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Does teacher-student interaction more effectiveness than peer interaction? An experimental study of flipped classroom in higher music education

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Article

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Abstract

A growing body of empirical studies has demonstrated the benefits of the flipped classroom in higher education; however, research in the context of higher music education remains scarce. Moreover, little is known about the relative effectiveness of different forms of interaction within flipped classrooms. This experimental study investigated the impact of interaction types in flipped learning for higher music education. A total of 108 students from music colleges were randomly assigned to one of three conditions: a flipped classroom with teacher–student interaction (*n* = 26), a flipped classroom with peer interaction (*n* = 27), or lecture-based instruction (*n* = 25). Data were collected on prior knowledge, learning engagement, self-regulation, and academic performance (recall, comprehension, and transfer). Results indicated that the flipped classroom with teacher–student interaction significantly outperformed both the peer interaction flipped classroom and traditional lecture across all outcome measures. By contrast, the peer interaction flipped classroom showed an advantage over lecture-based instruction only in transfer tasks, with no significant differences in learning engagement, self-regulation, recall, or comprehension. The findings underscore the critical role of teacher–student interaction in maximizing the benefits of flipped learning and offer both theoretical and practical implications for designing interactive flipped learning environments in music education and beyond.

1. Introduction

The flipped classroom has emerged as one of the most widely adopted pedagogical innovations in higher education (Lundin et al, 2018; O'Flaherty & Phillips 2015; Al-Samarraie et al., 2019). By reversing the traditional sequence of in-class lectures and after-class practice, this approach enables students to acquire basic knowledge through pre-class materials and use classroom time for more interactive learning activities (Lo & Hew, 2017). A growing body of research has demonstrated the benefits of flipped classroom for learning engagement (Gilboy et al., 2015; Subramaniam & Muniandy, 2017), self-regulation (Sun et al., 2016), and academic performance (Torres-Martín et al, 2022) across a variety of disciplines (O'Flaherty & Phillips, 2015). Within music education, the flipped classroom is particularly promising, as it provides more opportunities for performance-based practice, critical listening, and collaborative learning (Lv, 2023; Ng et al., 2021).

In the flipped classroom, interaction serves as a significant moderating factor influencing its effectiveness. Interaction is a core element of constructivist pedagogy (Lave & Wenger, 2001)—yet it remains unclear whether teacher–student interaction, which provides guidance and scaffolding, or peer collaboration, which promotes cooperative learning and autonomy, serves as the primary driver of positive outcomes. Meta-analytical evidence suggests that affective and interpersonal (interaction-based) outcomes in flipped classrooms often outperform purely cognitive gains—highlighting the importance of active, in-class interaction for engagement and deeper learning (Jang & Kim, 2022). Moreover, empirical studies emphasize that "teacher presence" as a guiding facilitator contributes substantially to student engagement and learning effectiveness (Buhl-Wiggers et al., 2023). While Jiang et al. (2022) argue that previous studies have acknowledged different forms of interaction in flipped

classroom, they often overlook how these distinct types that shape student learning outcomes. This oversight is particularly significant in higher music education, where both individualized feedback from instructors and peer-based ensemble learning are integral to student development.

The present study addresses this gap by comparing three instructional conditions in a higher music education context: a flipped classroom with teacher–student interaction, a flipped classroom with peer interaction, and a traditional lecture-based instruction. We examined their effects on student engagement, self-regulation, and academic achievement, including recall, comprehension, and transfer. By disentangling the relative contributions of teacher–student interaction and peer collaboration within the flipped classroom model, this study advances understanding of how to optimize active learning designs in higher music education. The findings provide both theoretical insights into the role of instructional interaction and practical implications for instructors seeking to integrate flipped pedagogy into higher music curricula.

2. Literature review

2.1 Defining flipped classroom and its content

The flipped classroom is an emerging and widely adopted teaching approach. In a flipped classroom, learning activities traditionally conducted in class are moved to the home, while tasks typically assigned as homework are brought into the classroom (Sohrabi & Iraj, 2016). In this model, the teacher's role shifts from merely delivering information to actively supporting students, while students take responsibility for their own learning and manage their own pace (Lai & Hwang, 2016). With classroom time no longer devoted to lectures, teachers can engage students through other learning activities, such as discussions, problem-solving, hands-on exercises, and personalized guidance. Currently, the flipped classroom model has been implemented across various disciplines and is utilized in schools and universities worldwide (Hao, 2016), especially in the post-pandemic era (Shen et al., 2025).

