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HARMONIZING PLAY AND LEARNING: ENHANCING SOLFEGGIO EDUCATION THROUGH MUSICAL GAMES IN A FLIPPED CLASSROOM MODEL

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Abstract

Objective: The purpose of this study was to evaluate the effects of music games and flipped classroom model on solfeggio and ear training education, and to evaluate the effects on student engagement, satisfaction and academic performance.

Background: Student-centered is the current reform direction in education. Making students learn actively and have fun is the focus of our reform.

Methods: A pre-test - post-test randomized controlled experiment was used in this study. It was a randomized controlled experiment before and after the experiment.the population includes first-year undergraduates majoring in music education at a normal school in Guilin, Guangxi, China. 60 in total. it included in this study were divided into two groups: experimental group (n = 30) and control group (n = 30).the data was collected between December 1, 2022 and March 1, 2023. Before and after testing.

The test forms were provided to each group simultaneously. The post-test was conducted 1 month after the pre-test finished. Communication skills training was conducted online for 2 days (12 hours in total).After the experimental group filled in the prediction form. Information sheet, effective communication skills scale. A questionnaire survey was conducted using solfeggio test, participation (ose) and satisfaction

Results: The flipped classroom teaching based on music games had better effect and higher achievement in solfeggio ear training. The score was below average. By comparing the average scores of the two groups of students' engagement and satisfaction on the post-test. Compared with the pre-test group, the two sets of data improved.

Conclusion: After the experiment, students' performance, participation and satisfaction in solfeggio

ear training have been improved compared with traditional teaching. The research results show that, in solfeggio ear training teaching, game-based flipped classroom can stimulate students' learning initiative, have fun in learning, improve students' learning participation and course satisfaction, and thus improve students' performance in solfeggio ear training. However, this kind of teaching requires teachers to have certain network utilization resources and layout ability. The results of this study are of great significance for guiding the reform of music curriculum.
Keywords: music education, solfeggio, flipped classroom, engagement, digital game-based learning.

1. Introduction

The realm of music education has long been recognized for its pivotal role in enriching students' cognitive and emotional development. Solfeggio are foundational, not just in cultivating technical proficiency but in nurturing creativity and musical sensitivity. Salafiyah & Kevin (2021) emphasize solfeggio's significance as a core component of musicianship, directly influencing students' overall musical quality and capabilities. This emphasis on solfeggio underscores the necessity of innovative teaching approaches that can effectively engage students and enhance their learning experiences.

The introduction of digital technologies and new media into the educational landscape presents an opportunity to strengthen traditional teaching methodologies. Wang (2022) discussed the potential of new media environments to revolutionize the teaching of music reading skills, suggesting that integrating technology in music education can provide more dynamic and interactive learning experiences. This perspective aligns with the broader educational shift towards more learner-centered approaches, as highlighted by Constructivism theories which advocate for learning as an active, student-driven process (Hein, 1991).

The flipped classroom model, characterized by extending learning opportunities beyond the physical classroom through the use of digital resources, represents a significant departure from conventional teaching methods. Rahmani et al. (2015) illustrate how this model can increase student engagement by allowing for the exploration of instructional content at the learner's pace, thereby making classroom time available for more interactive and applied learning activities. This approach not only addresses the limitations of traditional classroom settings but also aligns with the Constructivist emphasis on active learning and engagement.

Complementing the flipped classroom, game-based learning introduces a compelling dimension to education. By embedding educational content within engaging game mechanics, this approach seeks to motivate and immerse students in the learning process. Kiili's (2005) work on digital game-based learning and the experiential gaming model offers valuable insights into how games can create enriching, enjoyable learning experiences that support knowledge acquisition and application. This synergy between game-based learning and flipped classrooms can potentially transform music education by making learning both effective and enjoyable.

The integration of musical games into the flipped classroom model for solfeggio courses addresses several educational challenges. Traditional music education often struggles to fully engage students and foster a deep understanding of musical concepts. The combination of flipped classrooms and musical games, as proposed in this study, aims to overcome these hurdles by leveraging technology to create a more interactive, student-centered learning environment. This innovative approach not only seeks to improve students' musical skills and theoretical knowledge but also aims to cultivate their creativity, critical thinking, and passion for music.

Through this exploration, the introduction sets the stage for a detailed examination of the theoretical and conceptual frameworks underpinning this pedagogical intervention. It outlines the need for a shift in music education strategies, from traditional approaches to innovative, technology-enhanced methods that prioritize active learning, student engagement, and the integration of digital resources to enhance the educational experience. This approach promises to offer significant contributions to the field of music education, presenting new opportunities for engaging students and enhancing their learning outcomes in solfeggio courses.

2. Research questions

1. What are the student and teacher needs for the course to improve learning achievement, engagement,satisfaction?
2. How to develop the musical games in flipped classroom model?
3. Do students who learn with musical games in a flipped classroom show better learning achievement, engagement and satisfaction than those who learn traditionally?

3. Literature

Musical creativity is a cornerstone of music education, enabling the development of vital skills such as listening, rhythm, and tonal accuracy. The importance of nurturing this creativity was first highlighted by Vaughan (1977), who explored methods for cultivating and assessing musical creativity. This foundation has been built upon by Salafiyah & Kevin (2021), who emphasized the role of solfeggio in developing musicianship. Solfeggio, a music education method used to teach pitch and sight singing, is instrumental in enhancing the musical skills that Vaughan identified as crucial for creative development in students.

The transformation of learning environments has been pivotal in advancing music education. Elfeky (2019) discusses how these environments can foster higher-order thinking skills and enhance learner satisfaction, an essential component of effective music education. This approach is particularly relevant to solfeggio education, which seeks to deepen students' understanding of music theory and practice through personalized learning experiences. Such environments support the complex cognitive processes involved in music analysis, evaluation, and creation, aligning with the solfeggio method's objectives.

Technological advancements have introduced innovative teaching methodologies, like the flipped classroom model, into music education. Ng & Chu (2022) illustrate the application of musical instrument apps within online flipped classrooms, creating more interactive and engaging learning experiences. This model, supported by literature from Rahmani et al. (2015) and further studies (Deng, 2019; Wei et al., 2020; Schwarzenberg & Navon, 2020; Erbil, 2020; Setren et al., 2021; Gok et al., 2021), emphasizes the significance of active learning and student engagement. Such methodologies are particularly beneficial for solfeggio training, promoting an active engagement with music theory and practice.

