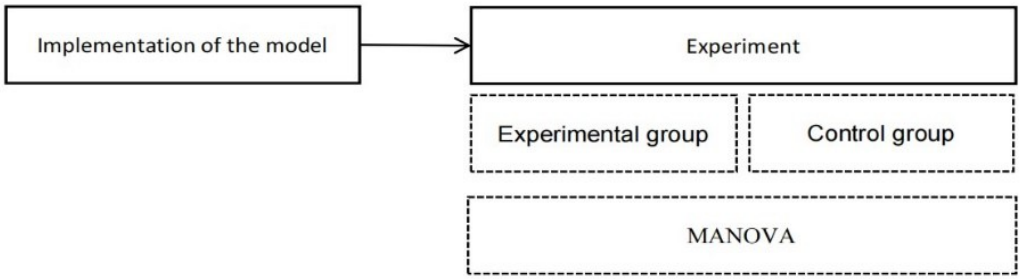

Figure 7. Test Arrangement

4. RESULTS

4.1. Does the game-based flipped classroom (GBL+FC) model improve performance in solfeggio course?

The pre-test and post-test focused on five indicators of students' performance, with four questions for each indicator. Therefore, each group had 20 questions in total, with each question worth 5 points, for a total of 100 points.

The experiment was conducted in the electronic classroom, and the teaching plan was validated. The results of the experiment are presented here.

Table 4. Normal Distribution of Pre-test Scores

	Group	Shapiro-Wilk Statistic	Df	Sig.
Pre-test	Control group	0.97	45	0.395
	Experimental group	0.96	45	0.192

The Shapiro-Wilk test results for the pre-test scores of both the control and experimental groups show that the data are normally distributed. For the control group, the test statistic was 0.97 with a significance value of 0.395, while for the experimental group, the test statistic was 0.96 with a significance value of 0.192. Both p-values are greater than 0.05, which confirms that the pre-test scores of both groups follow a normal distribution. This normality allows for the use of parametric tests in further analyses, ensuring that the statistical methods applied to evaluate the effectiveness of the GBL+FC model on student performance are appropriate.

Table 5. Pre-test Results: Control Group and Experimental Group

IV	n	X	S	Levene's test		t	df	Sig.
				F	Sig.			
Group	C 45	63.94	10.29	0.53	0.469	-1.31	65	0.099
	E 45	67.35	11.09					

DV was Pre-test score. Shapiro-Wilk of Group C and E were .967 and .957 Sig. were .395 and .192

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Table 5 shows the pre-test results for both the control group (C) and the experimental group (E). The control group had a mean score of 63.94 with a standard deviation of 10.29, while the experimental group had a mean score of 67.35 with a standard deviation of 11.09. Levene's test for equality of variances gave a value of 0.53 with a p-value of 0.469, indicating that the variances of the two groups are equal. The t-test showed a t-value of -1.31 and a p-value of 0.099, meaning there is no significant difference between the two groups' pre-test scores. Additionally, the Shapiro-Wilk test confirmed that both groups' scores are normally distributed, with p-values of 0.395 for the control group and 0.192 for the experimental group, both greater than 0.05. This confirms that both groups have similar pre-test scores, with equal variances and normal distribution, ensuring the validity of further comparisons and the reliability of the study's results.

Table 6. Post-test Results: Control Group and Experimental Group

Group	N	Mean (X)	Standard Deviation (SD)	Shapiro-Wilk Statistic	Shapiro-Wilk Sig.	Levene's Test (F)	Levene's Test Sig.	t-value	df	Sig. (2-tailed)
Control Group (C)	45	69.20	9.80	0.965	0.312	0.47	0.495	-4.85	88	0.000
Experimental Group (E)	45	85.50	8.60	0.972	0.421	-	-	-	-	-

The post-test results show a clear difference between the control group and the experimental group in table 6. The control group achieved a mean score of 69.20 with a standard deviation of 9.80, while the experimental group, which used the GBL+FC model, scored significantly higher with a mean of 85.50 and a standard deviation of 8.60. This indicates that the experimental group performed much better in the post-test compared to the control group.