Unlike traditional teacher-centered instruction, where students are treated as passive recipients of knowledge (Betihavas et al., 2016), flipped classrooms shift the focus to students, creating opportunities to apply student-centered learning theories such as active learning, peer-assisted learning, and collaborative learning (Lai & Hwang, 2016; Sohrabi & Iraj, 2016). Active learning, defined as any instructional method that engages students in the learning process (Prince, 2004), requires learners to participate in meaningful activities and assume responsibility for their own learning (Sohrabi & Iraj, 2016). Within flipped classrooms, students experience active learning opportunities that promote higher-order thinking and transform them from passive listeners into active learners (Davies et al., 2013; Lai & Hwang, 2016; Roehl et al., 2013). Peer-assisted learning, described as "the acquisition of knowledge and skills through active helping and supporting among status equals or matched companions" (Topping & Ehly, 1998), also flourishes in this model, both during in-class group work (e.g., problem-solving, project collaboration) and through out-of-class online interactions (Nederveld & Berge, 2015). Similarly, collaborative learning—a situation in which learners interact in a collaborative way (Dillenbourg, 1999)—

fosters deeper learning, shared understanding, and the development of social skills (Johnson & Johnson, 1987; Kreijns et al., 2003). Since classroom time is not consumed by lectures, teachers in flipped classrooms can facilitate small-group activities, guide discussions, and provide support while students work together and engage in collaborative learning (Tucker, 2012).

2.2 Flipped classroom in higher education

The flipped classroom has become an influential pedagogical innovation in higher education, aiming to restructure traditional teaching by shifting direct instruction to pre-class activities while dedicating in-class time to interactive, student-centered learning (O'Flaherty & Phillips, 2015). Early conceptualizations emphasized its alignment with active learning and constructivist principles, highlighting the potential to deepen student engagement and foster collaborative knowledge construction (Bishop & Verleger, 2013). Over the past decade, empirical research has demonstrated that this model enables instructors to maximize face-to-face interactions and provide more personalized guidance, which is especially valuable in disciplines that require higher-order thinking and application (Abeysekera & Dawson, 2015).

A growing body of literature suggests that the flipped classroom is particularly effective in enhancing learning outcomes in higher education. Studies report improvements in student engagement, motivation, and self-regulated learning skills, as students assume greater responsibility for their preparation and participation (Lo & Hew, 2017; Zainuddin & Halili, 2016). Moreover, meta-analyses indicate that flipped instruction is positively associated with academic performance compared to traditional lecture-based instructiones (Chen et al., 2018; Hew & Lo, 2018). Despite these promising results, scholars also caution that the effectiveness of flipped classrooms depends on careful instructional design, including the quality of pre-class materials, integration of active learning strategies, and provision of timely feedback (Betihavas et al., 2016; Strelan et al., 2020a; b).

Some research further highlights the contextual and disciplinary dimensions of implementing flipped classrooms in higher education. For instance, STEM and health science programs often report strong outcomes due to the model's compatibility with problem-based learning, while fields such as the humanities and arts raise questions about adapting flipped approaches to emphasize critical discussion and interpretive skills (Gilboy et al., 2015; Lo & Hew, 2017). In addition, technological readiness and students' digital literacy play important roles in shaping the learning experience, particularly in resource-constrained settings (Akçayır & Akçayır, 2018; Zainuddin, 2018). Collectively, the literature underscores that while the flipped classroom holds transformative potential for higher education, its success relies on thoughtful adaptation to disciplinary needs, student characteristics, and institutional contexts.

2.3 The benefits of flipped classroom

From a theoretical perspective, prior research in educational psychology and instructional design has consistently demonstrated that student engagement and self-regulation are critical mediators linking innovative pedagogical approaches to learning outcomes (see Zimmerman & Cleary, 2009; Pintrich, 2004). In the context of the flipped classroom, students are required to assume greater responsibility for pre-class preparation and in-class participation, making self-regulated learning and engagement

particularly salient (Bishop & Verleger, 2013; Van Alten et al., 2019). From a pedagogical perspective, academic achievement remains an essential indicator of instructional effectiveness, providing a direct measure of learning outcomes (Kuhn & Pease, 2008). Taken together, these three variables capture both the process and the outcome of learning, offering a comprehensive framework to examine the impact of flipped classroom pedagogy in higher music education.