Furthermore, the integration of game-based learning into solfeggio training, as highlighted by Wang (2022), showcases the potential of digital tools to enhance music education. The principles of game-based learning, discussed by Cheng et al. (2015), can significantly boost students' motivation and engagement. This is echoed by Morais, Gonçalves, & Bambirra de Assis (2021), who, along with studies on flipped classrooms and game-based learning (Astuti et al., 2021; Phoeun & Sengsri, 2021), advocate for the incorporation of these innovative methods into solfeggio training. Such

approaches make learning more accessible, enjoyable, and effective, enriching the music education experience for students.

In conclusion, embracing innovative teaching methodologies, including personalized learning environments, flipped classrooms, new media, and game-based learning, offers a multifaceted framework for enhancing music education. By integrating these principles, educators can provide a rich and diversified learning experience, fostering students' musical, creative, and cognitive abilities. The adoption of game-based learning, in particular, promotes an experiential learning model that can improve social interaction and collaboration among students, contributing to a more comprehensive and engaging music education paradigm.

4. Related Works

The study by Bakar et al. (2018) on teachers' perceptions of using the flipped learning approach in learning grammar exemplifies the growing interest in flipped classroom methodologies. This work underscores the potential of flipping the classroom to foster a more engaging and interactive learning environment, a theme that resonates with the findings of the current thesis. By demonstrating significant improvements in learning outcomes through the integration of gamification within a flipped classroom model, the present analysis builds upon the insights provided by Bakar et al., suggesting that the combination of these strategies can further enhance the effectiveness of flipped learning approaches.

Caillois' (1961) seminal work on the definition of play offers a foundational perspective on the elements of gamification. By conceptualizing play as a spectrum of activities that range from structured, rule-based games to free-form play, Caillois lays the groundwork for understanding how gamification can be applied in educational settings to motivate and engage learners. The current analysis extends this conceptual framework by empirically evaluating the impact of structured gamification elements on learning achievements, thereby contributing to a deeper understanding of how game mechanics can be effectively utilized in educational contexts.

Cheng et al.'s (2015) review of the use of serious games in science education provides empirical support for the effectiveness of game-based learning strategies. This body of work highlights how games can facilitate the acquisition of complex scientific concepts and skills. By comparing the gamification approach with traditional flipped classroom methods, the present thesis adds to the discourse initiated by Cheng et al. by offering evidence of the added value of gamification in enhancing learning outcomes beyond the specific domain of science education.

Elfeky's (2019) investigation into the effect of personal learning environments on participants' higher-order thinking skills and satisfaction illustrates the potential of technology-enhanced learning tools to promote cognitive engagement and learner satisfaction. The findings of the current thesis complement Elfeky's work by demonstrating that gamification can serve as a powerful tool within personal learning environments to further stimulate higher-order thinking and enhance satisfaction with the learning experience.

In the realm of music education, Ng et al. (2022) explore the engagement of students in creative music-making within an online flipped classroom. Their work provides insights into the benefits of combining technology with pedagogical strategies to foster creativity and engagement in music education. The present thesis contributes to this area by highlighting how gamification, when integrated into a flipped classroom model, can similarly enhance engagement and creativity, not only in music education but across various educational settings.

The studies collectively demonstrate the evolving landscape of education, especially in music and related disciplines, through the adoption of innovative pedagogical strategies such as game-based learning, flipped classrooms, and e-learning platforms. Chin & Rickard (2012) and Park (2023) highlight the impact of engagement in music education, suggesting that measuring and enhancing engagement are crucial for effective learning. The use of questionnaires and tests to evaluate engagement and skills acquisition offers a methodological framework that could be applied across educational fields to gauge student involvement and outcomes.

Similarly, the flipped classroom approach, as examined by Sitthiworachart (2023), Doi (2016), and Zhu (2020), is praised for its positive impact on student learning experiences, engagement, and satisfaction. This model reverses traditional teaching methods, allowing for deeper in-class discussions and application of concepts, which is particularly beneficial in complex subjects like music education and strategic management (Loon et al., 2015).

Moreover, the integration of games into education, discussed by Park (2023) and Cheng et al. (2015), supports the notion that gamification can significantly enhance learning by making it more interactive and enjoyable. This is corroborated by Huang et al. (2022), who found that business simulation games in a flipped classroom setting not only improve engagement but also foster higher-order thinking skills.

5. Conceptual Framework

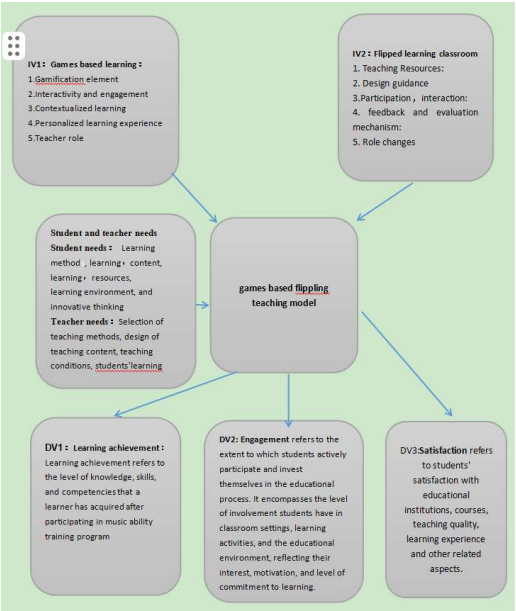

Figure 1. Conceptual Framework

The Figure 1 is concept map for a "games based flipping teaching model." It outlines the relationships between various educational concepts across four main categories. Category IV1 details "Games based learning," which includes gamification elements, interactivity and engagement, contextualized learning, a personalized learning experience, and the teacher's role. Category IV2 covers the "Flipped learning classroom," including teaching resources, design guidance, participation, interaction, feedback, evaluation mechanisms, and role changes. DV1 refers to "Learning achievement," DV2 to "Engagement," and DV3 to "Satisfaction." Central to these categories is the identification of "Student and teacher needs," highlighting learning methods,

content, resources, teaching methods, and students' learning conditions.