Statistical analyses confirm the significance of these results. The Shapiro-Wilk test confirmed normal distribution for both groups ($p > 0.05$), and Levene's test showed equal variances ($p = 0.495$). An independent t-test revealed a statistically significant difference between the two groups ($t = -4.85$, $p = 0.000$), highlighting the effectiveness of the GBL+FC model in improving learning outcomes.

4.2. Does the use of GBL+FC approach compared to the traditional teaching method, have a significant effect on enhancing student engagement in solfeggio course?

The results in Table 8 highlight significant differences in engagement between the control group (CG) and the experimental group (EG) across all categories. In behavioral engagement, the EG scored 19.50, significantly higher than the CG's 15.00. Similarly, in emotional engagement, the EG achieved a mean score of 19.80, compared to the CG's 14.20. For cognitive engagement, the EG scored 20.20, while the CG scored 15.10, and in active engagement, the EG scored 20.00 compared to the CG's 15.30. These higher scores across all dimensions indicate that the GBL+FC model significantly enhances student engagement.

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Table 8. Descriptive Statistics of the Items of Engagement

Engagement	Item	Group	Mean	Std. Deviation
Behavioral	CG	45	15.00	1.750
	EG	45	19.50	0.950
Emotional	CG	45	14.20	1.400
	EG	45	19.80	0.900
Cognitive	CG	45	15.10	1.600
	EG	45	20.20	0.850
Active	CG	45	15.30	1.550
	EG	45	20.00	0.920

The experimental group's consistently higher engagement levels suggest that students in the gamified flipped classroom were more motivated, emotionally invested, cognitively involved, and actively participating in their learning compared to those in the traditional classroom. This underscores the effectiveness of the GBL+FC model in fostering a more engaging and interactive learning environment.

4.3. Does GBL+FC model improve student satisfaction in solfeggio course?

Table 9. Students Perceptions of the Gamified Flipped Classroom Model: Strengths, Challenges, and Suggestions for Improvement

Perceptions and Suggestions	Related Area/Explanation	Frequency of Mention
Course Design		
The course design is innovative and engaging	The course design introduces innovative and interactive elements, capturing students' interest.	12
Effectiveness of using game elements (Games: Dancing Line and Rhythm Master)	Game elements increase student engagement and enhance learning motivation.	10
Design of student collaboration and interaction	Group work and discussions enhance understanding and problem-solving abilities.	9
Self-directed learning and feedback mechanisms	Independent and flexible self-directed learning promotes personal growth and learning progress	8
Skill Development		
Development of communication and collaboration skills	Students improved communication and collaboration skills through group work.	8
Development of critical thinking and writing skills	The course encourages critical thinking and enhances writing and expression abilities.	6
Convenience of use	The platform is user-friendly, and game tools enhance interaction and engagement.	8

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Convenience of using the online platform (Chaoxing)	The online platform is functional and convenient for students to use for supplementary learning and resource searching.	7
Ease of using gamified elements	The game-based tools are easy to use, enhancing student interaction and making learning more engaging.	6
Expectations for the Teaching Model		
Desire for more flexible course structure and pace	Students would like the course schedule to be more flexible, with a pace that isn't too fast or slow.	5
Desire for more interactive and practical opportunities	Students expect more in-class interaction and hands-on opportunities to reinforce learning.	7
Suggestions for Improvement	Enhance game variety, improve platform stability, and provide more post-class tutoring and skill training for better learning.	8
Increase variety of game elements	More diverse game content could increase the course's appeal and challenge.	6
Improve platform stability and functionality	The online platform's stability and interactive features need improvement to enhance the learning experience.	5
Increase post-class tutoring and skill training	Students hope for more post-class tutoring and skill development opportunities to solidify their learning.	6

Table 9 shows students' positive response to the GBL+FC model. They found the course design engaging and appreciated the use of game elements, which increased motivation. Collaboration was praised, as group work helped students understand the material. The course was effective in developing skills like singing, music theory, and collaboration.