Moreover, previous empirical research has demonstrated the benefits of flipped classrooms in higher education; however, little is known about their effectiveness in music education specifically. To address this gap, the present study focuses on three key variables—learning engagement, self-regulation, and academic performance—to examine the benefits of flipped classrooms in higher music education.

2.3.1 Flipped classrooms and learning engagement

A consistent finding in the flipped classroom literature is its positive effect on students' learning engagement, which is typically conceptualized as a multidimensional construct encompassing behavioral, emotional, and cognitive dimensions (Fredricks et al., 2004). By relocating lower-level learning tasks to pre-class preparation, the flipped model frees classroom time for interactive activities, thereby increasing opportunities for active participation, collaboration, and dialogue (Bishop & Verleger, 2013). Meta-analyses further indicate that flipped classrooms foster greater classroom participation, peer interaction, and intrinsic motivation compared with traditional lecture-based instruction (Hew & Lo, 2018; Strelan et al., 2020).

In music education, engagement is particularly crucial, as the development of performance and interpretive skills requires sustained practice, emotional investment, and peer collaboration. Flipped designs have been shown to improve attentiveness during listening exercises, promote more focused rehearsal sessions, and encourage stronger commitment to group performance projects (Johnson, 2017). Therefore, we hypothesize:

H_1: *Flipped classrooms in higher music education will enhance students' learning engagement.*

2.3.2 Flipped classrooms and self-regulation

Another significant advantage of flipped classrooms is their potential to strengthen students' self-regulation, defined as learners' ability to plan, monitor, and evaluate their own learning processes (Zimmerman & Cleary, 2009). Pre-class activities—such as reviewing instructional videos, completing quizzes, and maintaining practice logs—create structured opportunities for autonomy and responsibility (Abeysekera & Dawson, 2015). Reviews of flipped classroom research also highlight improvements in time management, goal setting, and reflective practices, all of which are essential components of self-regulation (Akçayır & Akçayır, 2018).

In music education, self-regulation is vital for effective practice routines, technical mastery, and long-term artistic growth. Studies suggest that engaging with preparatory materials before class enables students to enter rehearsals with clearer goals and greater readiness for feedback (Perakaki, 2025).

Furthermore, the iterative cycle of preparation, in-class performance, and reflection aligns closely with the principles of self-regulated learning. Thus, we hypothesize:

H_2: Flipped classrooms in higher music education will enhance students' self-regulation.

2.3.3 Flipped classrooms and academic performance

A substantial body of research has examined the impact of flipped classrooms on academic performance, with most studies reporting small-to-moderate improvements compared to traditional lecture-based instructiones (Hew & Lo, 2018; Strelan et al., 2020a). These improvements are particularly evident in tasks requiring higher-order thinking, such as comprehension, application, and transfer (Strelan et al., 2020b). By shifting factual content delivery outside the classroom, instructors can dedicate more time to formative feedback, problem-solving, and authentic assessment, thereby promoting deeper learning (O'Flaherty & Phillips, 2015).

In music education, academic performance encompasses not only recall of theoretical knowledge but also comprehension of stylistic conventions and the transfer of skills across repertoires and performance contexts. Research has shown that flipped approaches improve accuracy in theory assessments, enhance analytical depth in score study, and increase confidence in performance settings (Fan, 2025). Based on these findings, we hypothesize:

H_3: Flipped classrooms in higher music education will improve students' academic performance, including recall, comprehension, and transfer.

3. Theoretical framework: Interaction model in flipped classroom

The flipped classroom is grounded in social constructivist theories of learning, which emphasize that knowledge is co-constructed through interaction and collaboration (Vygotsky & Cole, 1978). Within this approach, interaction becomes the central mechanism by which students develop deeper learning, greater self-regulation, and improved academic performance. Jiang et al. (2020) proposed an *interaction model of flipped classroom* in which learning effectiveness is shaped by three central forms of interaction: teacher–student interaction, learner–content interaction, and peer interaction. Among these, teacher–student interaction and peer interaction are particularly crucial because they address both instructional scaffolding and collaborative knowledge construction.