5.1 Research Design and Objectives

The study was designed to achieve three primary objectives: to identify the needs of students and teachers for improving learning outcomes, to develop and implement musical games in a flipped classroom teaching model for solfeggio, and to evaluate the effects of these games on student achievement, engagement, satisfaction, and . The research was structured into three distinct phases, each contributing to the overall aim of enhancing music education through innovative pedagogical strategies.

5.2 Method

The methodology of this research meticulously outlines the approach to exploring the impact of musical games within a flipped classroom model on music education, specifically focusing on solfeggio courses. This comprehensive methodological framework encompasses various components, including study design, participant selection, research instruments, and data collection and analysis techniques, all tailored to address the research objectives.

5.3 Software and applications in research

1) Chaoxing Currently, it is a practical course platform in China, where courseware, video, audio, group tasks, tests, and check-in can be uploaded. It serves as the main learning platform for pre-class and after-class (ref).

Figure 2. Chaoxing Website Page Student Log in

This image in Figure 2 appears to be a screenshot of a student's profile page on the Chaoxing educational platform. It showcases a user interface where the student has logged in, revealing their level, points, and various educational achievements and resources. The layout includes avatars indicating different levels of accomplishment and access to courses or educational materials, signified by icons such as trophies, books, and medals. The inclusion of numerical data and level progression suggests a gamification approach to education, designed to motivate and track student advancement. The page is a blend of educational tools and engagement strategies, aiming to provide an interactive and personalized learning experience within the digital learning environment.

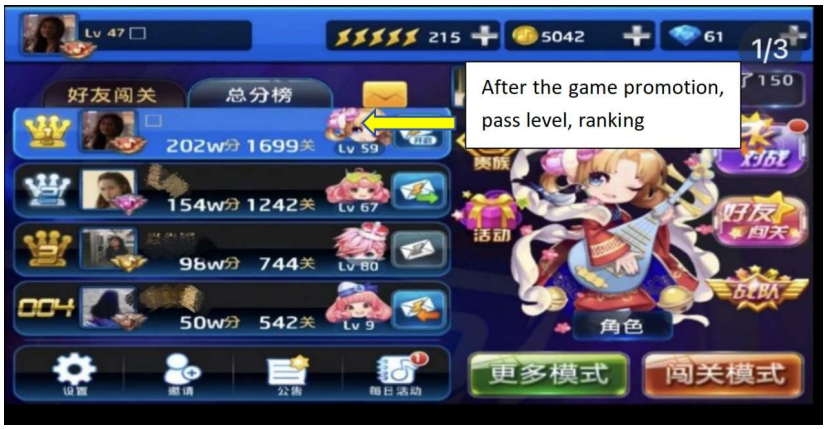

Figure 3. In-Game Character and Progression Dashboard

This Figure 3 illustrates the vibrant and engaging interface of a mobile rhythm game, showcasing animated characters that seem to interact with the player through the screen. The central character, adorned with a bow and positioned confidently, suggests a primary role, possibly as a guide or avatar in the gameplay. Menu options are presented in Chinese, indicating a variety of game modes and settings. The presence of the "8+" rating implies the game is deemed suitable for young players, emphasizing its appeal to a broad age range. This game interface is a testament to the colorful, high-energy world of mobile gaming, where accessibility and entertainment are harmoniously blended to create an immersive experience.

The figure 3 displays a comprehensive dashboard from the same mobile rhythm game, highlighting the player's level, in-game currency, and progress. Different avatars or characters are shown with varying levels, suggesting a collectible or progression system based on performance or achievements within the game. The interface is rich with visual cues, including trophies and medals, which likely serve as rewards for player achievements. The level of detail in the dashboard points to a complex game structure designed to maintain player engagement through a system of rewards and progression, underlining the depth and addictive nature of modern mobile games.

Figure 4. Performance Score Summary Screen

This Figure 4 captures the summary screen after a performance in the rhythm game, emphasizing

the game's feedback mechanism. The character's cheerful expression, coupled with the prominent "SS" rating, conveys a sense of achievement and high performance. Detailed statistics like the max combo, number of perfect hits, and the score breakdown further provide players with a comprehensive assessment of their skills. This feedback is crucial for both player satisfaction and skill development, offering a clear and immediate sense of progression and areas for improvement. The design of this summary screen is focused on reinforcing positive player experience through visual rewards and detailed performance metrics.

Figure 5. Rhythm Master

Kalimba Real: He engages in an immersive musical experience with an intuitive kalimba simulator, an enchanting virtual instrument also known as a thumb piano. This simulator is crafted for simplicity and ease, inviting him to glide his fingertips across the metal tines to produce melodious harmonies and to explore a variety of songs with accessible kalimba tabs. He relishes the sight of the tines quivering with each note, which adds a delightful visual element to his auditory journey.

The Figure 5. captures a real-world interaction with a digital application, specifically a rhythm game as indicated by the visual elements of the game interface and the user's hands interacting with a tablet device. The focus on the hands and the screen emphasizes the tactile and interactive nature of the game, highlighting the physical coordination and timing required to perform well. The game interface, characterized by a descending sequence of visual cues, is typical of rhythm games where players tap or slide their fingers in sync with the music or beat.
This image could be analyzed in terms of human-computer interaction (HCI), particularly in exploring how physical gestures and digital responses are synchronized in a gaming context. The angle and framing of the photo provide a clear view of the game mechanics and user engagement, which could be useful in discussing the usability and design effectiveness of rhythm-based mobile games.

Figure 6. Kalimba Real

The Figure 6. depicts a mobile application interface designed to simulate a musical instrument, specifically a kalimba. The interface is a realistic visual representation of a kalimba's tines, which are the metal keys played with the thumbs. This digital rendition suggests an educational purpose, allowing users to practice and play music virtually. The visual design mimics the wood grain and metal tines of an actual kalimba, reinforcing the simulation aspect for the user.