Students found the Chaoxing platform easy to use but suggested it could be more interactive and stable. The gamified tools were well-received for making learning more fun. Looking ahead, students wanted more flexibility in pacing, more in-class interaction, and a greater variety of game elements. They also suggested improving platform stability and offering more post-class support.

In conclusion, students were generally satisfied with the model but identified areas for improvement.

Table 10. the mean and standard deviation of satisfaction

Group	Mean	Std
Control Group	43.49	6.51
Experimental Group	65.11	5.61

Table 10 shows the mean and standard deviation of satisfaction scores for both the control group and the experimental group. The control group had a mean score of 43.49 with a standard deviation of 6.51, while the experimental group had a mean score of 65.11 with a standard deviation of 5.61. These results indicate that the experimental group had significantly higher satisfaction scores compared to the control group, suggesting that the GBL+FC model led to greater student satisfaction. This study also includes a qualitative analysis, which summarizes the experiences of students, teachers, and experts using GBL+FC model in solfeggio course. As shown in Table 10 below.

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Table 11. Qualitative Results of the Students, Teachers, and Experts Experience with GBL+FC model

Category	Finding	Data Sources
Perception of the Model	Students have a positive perception of GBL+FC model's ability to enhance learning engagement.	"The game-based learning helped me stay engaged and the flipped classroom allowed me to study at my own pace" (S1, Student 25).
	Teachers found GBL+FC model effective in motivating students and improving participation.	"I noticed higher participation in class, and students seemed more focused and motivated during the games" (T1, Teacher 3).
Engagement in Game-Based Activities	Students reported increased behavioral, emotional, and cognitive engagement through gamification.	"The rhythm games helped me improve my timing and focus. I was more engaged than in traditional lessons" (S2, Student 12).
	Teachers observed greater enthusiasm and interaction among students during game-based activities.	"The games encouraged students to collaborate more, and they seemed to enjoy the learning process more" (T2, Teacher 2).
Student Satisfaction	Students expressed higher satisfaction with GBL+FC model compared to traditional teaching.	"I prefer this method. The games made the lessons more interesting and less stressful" (S3, Student 45).
	Experts highlighted that GBL+FC fostered a more flexible and personalized learning experience.	"The students were able to learn at their own pace and engage more with the materials, which increased their overall satisfaction" (E1, Expert 3).

Notes: **S** refers to Students (90 total), with identifiers like S1, S2, etc. **T** refers to Teachers (5 total), with identifiers like T1, T2, etc. **E** refers to Experts (5 total), marked as E1, E2, etc.

It summarized the qualitative feedback from 90 students, 5 teachers, and 5 experts regarding GBL+FC model in solfeggio course in table 11. The data is categorized into three areas: Perception of the model: Students appreciated the flexibility and engagement provided by GBL+FC model. Teachers noted increased participation, and experts highlighted the model's effectiveness in fostering a personalized learning experience. Engagement in game-based activities: Students reported higher levels of engagement across behavioral, emotional, and cognitive dimensions, with many appreciating the rhythm-based games. Teachers observed more enthusiasm and collaboration in class, while experts confirmed the positive impact on student interaction. Student satisfaction: Students expressed higher satisfaction with GBL+FC compared to traditional methods, finding the lessons more enjoyable. Teachers noted a more positive attitude from students, and experts affirmed the model's role in improving overall satisfaction by promoting active participation and self-paced learning.

The findings suggest that GBL+FC effectively enhances student engagement, performance, and satisfaction in solfeggio course.

5. DISCUSSION

5.1. Impact of GBL+FC model on Solfeggio Performance

This study demonstrates the effectiveness of the game-based flipped classroom (GBL+FC) model in improving performance in solfeggio course. The results are consistent with Lumbantoruan's [1] study, which found that students show higher metacognitive awareness and better performance when actively engaged in the learning process through game-based methods. The model significantly boosts student engagement by incorporating interactive and game-based elements that make learning more enjoyable and motivating. These elements, coupled with the flipped learning component, enable students to review

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materials at their own pace, which is crucial for mastering complex subjects like solfeggio. The experimental group's improved post-test scores confirm the model's effectiveness in enhancing performance. Furthermore, the integration of active learning strategies, such as collaboration and problem-solving, creates a supportive environment, reinforcing the positive impact of GBL+FC on students' academic outcomes.