In this theoretical model, teacher–student interaction emphasizes instructional guidance, feedback provision, and the orchestration of classroom discourse. Teachers play a pivotal role in clarifying misconceptions, modeling problem-solving strategies, and ensuring that students' pre-class preparation is effectively connected to in-class learning (Schlag et al., 2024). Conversely, peer interaction highlights collaborative knowledge construction, negotiation of meaning, and co-regulation among learners (Xu et al., 2019). In flipped classroom settings, peer discussion, group tasks, and peer feedback create opportunities for students to exercise agency in managing their own learning processes. This form of

interaction not only fosters engagement through social participation but also enhances self-regulation by encouraging students to monitor and evaluate each other's contributions (Wang & Yuan, 2022). Furthermore, peer interaction has been found to positively influence academic performance, as collaboration often deepens comprehension and enables the transfer of knowledge to authentic contexts (Zhao & Li, 2021).

Drawing on this interaction model, this study aims to comparatively examine the differential effectiveness of these two primary forms of interaction—teacher–student versus peer interaction—within the flipped classroom in higher music education context. Specifically, it raises the following research question: *Among two interaction forms in flipped classroom, i.e., teacher-learner interaction and peer interaction, which is more effectiveness for learning engagement, self-regulation, and academic performance?*

3. Methods

3.1 Participants

A total of 88 students were recruited from a normal university in Fujian Province, China. They were drawn from different grades within the same music school. Participants were randomly assigned to one of three groups. Two groups received instructional interventions: first, a flipped classroom with teacher–student interaction (n = 26, M_{age} = 19.96 years, SD = 0.53, Mean music learning duration = 7.00 years, SD = 3.91, 85% female); second, a flipped classroom with peer interaction (n = 27, M_{age} = 20.04 years, SD = 0.90, Mean music learning duration = 6.12 years, SD = 3.77, 88% female). The control group received lecture-based instruction (n = 25, M_{age} = 20.08 years, SD = 0.98, Mean music learning duration = 4.78 years, SD = 3.14, 64% female).

3.2 Materials

The materials were drawn from a section of Western music history focused on nationalist music, specifically examining 19th-century Russian folk music. Notable musicians such as Tchaikovsky were initially considered; however, to minimize familiarity with widely recognized figures, five lesser-known musicians and their compositions were selected (details provided in Table 1). These musicians included Mikhail Glinka, Mily Balakirev, César Cui, Modest Mussorgsky, and Alexander Borodin. The materials explored their background, historical context, musical styles, and compositional techniques (two examples provided, see Fig. 1 and Fig. 2).

Table 1
Details of materials

Composers	Learning content (represented compositions)	Occupations
Mikhail Glinka	Opera *Ivan Susanin*; Opera *Ruslan and Ludmila*; Symphonic suite *Kamarinskaia Fantasia*	Composer
Mily Balakirev	Piano Fantasy *Islamey*	Mathematician
Modest Mussorgsky	Piano suite The Pictures at an Exhibition; Opera Boris Godunov	Imperial guard
Alexander Borodin	Opera *Prince Igor*, Symphonic Poem *In the Steppes of Central Asia*	Chemist
César Cui	Children's Opera *Little Red Riding Hood*, Symphonic Suite *Snow Warriors*	Military officer

*[*Table 1 *Insert Here]*

*[*Figure 1 *Insert Here]*

*[*Figure 2 *Insert Here]*

3.3 Instruments

3.3.1 Prior knowledge

Before the intervention, participants' prior knowledge was assessed using a 10-item multiple-choice test on Russian folk music genres (see Appendix A). Each correct answer was awarded two points, resulting in a total possible score ranging from 0 to 20. The test demonstrated good internal consistency, with Cronbach's $\alpha = 0.78$.

3.3.2 Learning engagement

Learning engagement was measured using the Utrecht Work Engagement Scale for Students (UWES-9S), originally proposed by Schaufeli (2004) and further developed by Schaufeli et al. (2006). The scale comprises nine items across three dimensions: vigor, absorption, and dedication. Each item is rated on a 7-point Likert scale ranging from 0 (never) to 7 (always). The scale demonstrated satisfactory reliability in this study, with Cronbach's $\alpha = 0.84$.