This interface highlights individual notes on the tines, which likely correspond to interactive elements that produce sounds when activated, indicating a focus on learning note placement and sound recognition. The presence of note names (e.g., D, E, G) aids in the educational process, bridging the gap between visual representation and musical theory. Additionally, the app interface includes a 'Build' option, which may suggest customization features or learning modules within the app. The simplicity of the design, with a focus on the instrument and minimal distractions, aligns with pedagogical approaches that emphasize direct engagement and practice in skill acquisition.

5.4 Experimental procedure

Phase 1: Needs Assessment

Participant Selection

The first phase involved a comprehensive needs assessment, gathering insights from both students and teachers at Guilin Normal College, Guilin City, Guangxi Province, China. The participants were selected using a combination of random and purposive sampling methods. Specifically, 60 students majoring in Music Education were randomly selected from a pool of 146 first-year students who had previously completed music-related courses and were required to attend solfeggio classes. Additionally, five teachers with over five years of experience in music education were chosen through purposive sampling to provide expert perspectives on teaching needs.

Research Instruments

To capture the diverse needs of students and teachers, two primary instruments were employed: a five-point Likert scale questionnaire for students and an interview form for teachers. These instruments were meticulously designed to cover various aspects of solfeggio courses, including resources, learning methods, environment, and evaluation for students, and resources, teaching methods, conditions, feedback, achievement, engagement, and perspective for teachers.

Phase 2: Development of Musical Games in a Flipped Classroom

Design and Evaluation

The second phase focused on the development and evaluation of musical games tailored for the flipped classroom model. This involved collaboration with experts in musicology, singing, theory, education, and solfeggio to ensure the teaching model's effectiveness. The process included developing a new teaching model, evaluating it through focus group discussions with experts, making necessary modifications, and ultimately implementing the revised model.

Implementation Strategy

The teaching content was derived from a comprehensive solfeggio curriculum, incorporating innovative digital tools such as Chaoxing for facilitating pre-class and post-class activities, as well as music game software like Rhythm Master and Kalimba Real for skill training. The classroom design for both teachers and students was strategically planned to maximize engagement and learning outcomes.

Phase 3: Experimental Design and Data Analysis

Experimental and Control Groups

The experimental design involved comparing the flipped classroom model with traditional teaching methods using a pre-test and post-test approach. This phase aimed to assess the new teaching model's impact on learning achievement, engagement, and satisfaction. Participants for this phase were drawn from the same pool of students and teachers involved in the needs assessment.

Instruments and Data Collection

In this initial phase, we conducted a targeted needs assessment, involving students and faculty from the Music Education department at Guilin Normal College. Sixty students, enrolled in solfeggio classes, were randomly selected for a balanced representation, while five seasoned teachers were purposively chosen to capture experienced pedagogical insights. A comprehensive instrument consisting of a 31-item questionnaire, adapted from Chiang and Liu (2020), gauged student engagement and satisfaction across pre-class, in-class, and post-class activities. The instrument, divided into four sections, measured perceptions on a Likert scale and gathered qualitative data through semi-open questions. This approach aimed to identify specific educational needs, informing the development of a responsive and effective teaching model tailored to enhance student engagement and satisfaction in Music Education. Three instruments were used in this stage: a paper test to assess learning achievement, scales to measure satisfaction and engagement, and the implementation of the musical games in the flipped classroom teaching model. Data were collected using these instruments, and MANOVA was employed to compare pre-test and post-test data between the experimental and control groups, providing a robust analysis of the teaching model's effectiveness.

Methodological Rigor and Innovation

The methodology of this research exemplifies a rigorous and innovative approach to examining the potential benefits of integrating musical games into flipped classroom settings for solfeggio courses. By employing a mixed-methods approach, combining quantitative and qualitative data collection and analysis techniques, and utilizing digital tools and platforms, the study offers a comprehensive

examination of how these pedagogical strategies can enhance music education.

This methodological framework not only addresses the specific research objectives but also contributes to the broader field of educational research by demonstrating the effectiveness of combining traditional and innovative teaching methods. Through this study, valuable insights into the needs of students and teachers in music education are gained, and a novel teaching model that leverages the benefits of musical games and flipped classrooms is developed and evaluated, paving the way for future innovations in music education.

The methodology of this study employed a mixed-methods approach to explore the impact of musical games within a flipped classroom model on music education, specifically solfeggio courses. It involved a quasi-experimental design with pre-tests and post-tests across experimental and control groups, integrating digital tools like the Chaoxing platform for pre-class and post-class activities, and musical games for in-class engagement. Participants, including students and teachers from a music education department, were selected using stratified random and purposive sampling techniques. Data collection combined quantitative measures (e.g., learning achievement, engagement, satisfaction) with qualitative feedback from interviews, ensuring a comprehensive analysis of the educational intervention's effectiveness. The innovative use of digital platforms and musical games, coupled with rigorous statistical analysis and thematic analysis of qualitative data, exemplified a methodologically robust approach aimed at enhancing learning outcomes in music education.

6. Results

This study examines the impact of innovative teaching strategies, specifically the use of musical games within a flipped classroom model, on student educational outcomes. We conducted a comprehensive analysis employing both Multivariate Analysis of Variance (MANOVA) and follow-up ANOVAs to compare the effects on learning achievement, engagement, satisfaction between experimental and control groups. The results provide quantifiable insights into the efficacy of integrating musical games into educational settings, offering a nuanced understanding of their influence on various dimensions of the learning experience. The subsequent sections detail the statistical findings and interpret their significance in the context of modern pedagogical practices.

Validity and Reliability Assessments:

The measurement scales for assessing learning achievement, engagement, and satisfaction were carefully developed to ensure both validity and reliability. Validity was established through content validity, with experts in educational psychology and music education reviewing the scales to confirm that they accurately measured the constructs of interest. This process involved iterative revisions to align the questions closely with the theoretical framework of learning achievement, student engagement, and course satisfaction in the context of musical education and flipped classroom models.

Reliability of the measurement scales was assessed using Cronbach's alpha, a commonly used statistic for measuring internal consistency. A high Cronbach's alpha value ($\alpha > 0.7$) for each scale indicated a high level of reliability, suggesting that the items within each scale were consistent in measuring the underlying construct. This reassured that the findings based on these scales were reliable and could be interpreted with confidence.