5.2. GBL+FC model Enhances Student Engagement in Solfeggio

The data from the engagement scale reveal that GBL+FC model significantly enhances student engagement across all four dimensions: behavioral, emotional, cognitive, and active engagement. This aligns with Salafiyah and Kevin's [2] finding that students' attitudes are a critical factor in adopting new learning approaches. The experimental group displayed higher engagement in each category compared to the control group, which followed traditional methods. The model's interactive and motivating design fosters greater participation, encouraging students to take an active role in the learning process. Additionally, it promotes emotional investment and cognitive involvement, as students connect with the content on a deeper level. These findings underscore the effectiveness of GBL+FC model in creating a dynamic and engaging learning environment that encourages active participation and emotional connection to the subject matter, aligning with previous studies [9] on the positive relationship between engagement and learning outcomes.

5.3. The Impact of GBL+FC model on Student Satisfaction in Solfeggio

The satisfaction scores demonstrate a clear advantage for GBL+FC model, with students reporting significantly higher satisfaction compared to those in the control group. This result is consistent with the findings of Brull & Finlayson [8] that effective, interactive learning methods enhance student satisfaction. The higher satisfaction in the experimental group suggests that the game-based flipped classroom model offers a more engaging and enjoyable learning experience. The game-based elements likely contribute to students' motivation by making learning feel more interactive and rewarding. Additionally, the flipped classroom approach, which allows students to engage with materials at their own pace, further increased satisfaction by promoting flexibility and independent learning. These findings support the argument that active learning approaches, such as GBL+FC, enhance not only engagement but also overall student satisfaction, thus leading to a more effective and fulfilling learning experience.

6. CONCLUSION

The GBL+FC model effectively merges game-based learning (GBL) and flipped classroom (FC) strategies to create an engaging, student-centered learning environment. By enabling students to review materials independently and apply knowledge in interactive classroom activities, the model fosters deeper understanding and retention. Game elements such as interactive tasks, team challenges, and recognition systems enhance motivation and participation, making learning more enjoyable and productive

The integration of technology plays a key role in supporting personalized learning and collaboration. Real-time feedback tools and online resources provide continuous support, enabling students to adjust their learning strategies for better outcomes. This approach shifts the teacher's role to that of a facilitator, empowering students to take ownership of their learning and engage more actively.

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In sum, the GBL+FC model improves performance, engagement, and satisfaction, offering a modern, technology-driven approach that enhances learning outcomes while promoting deeper cognitive engagement and student autonomy.

6.1. Significance of The Study

The study demonstrates the impact of the GBL+FC model on enhancing solfeggio performance through interactive game elements and self-paced learning. It supports both cognitive and affective development, leading to better retention and understanding of music concepts. The model also increases motivation, collaboration, and engagement, providing valuable insights into how technology can improve music education outcomes.

6.2. Limitations and Future research

Limitations of this study include the scale used to measure engagement and satisfaction, which may not fully capture the complexity of gamified and flipped learning experiences. Future research should explore other dimensions of engagement and validate the model across diverse student populations. Further investigation into the role of different game-based platforms and adaptive learning technologies is also needed, along with consideration of socio-economic factors that could affect access to digital resources.

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Authors state no funding involved.

Muyi Li was responsible for the conceptualization and methodology of the study, as well as the formal analysis and investigation. Muyi Li also contributed to the writing of the original draft and review of the manuscript.

Dr. Jirarat Sitthiworachart (Corresponding Author) managed the project, ensured the communication between authors, and oversaw the submission, revision, and publication process.

Dr. Jirarat Sitthiworachart contributed to the methodology, writing the original draft, and revisions of the manuscript.

Dr. Thanin Ratanaolarn contributed to the investigation, formal analysis, and writing the review and editing of the manuscript. Dr. Thanin Ratanaolarn also provided critical revisions and feedback during the preparation of the manuscript.

All authors read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The research related to animal use has complied with all relevant national regulations and institutional policies for the care and use of animals.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author,muyi Li, upon reasonable request.

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