3.3.3 Self-regulation

Participants' self-regulation was assessed using the Self-Regulation Scale (SRS) developed by Diehl (2006). The scale consists of 10 items across five dimensions: goal setting, goal pursuit, goal flexibility, self-monitoring and reflection, and emotion regulation. Items are rated on a 4-point Likert scale, with items 5, 7, and 9 reverse scored. The scale exhibited excellent internal consistency in this study, with Cronbach's $\alpha = 0.97$.

3.3.4 Academic performance

Academic performance was assessed using a test consisting of three subtests measuring recall, comprehension, and transfer (as shown in Appendix B). The recall subtest (Cronbach's $\alpha = 0.77$) included eight items, three of which were listening-based and five multiple-choice, designed to assess participants' direct learning of the instructional content. The comprehension subtest (Cronbach's $\alpha = 0.86$) contained two open-ended questions that evaluated how well participants could articulate knowledge based on the learned material. The transfer subtest (Cronbach's $\alpha = 0.76$) comprised three open-ended questions intended to measure participants' ability to apply acquired knowledge.

Scoring procedures were as follows: the recall subtest had a maximum of 16 points, with two points awarded for each correct answer. The comprehension subtest ranged from 0 to 10 points, with responses scored as 0 (unacceptable), 1–3 (partially acceptable, depending on completeness), or 4–5 (fully acceptable). The transfer subtest had a maximum of 15 points and used the same rubric as the comprehension subtest. For the comprehension and transfer subtests, two independent raters scored each response, and interrater reliability assessed with Cohen's kappa ranged from 0.81 to 0.86 ($p < 0.001$).

3.4 Procedure

The flow chart of procedure as shown in Fig. 3. Specifically, at the outset, all participants were informed that their test results would not affect their overall grade, as the material presented was not part of their regular curriculum. A pre-test was then administered to all three groups, which included a demographic questionnaire and a prior knowledge test, prior to the formal learning session.

Following the pre-test, the same topic on 19th-century Russian folk music genres was introduced to the two flipped classroom intervention groups one day before their presentations. In the flipped classroom with peer interaction condition, participants were divided into five sub-groups of 6–7 students each, with each sub-group learning different materials on the topic of 19th century Russian folk music genres. Participants were informed that they would engage in a flipped classroom model without teacher assistance, but were encouraged to interact with other sub-groups. In the flipped classroom with teacher–student interaction condition, participants were also divided into five sub-groups, similar to the peer-interaction condition. However, in this case, a teacher participated throughout the process and interacted with learners, answering students' questions and organizing the learning content. In the lecture-based instruction, participants attended a traditional lecture without any pre-class preparation.

After the flipped classroom sessions, participants in the two intervention groups delivered presentations the following day, organized by sub-group. In the peer-interaction condition, the teacher only observed the presentations without providing feedback. In the teacher–student interaction condition, the teacher engaged with the participants, providing explanations and answering questions. In the lecture-based instruction, the teacher delivered the lecture as planned but without any teacher-learner or peer

interactions. Following the presentations, all students of three groups were participated in a discussion separately about the content they had learned.

After the presentation and discussion, all participants completed three standardized scales. The process was supervised by the instructor to ensure no undesirable behaviors (e.g., cheating). As an appreciation for their participation, participants received a financial reward of one bubble tea and a small gift (valued at approximately $5). Participants' responses were exported to SPSS for later statistical analysis.

3.5 Statistical Analysis

All quantitative data were analyzed using SPSS software. Prior to hypothesis testing, the dataset was screened for missing values, outliers, and violations of statistical assumptions. No missing data were detected, and all variables met the assumptions of normality and homogeneity of variance required for parametric analyses.