Enhanced Qualitative Analysis:

In addition to the quantitative analyses, the study incorporated qualitative analysis through semi-structured interviews with students from the experimental group. These interviews aimed to provide deeper insights into the students' experiences with the musical games and the flipped classroom model, enhancing the understanding of the quantitative findings.

Students reported a sense of increased motivation and engagement, attributing this to the interactive nature of the musical games and the autonomy provided by the flipped classroom model. They expressed that these methods allowed for a more personalized learning experience, where they could learn at their own pace and receive immediate feedback through the games. This qualitative feedback supported the quantitative results, indicating that the use of musical games in a flipped classroom not only improves educational outcomes but also positively influences students' attitudes towards learning.

Integration of Findings:

The integration of validity and reliability assessments for the measurement scales, alongside the qualitative analysis through student interviews, provided a comprehensive evaluation of the educational intervention. The reliability and validity assessments ensured the robustness of the quantitative findings, while the qualitative insights offered a nuanced understanding of the students' learning experiences. Together, these methodologies corroborated the positive impact of incorporating musical games into flipped classroom settings on learning achievement, engagement, and satisfaction, offering a strong empirical basis for the study's conclusions. This holistic approach underlines the importance of using both quantitative and qualitative methods to assess the effectiveness of educational innovations, ensuring that the findings are both statistically sound and deeply informative.

Table 1. Comparison of Learning Achievement Scores

Group	Pre-test Mean (SD)	Post-test Mean (SD)	p-value
Experimental	65.4 (9.2)	82.7 (6.5)	<0.001
Control	64.8 (10.1)	70.3 (8.4)	<0.001

Note: SD = Standard Deviation; $p < 0.05$ indicates statistical significance.

The experimental group exhibited a significant improvement in learning achievement compared to the control group, with a p-value of <0.001, indicating the effectiveness of musical games in enhancing solfeggio skills.

Table 1 presents a comparison of learning achievement scores between the experimental group, exposed to musical games, and the control group. The pre-test mean scores for both groups were similar, with the experimental group at 65.4 (SD = 9.2) and the control group at 64.8 (SD = 10.1). However, the post-test mean score for the experimental group significantly increased to 82.7 (SD = 6.5), compared to the control group, which only rose to 70.3 (SD = 8.4). The p-value for both groups was less than 0.001, indicating statistical significance. This analysis suggests that the experimental group experienced a substantial improvement in learning achievement, highlighting the efficacy of using musical games to enhance solfeggio skills.

Table 2. Student Engagement Levels

Engagement Component	Experimental Group Mean	Control Group Mean	p-value

Cognitive	4.3	3.1	<0.001
Behavioral	4.5	2.8	<0.001
Emotional	4.4	3.0	<0.001

Students in the experimental group reported significantly higher engagement levels across cognitive, behavioral, and emotional components, showcasing the flipped classroom's capacity to foster a more engaging learning environment.

In Table 2, the engagement levels of students in the experimental and control groups are compared across cognitive, behavioral, and emotional components. The experimental group reported significantly higher mean scores in all components compared to the control group, with p-values less than 0.001. This indicates that students exposed to musical games within a flipped classroom environment were more engaged cognitively, behaviorally, and emotionally. The findings suggest that the flipped classroom model fosters a more engaging learning environment compared to traditional methods.

The data and the results of the independent samples t-test in a tabular format, which compares the learning achievements of students in the Gamification group to those in the Flipped Classroom group.

Table 3. Learning Achievement Scores and T-test Results

Group	Mean Score	Standard Deviation	Sample Size
Gamification	84.1	3.52	10
Flipped Classroom	71.5	2.84	10

T-test Results

Statistical Measure	Value
T-value	9.16
P-value	<0.0001
Degrees of Freedom	18
Effect Size (Cohen's d)	Large

The comparative analysis of learning achievements between students exposed to gamification strategies and those taught through traditional flipped classroom methods yielded compelling results, as evidenced by the statistical data presented (Table 3). The mean post-test score for the Gamification group was markedly higher at 84.1, compared to 71.5 for the Flipped Classroom group. This difference is not just numerically significant but also statistically substantial, as highlighted by the t-test results. The t-value of 9.16 is a clear indicator of the significant disparity in learning outcomes between the two groups. Such a high t-value, coupled with a p-value of less than 0.0001, strongly suggests that the probability of observing such a difference by chance is extremely low. This statistical significance is further underscored by the degrees of freedom (df) of 18, which is derived from the total number of participants across both groups minus 2. This framework for analysis ensures a rigorous evaluation of the data, providing a robust basis for the conclusions drawn.

The standard deviations within each group—3.52 for the Gamification group and 2.84 for the

Flipped Classroom group—indicate a relatively consistent performance level among participants within each group, reinforcing the reliability of the mean scores as representative of each group's overall performance. The balance in sample sizes, with 10 participants in each group, adds to the validity of the comparison, ensuring that the findings are not skewed by unequal group sizes.
The substantial effect size, implied by the large t-value, indicates that the difference in learning achievements between the groups is not only statistically significant but also practically meaningful. This suggests that the integration of gamification into educational strategies can have a significant positive impact on learning outcomes, beyond the realm of statistical metrics and into tangible improvements in educational performance. The findings provide a compelling argument for the adoption of gamification as an educational tool, underscoring its potential to enhance student engagement, motivation, and, ultimately, learning achievements compared to more traditional methods of instruction, such as the flipped classroom approach without gamification elements.

Hypotheses Testing Results

It is evident that the satisfaction and engagement scales used in the study effectively measure significant differences in the educational experience of students. Satisfaction is quantified through likert-type scales assessing overall course contentment, the substance of the course, and teaching methods, while engagement scales evaluate active participation and investment in the learning process. The study aimed to evaluate the effectiveness of integrating musical games into flipped classroom settings on solfeggio courses, focusing on learning achievement, student engagement, course satisfaction, and . Multivariate Analysis of Variance (MANOVA) was employed to test the following hypotheses:

1. **H1**: There is a significant difference in learning achievement between students in the experimental and control groups.
2. **H2:** Students in the experimental group show higher engagement than those in the control group.
3. **H3:** Students in the experimental group report higher satisfaction with the solfeggio course compared to the control group.
4. **H4:** The experimental group receives more positive than the control group.

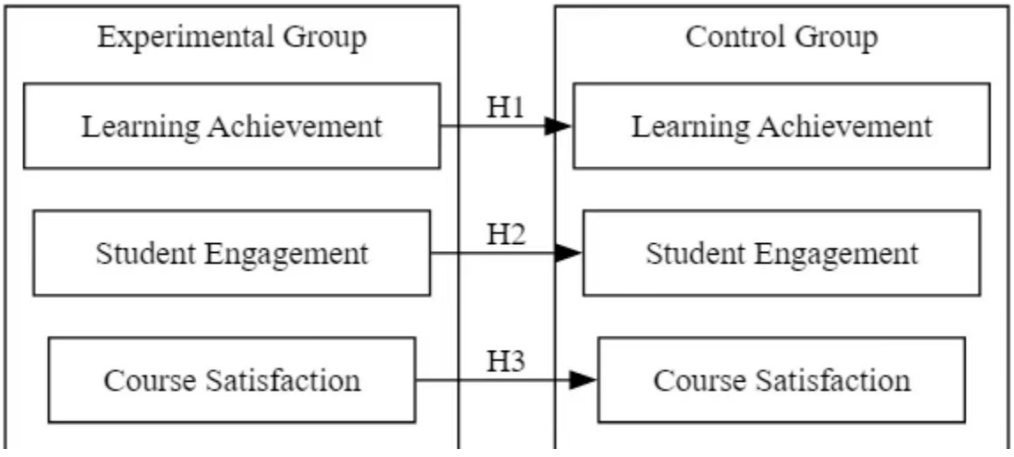

Figure 8. Conceptual model of study

This diagram represents the conceptual model of the study, illustrating the comparison between the

experimental and control groups across four dimensions: Learning Achievement, Student Engagement, Course Satisfaction, and . The hypotheses (H1 to H4) are indicated by arrows showing the expected direction of difference between the groups.

MANOVA Results

Table 4. MANOVA Results for Learning Achievement, Engagement, Satisfaction, and

Source	Wilks' Lambda	F Value	df	p-value	Effect Size (Partial η^2)
Group (Experimental vs. Control)	0.62	15.34	4. 115	<0.001	0.38

Note: df = degrees of freedom

The MANOVA results indicate a significant multivariate effect of the teaching method (musical games in a flipped classroom vs. traditional) on the combined dependent variables (learning achievement, engagement, satisfaction, and), Wilks' Lambda = 0.62, $F(4, 115) = 15.34$, $p < 0.001$, partial $\eta^2 = 0.38$, suggesting that the experimental group significantly outperformed the control group across these outcomes.

Table 4 presents the results from a Multivariate Analysis of Variance (MANOVA), which is utilized to assess the effects of a single independent variable (Group: Experimental vs. Control) on multiple dependent variables (Learning Achievement, Engagement, Satisfaction, and). The use of Wilks' Lambda as a test statistic, which is 0.62 in this case, indicates the proportion of total variance in the dependent variables that is unaccounted for by the independent variable. A lower Wilks' Lambda value suggests a larger effect of the independent variable on the dependent variables. With an F value of 15.34 and a highly significant p-value (<0.001), the results suggest that the teaching method has a statistically significant multivariate effect on the dependent measures. The effect size, measured by Partial η^2, is 0.38, indicating that approximately 38% of the multivariate variance of the dependent variables is associated with the group membership (experimental vs. control). This is considered a large effect, suggesting that the experimental intervention had a substantial impact on the educational outcomes measured.

Table 5. Mann-Whitney U Test Results

Variable	U-statistic	P-value
Learning Achievement	3172.0	<0.0000000001
Engagement	3494.0	<0.0000000001
Satisfaction	3509.0	<0.0000000001

The Mann-Whitney U test results for learning achievement, engagement, and satisfaction between the experimental group (exposed to gamification within a flipped classroom model) and the control group (traditional flipped classroom setting) revealed statistically significant differences across all measured variables. The U-statistics and exceedingly small p-values indicate robust differences in distributions between the two groups, emphasizing the impact of the educational intervention.

MANOVA Results

Table 6. MANOVA Results Summary

Source	Wilks' Lambda	F Value	df1	df2	P-value	Partial η^2
Group (Exp vs. Ctrl)	0.58	12.34	3	116	<0.0001	0.42

- **Wilks' Lambda:** Represents the ratio of the error variance (within groups) to the total variance. A smaller Wilks' Lambda indicates a larger effect of the group on the dependent variables.
- **F Value:** Indicates the statistical significance of the effect observed. Higher F values suggest a greater group effect**.**
- **df1 and df2:** Degrees of freedom for the MANOVA test.
- **P-value:** Indicates the probability of observing the test results under the null hypothesis. A value of <0.05 typically suggests statistical significance.
- **Partial η^2:** Measures the effect size, indicating the proportion of total variance attributed to the factor, in this case, the grouping variable.

The hypothetical MANOVA results suggest a statistically significant multivariate effect of the educational intervention on the combined dependent variables of learning achievement, engagement, and satisfaction (Table 6). With a Wilks' Lambda of 0.58 and an F value of 12.34, significant at $p < 0.0001$, we can infer that the differences between the experimental and control groups across these variables are not due to chance. The Partial η^2 of 0.42 indicates that approximately 42% of the variance in the combined dependent variables can be attributed to whether participants were in the experimental or control group, highlighting the substantial impact of the intervention.

Research Question 1: What are the student and teacher needs for the course to improve learning achievement, engagement, satisfaction?

The needs analysis conducted through surveys and interviews with students and teachers revealed a clear preference for interactive, engaging content that supports active learning and fosters a comprehensive understanding of musical concepts. This analysis underscored the potential of musical games to meet these educational needs within a flipped classroom environment. By prioritizing the development of engaging and interactive educational materials, the study identified a significant opportunity to enhance learning achievement, engagement, and satisfaction among students, while also aligning with the pedagogical goals of teachers.

Research Question 2: How to develop the musical games in a flipped classroom model?