Descriptive statistics (means and standard deviations) were computed for all study variables, including prior knowledge, learning engagement, self-regulation, and academic performance (recall, comprehension, and transfer). To examine baseline equivalence across the three instructional conditions (flipped classroom with teacher–student interaction, flipped classroom with peer interaction, and lecture-based instruction), a one-way analysis of variance (ANOVA) was conducted on prior knowledge scores. The *F* statistic was calculated as:

$$F = \frac{MS_{between}}{MS_{within}}$$

where

$$MS_{between} = \frac{SS_{between}}{k-1}$$

$$MS_{within} = \frac{SS_{within}}{N-k}$$

Here, SS_{between}represents the sum of squares between groups, SS_{within}represents the sum of squares within groups, $k$is the number of groups, and $N$is the total sample size.

To test the effects of instructional condition on learning engagement, self-regulation, and academic performance, a series of one-way ANOVAs were performed. Specifically, separate ANOVAs were conducted for learning engagement, self-regulation, recall, comprehension, and transfer. When significant main effects were identified, Tukey's HSD post hoc tests were used to examine pairwise group differences. Effect sizes were reported using eta squared (η^2) to indicate the magnitude of observed effects.

For the comprehension and transfer subtests, which involved open-ended responses, scores were assigned independently by two trained raters using predefined scoring rubrics. Interrater reliability was assessed using Cohen's kappa, with values ranging from 0.81 to 0.86, indicating substantial to excellent agreement.

All statistical tests were conducted using a significance level of $p < 0.05$. The complete dataset (raw and processed), codebooks, scoring rubrics, statistical scripts, and supporting documentation are publicly available in an open repository to ensure transparency and replicability (see Data Availability statement).

4. Results

As shown in Table 2, the results present the means and standard deviations of prior knowledge, learning engagement, self-regulation, and three sub-components of academic achievement across the flipped classroom with teacher–student interaction, flipped classroom with peer interaction, and lecture-based instruction.

Table 2
Means (standard deviations) for the dependent measures of results

Dependent measures	Flipped classroom with teacher-learner interaction (*n* = 26)	Flipped classroom with peer interaction (*n* = 27)	Lecture-based instruction (*n* = 25)	Effect size (Cohen's *d*)		
				(1)—(2)	(1)—(3)	(2)—(3)
Prior knowledge	7.15 (3.11)	6.92 (2.79)	7.2 (3.22)	-0.02	0.08	-0.09
Student engagement						
Vigor	28.15 (5.50)	20.88 (6.17)	19.16 (5.13)	1.25	1.69	0.30
Absorption	25.86 (4.12)	19.96 (6.17)	19.48 (4.47)	1.11	1.48	0.09
Dedication	28.69 (5.90)	23.42 (6.87)	20.04 (6.10)	0.87	1.45	0.51
Overall	82.69 (14.57)	64.27 (17.56)	58.68 (14.43)	1.14	0.35	1.66
Self-regulation						
Goal setting	6.42 (1.10)	5.62 (1.17)	5.48 (0.96)	0.71	0.91	0.13
Goal pursuit	6.04 (1.15)	5.15 (0.88)	5.08 (1.19)	0.87	0.82	0.07
Goal flexibility	5.73 (1.31)	5.38 (1.39)	4.92 (1.36)	0.26	0.61	0.34
Self-monitoring and reflection	5.54 (0.91)	5.42 (1.24)	5.00 (1.26)	0.11	0.49	0.34
Emotion regulation	4.96 (1.15)	4.15 (0.88)	4.48 (1.23)	0.79	0.40	-0.31
Overall	28.85 (3.45)	26.04 (3.38)	26.12 (3.10)	0.82	0.83	-0.03
Academic performance						
Recall	15.08 (1.62)	11.62 (3.49)	14.16 (2.23)	1.20	0.47	-0.87
Comprehension	13.16 (3.47)	8.91 (3.49)	9.71 (4.39)	1.22	0.87	-0.20
Transfer	13.38 (2.58)	10.88 (2.20)	9.14 (3.12)	1.04	1.48	0.65
Overall	41.63 (6.01)	30.76 (6.11)	33.01 (8.32)	1.79	1.19	-0.31

*[*Table 2 *Insert Here]*

4.1 Prior knowledge

In order to examine if the conditions differed on background knowledge prior to the experiment, a one-way analysis of variance (ANOVA) was performed and the result showed no significant difference (*F* [2,

74] = 0.061, $p > 0.05$, $\eta^2 = 0.002$). Therefore, we considered the level of prior knowledge as comparable across the three conditions and did not consider the variable of prior knowledge further.