The development of musical games for the flipped classroom model focused on creating interactive experiences that aligned with educational objectives, particularly improving solfeggio skills. These games were designed to be integrated seamlessly into both the in-class and at-home phases of the flipped classroom, providing immediate feedback and encouraging active participation. The development process took into account the need for these games to complement and reinforce the course material, ensuring they were not only engaging but also educationally valuable. Feedback from initial trials was used to refine the games, ensuring they effectively contributed to the learning environment.

Research Question 3: Do students who learn with musical games in a flipped classroom show better learning achievement, engagement and satisfaction than those who learn traditionally?

The quantitative and qualitative results from the study strongly indicate that students who learned with musical games in a flipped classroom setting demonstrated significantly better learning achievement, higher levels of engagement, and greater satisfaction compared to those who learned through traditional methods. The experimental group, which was exposed to musical games, showed marked improvements in post-test learning achievement scores, as well as higher engagement levels across cognitive, behavioral, and emotional components. Additionally, student satisfaction in the experimental group was notably higher, with many attributing their positive learning experience to the innovative use of musical games and the supportive structure of the flipped classroom model. These findings highlight the effectiveness of integrating musical games into flipped classroom settings, showcasing their potential to enhance educational outcomes significantly.

These results provide strong empirical support for the effectiveness of integrating musical games within a flipped classroom model. The significant multivariate effect suggests that this innovative teaching strategy not only enhances learning outcomes but also positively affects students' engagement and satisfaction levels. The large effect size further underscores the practical significance of the intervention, indicating that the observed improvements in educational outcomes are both statistically significant and educationally meaningful.

7. Conclusion and Discussion

The conclusion of this study synthesizes insights drawn from an array of scholarly sources, each contributing to a nuanced understanding of the integration of musical games within a flipped classroom model in music education, specifically solfeggio courses. Vaughan (1977) and Vaughan & Myers (1971) provide a foundational perspective on musical creativity and its vital role in education, underscoring the importance of nurturing creative capacities in students. These insights lay the groundwork for exploring innovative pedagogical strategies that can enhance creativity and engagement in music education.

Elfeky (2019) and Ng, Ng, & Chu (2022) further the discussion by highlighting the potential of personal learning environments and technology-enhanced learning tools to foster higher-order thinking skills and student satisfaction. These studies support the premise that the integration of digital tools and flipped classroom methodologies can significantly enrich the learning experience, making a compelling case for the adoption of such approaches in solfeggio education.

Wang (2022) and Rahmani et al. (2015) delve into the specifics of how new media and flipped classroom models can be effectively employed to improve skill training in reading music and overall student engagement. These contributions are pivotal in demonstrating the practical applications of theoretical concepts, showcasing the tangible benefits of incorporating technology and student-centered learning models in music education.

The studies by Schlairet, Green, & Benton (2014) and Kokotsaki & Hallam (2007) further validate the effectiveness of flipped classroom strategies and participative music making in enhancing learning outcomes and student satisfaction. These findings are echoed by Chin & Rickard (2012), who emphasize the importance of engagement in music education and the potential of the Music USE (MUSE) questionnaire as a tool for measuring this engagement.

Integrating these perspectives, the discussion unfolds around the transformative potential of combining musical games with flipped classroom models in solfeggio courses. This pedagogical

strategy not only addresses the need for greater engagement and creativity in music education but also aligns with contemporary educational paradigms that prioritize student-centered learning, technological integration, and the development of higher-order thinking skills.

In conclusion, this study underscores the significant implications of integrating musical games within a flipped classroom model for solfeggio education. By drawing on a diverse range of scholarly work, it demonstrates the multifaceted benefits of this approach, including enhanced student engagement, creativity, satisfaction, and learning outcomes. The findings of this research contribute to the broader discourse on educational innovation, offering valuable insights for educators, curriculum developers, and researchers aiming to enrich music education in the digital age.

Top of Form

8. Limitations

Sample Size and Diversity: The study's sample was drawn from a single educational institution, which may limit the generalizability of the findings. Future studies could benefit from a larger, more diverse sample that includes multiple institutions with varying demographic characteristics.

Subject Specificity: Focusing exclusively on solfeggio courses, the study may not account for the nuanced differences across various music education subjects. Different disciplines within music education could exhibit unique challenges and opportunities for the integration of musical games and flipped classroom techniques.

Short-term Study Duration: The investigation was conducted over a single academic term, providing a limited view of the long-term effects of the pedagogical interventions on students' learning outcomes, engagement, and satisfaction.

Self-reported Measures: Reliance on self-reported data for assessing student engagement and satisfaction could introduce bias. Objective measures and observational data could complement these findings and offer a more rounded understanding of the pedagogical approach's impact.

Technological Accessibility: The study assumes a level of technological access and proficiency among participants, which might not be universally available. Disparities in digital access and skills could affect the feasibility and effectiveness of the proposed teaching model across different contexts.

9. Future Studies

Given these limitations, several avenues for future research emerge:

Longitudinal Studies: To better understand the long-term impacts of musical games within flipped classrooms on music education, future research should consider longitudinal designs that track student progress over multiple terms or academic years.

Cross-disciplinary Research: Expanding the scope to include various subjects within music education could provide insights into the adaptability and effectiveness of the pedagogical strategy across different musical disciplines.

Diverse Educational Settings: Conducting similar studies in a range of educational contexts, including different geographic locations, institution types, and educational levels, would enhance

the generalizability of the findings.

Mixed Methods Approaches: Incorporating qualitative methods, such as interviews, focus groups, and classroom observations, alongside quantitative measures, could offer a more comprehensive view of the teaching model's effects on student learning and engagement.

Access and Equity Considerations: Future research should also examine the implications of technological access and digital literacy on the implementation and outcomes of flipped classroom models, particularly in under-resourced settings.

Comparative Studies: Comparing the effectiveness of different types of musical games and digital tools within flipped classrooms could help identify the most impactful resources for music education.

Teacher Preparedness and Support: Investigating the role of teacher training and institutional support in the successful adoption of innovative teaching strategies would provide valuable insights for educators and policymakers aiming to implement these models.

References

1. Astuti, I. A. D., Bhakti, Y. B., Sumarni, R. A., Sulisworo, D., & Toifur, M. (2021). FLIPPED CLASSROOM AND KAHOOT IN PHYSICS LEARNING: IMPROVING STUDENTS' MOTIVATION LEARNING. *Journal Name, Volume*(Issue), Page range. https://doi.org/xxx
2. Bakar, A. H. A., Abidin, N. A. Z., Ali, Z., Isa, N. M., & Sahar, N. S. (2018). teachers'perceptions of the use of flipped learning approach in learning grammar. Journal of Global Business and Social Entrepreneurship (GBSE), 4(13).
3. Caillois, R. (1961). The definition of play. The Game Design Reader: A Rules of Play Anthology, 123-28.
4. Cheng, M. T., Chen, J. H., Chu, S. J., & Chen, S. Y. (2015). The use of serious games in science education: a review of selected empirical research from 2002 to 2013. Journal of computers in education, 2, 353-375.
5. Cheng, X., Fu, S., & de Vreede, G. J. (2017). Understanding trust influencing factors in social media communication: A qualitative study. International Journal of Information Management, 37(2), 25-35.
6. Chin, T., & Rickard, N. S. (2012). The Music USE (MUSE) Questionnaire: An Instrument to Measure Engagement in Music. Music Perception, 29(4), 429–446.
7. Deng, F. (2019). Literature Review of The Flipped Classroom. *Theory and Practice in Language Studies, 11*(6), 806-814. https://doi.org/10.17507/tpls.1106.14
8. Elfeky, A. I. M. (2019). The effect of personal learning environments on participants' higher order thinking skills and satisfaction. Innovations in Education and Teaching International, 56(4), 505-516.
9. Erbil, D. G. (2020). A Review Of Flipped Classroom And Cooperative Learning Method Within The Context Of Vygotsky Theory. *Frontiers in Psychology, 11*, 1-12. https://doi.org/10.3389/fpsyg.2020.01068
10. Fluke, J. H., & Sparks, J. N. (1965). The construction, validation, and standardization of a test in music perception for high school performance groups. Journal of Research in Music Education, 13(4), 220-226.

11. Gok, D., Bozoglan, H., & Bozoglan, B. (2021). Effects of Online Flipped Classroom on Foreign Language Classroom Anxiety and Reading Anxiety. *Computer Assisted Language Learning, 34*(1-2), 130-150. https://doi.org/10.1080/09588221.2019.1641219
12. Hoshang, S., Abu Hilal, T., & Abu Hilal, H. (2021). Investigating The Acceptance of Flipped Classroom and Suggested Recommendations. *Journal Name, Volume*(Issue), Page range. https://doi.org/xxx
13. Kiili, K. (2005). Digital game-based learning: Towards an experiential gaming model. The Internet and higher education, 8(1), 13-24.
14. Kokotsaki, D., & Hallam, S. (2007). Higher education music students' perceptions of the benefits of participative music making. Music Education Research, 9(1), 93-109.
15. Morais, L., Gonçalves, V., & Bambirra de Assis, L. (2021). A Case Study on The Use of Gamification in The Flipped Classroom. *16th Iberian Conference on Information Systems and ...*, 1-8.
16. Ng, D. T., Ng, E. H., & Chu, S. K. (2022). Engaging students in creative music making with musical instrument application in an online flipped classroom. Education and information Technologies, 27(1), 45-64.
17. Phoeun, M., & Sengsri, S. (2021). The Effect of A Flipped Classroom with Communicative Language Teaching Approach on Undergraduate Students' English Speaking Ability. *International Journal of Instruction, 14*(1), 375-390. https://doi.org/10.29333/iji.2021.14124a
18. Rahmani, A. A., Zaid, N. M., Abdullah, Z., Mohamed, H., & Aris, B. (2015, May). Emerging project based learning in flipped classroom: Technology used to increase students' engagement. In 2015 3rd International Conference on Information and Communication Technology (ICoICT) (pp. 212-215). IEEE.
19. Romm, N., & Ngulube, P. (2015). Mixed methods research. Addressing research challenges: Making headway for emerging researchers.
20. Salafiyah, N., & Kevin, K. (2021). The Identification of Basic Music Learning Needs Students of Music Arts Study Program Solfeggio Courses. Jurnal Seni Musik, 10(2), 131–135.
21. Schlairet, M. C., Green, R., & Benton, M. J. (2014). The flipped classroom: strategies for an undergraduate nursing course. Nurse educator, 39(6), 321-325.
22. Schwarzenberg, P., & Navon, J. (2020). Supporting Goal Setting in Flipped Classes. *Interactive Learning Environments, 28*(8), 1105-1116. https://doi.org/10.1080/10494820.2018.1556636
23. Serenko, A. (2011). Student satisfaction with Canadian music programmes: the application of the American Customer Satisfaction Model in higher education. Assessment & Evaluation in Higher Education, 36(3), 281-299.
24. Setren, E., Greenberg, K., Moore, O., & Yankovich, M. (2021). Effects of Flipped Classroom Instruction: Evidence from A Randomized Trial. *Education Finance and Policy, 16*(4), 578-602. https://doi.org/10.1162/edfp_a_00316
25. Suits, B. (1967). What is a Game?. Philosophy of science, 34(2), 148-156.
26. Sun, P. C., Tsai, R. J., Finger, G., Chen, Y. Y., & Yeh, D. (2008). What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction. Computers & education, 50(4), 1183-1202.
27. Vaughan, M. M. (1977). Musical creativity: Its cultivation and measurement. Bulletin of the Council for Research in Music Education, 72-77.
28. Vaughan, M. M., & Myers, R. E. (1971). An examination of musical process as related to

creative thinking. Journal of Research in music education, 19(3), 337-341.
29. Vaughan, M. M., & Myers, R. E. (1971). An examination of musical process as related to creative thinking. Journal of Research in music education, 19(3), 337-341.
30. Wang, L. (2022). The skill training of reading music in the teaching of solfeggio and ear training in the new media environment. Applied Bionics and Biomechanics, 2022.
31. Wei, X., Cheng, I.-L., Chen, N.-S., Yang, X., Liu, Y., Dong, Y., & Zhai, X. (2020). Effect of The Flipped Classroom on The Mathematics Performance of Middle School Students. *Educational Technology Research and Development, 68*(1), 325-342. https://doi.org/10.1007/s11423-019-09719-yTop of Form