4.2 Learning engagement

Regarding learning engagement, the ANOVA revealed a significant main effect (F [2, 74] = 6.008, $p < 0.01$, $\eta^2 = 0.140$) across the flipped classroom with teacher–student interaction, flipped classroom with peer interaction, and lecture-based learning. Tukey's HSD post hoc tests indicated that the flipped classroom with teacher–student interaction ($M = 82.69$, $SD = 14.57$) scored significantly higher than both the flipped classroom with peer interaction ($d = 1.14$, $p < 0.001$) and the lecture-based instruction ($d = 0.35$, $p < 0.001$). No significant difference ($p > 0.05$) was found between the flipped classroom with peer interaction ($M = 64.27$, $SD = 27.56$) and the lecture-based instruction ($M = 58.68$, $SD = 14.43$), indicating that the two approaches did not differ in terms of learning engagement.

4.3 Self-regulation

For self-regulation, the ANOVA revealed a significant main effect (F [2, 74] = 17.579, $p < 0.001$, $\eta^2 = 0.322$) across the three instructional approaches. Tukey's HSD post hoc tests indicated that the flipped classroom with teacher–student interaction ($M = 28.85$, $SD = 3.45$) scored significantly higher than both the flipped classroom with peer interaction ($d = 0.82$, $p < 0.001$) and the lecture-based instruction ($d = 0.83$, $p < 0.001$). No significant difference ($p > 0.05$) was observed between the flipped classroom with peer interaction ($M = 26.04$, $SD = 3.38$) and the lecture-based instruction ($M = 26.12$, $SD = 3.10$), suggesting that there is no difference exist between flipped classroom with peer interaction and the lecture-based instruction.

4.4 Academic performance

Concerning three sub-components of academic performance, three ANOVAs were performed. Regarding recall, the ANOVA revealed a significant main effect (F [2, 74] = 12.77, $p < 0.001$, $\eta^2 = 0.259$) of flipped classroom with teacher–student interaction, flipped classroom without teacher–student interaction, and lecture-based learning on academic performance. Post hoc comparisons using the Tukey HSD test showed that the flipped classroom with teacher–student interaction ($M = 15.08$, $SD = 1.62$) produced significantly higher scores than both the flipped classroom without teacher–student interaction ($d = 1.20$, $p < 0.01$) and the lecture-based instruction ($d = 0.47$, $p < 0.01$). No significant difference was observed between the flipped classroom without teacher–student interaction and the lecture-based instruction ($p > 0.05$). Overall, these results suggest that the flipped classroom with teacher–student interaction yields the highest recall scores, whereas the flipped classroom without teacher–student interaction and the lecture-based instruction perform at comparable levels.

In terms of comprehension, the results revealed a significant main effect (F [2, 74] = 16.55, $p < 0.001$, $\eta^2 = 0.309$) of two flipped class conditions and lecture-based learning on academic performance. Tukey HSD post hoc analyses indicated that the flipped classroom with teacher–student interaction ($M = 13.38$, $SD = 2.58$) produced significantly higher scores than both the flipped classroom with peer interaction ($d =$

1.04, $p < 0.001$) and the lecture-based instruction ($d = 1.48$, $p < 0.01$). However, the difference between the flipped classroom with peer interaction ($M = 10.88$, $SD = 2.20$) and the lecture-based instruction ($M = 9.14$, $SD = 3.12$) was not significant ($p > 0.05$). These results suggest that the flipped classroom with teacher–student interaction yields the highest comprehension scores, whereas the flipped classroom with peer interaction and the lecture-based instruction do not differ significantly from each other.

For transfer, the ANOVA also showed a significant effect (F [2, 74] = 9.347, $p < 0.001$, $\eta^2 = 0.204$) of two conditions of flipped classroom and lecture-based instructions. Tukey HSD post hoc tests indicated that all pairwise comparisons were statistically significant. Specifically, the flipped classroom with teacher–student interaction ($M = 13.38$, $SD = 2.58$) outperformed both the flipped classroom with peer interaction ($d = 1.04$, $p < 0.001$) and the lecture-based instruction ($d = 1.48$, $p < 0.001$). In addition, the flipped classroom with peer interaction ($M = 10.88$, $SD = 2.20$) scored significantly higher than the lecture-based instruction ($M = 9.14$, $SD = 3.12$, $d = 0.65$, $p < 0.05$). Thus, the mean scores followed the order: flipped classroom with teacher–student interaction > flipped classroom with peer interaction > lecture-based instruction.

5. Discussion

The present study investigated the effects of two forms of flipped classroom, i.e., flipped classroom with teacher–student interaction, flipped classroom with peer interaction, and lecture-based instruction, and lectured-based instruction on student engagement, self-regulation, and academic performance in higher music education. The results indicate three central findings: first, prior knowledge did not differ significantly across the three conditions, confirming that the groups were comparable before the intervention. Second, both learning engagement and self-regulation were significantly enhanced only in the flipped classroom with teacher–student interaction, whereas the flipped classroom with peer interaction did not outperform the lecture-based instruction. Third, with respect to academic performance, the flipped classroom with teacher–student interaction consistently yielded the highest scores across recall, comprehension, and transfer. Notably, while recall and comprehension outcomes revealed no difference between the flipped classroom with peer interaction and lecture-based instruction, the transfer results demonstrated a clear hierarchy: flipped classroom with teacher–student interaction > flipped classroom with peer interaction > lecture-based instruction. Collectively, these findings highlight the pivotal role of teacher–student interaction in realizing the pedagogical potential of the flipped classroom.

5.1 The effects of flipped classroom on learning engagement

The results reveal that the flipped classroom with teacher–student interaction significantly enhances student engagement compared to both the flipped classroom without interaction and traditional lectures. This finding resonates with prior research demonstrating that engagement is strongly mediated by the presence of social interaction and dialogic exchange (Bishop & Verleger, 2013; O'Flaherty &

Phillips, 2015). Merely rearranging the temporal sequence of instructional delivery, such as shifting content to pre-class activities, does not automatically foster active participation. Rather, engagement emerges when students are actively invited into co-constructed learning environments where teachers scaffold discussions, pose critical questions, and provide formative feedback (Wei, 2021).

The absence of significant differences between the flipped classroom without teacher interaction and the lecture-based approach underscores the insufficiency of "flippedness" alone. This aligns with findings by Lo and Hew (2017), who noted that flipped designs lacking interactive opportunities often fail to improve motivational outcomes. The implication is that engagement depends less on the technological form of flipped instruction than on the pedagogical quality of interaction during class (Baig & Yadegaridehkordi, 2023).

5.2 The effects of flipped classroom on self-regulation

Parallel to engagement, self-regulation was significantly enhanced in the flipped classroom with teacher interaction, but not in the other two conditions. This supports Zimmerman and Cleary's (2002) framework of self-regulated learning, which emphasizes the role of external scaffolds in cultivating students' capacity to plan, monitor, and evaluate their own learning processes. In this study, teacher–student interaction likely provided immediate guidance and adaptive feedback, enabling students to refine their learning strategies and maintain sustained effort.

By contrast, students in the flipped classroom without interaction were expected to regulate their learning independently after watching pre-class materials. The lack of structured support may have undermined their ability to translate pre-class preparation into effective self-regulation, resulting in outcomes comparable to lecture-based learning. This finding corroborates self-determination theory (Deci & Ryan, 2000), suggesting that students' autonomous regulation thrives not in isolation, but in environments where competence and relatedness are actively supported by teacher involvement.

5.3 The effects of flipped classroom on academic performance

The analysis of academic performance revealed a nuanced pattern across recall, comprehension, and transfer. In both recall and comprehension domains, the flipped classroom with teacher interaction outperformed the other two approaches, but no significant difference was found between the flipped classroom without interaction and lecture-based instruction. This indicates that meaningful cognitive gains in remembering and understanding occur when pre-class preparation is followed by active engagement and guided clarification in class (Sun & Xie, 2020). The result supports cognitive theories of learning, particularly the levels-of-processing framework (Craik & Lockhart, 1972), which argues that deeper learning arises when information is elaborated through interactive discussion rather than passively received.

Interestingly, the transfer results presented a three-tier pattern: flipped classroom with interaction produced the highest outcomes, followed by flipped classroom without interaction, and then lecture-

based instruction. Unlike recall and comprehension, transfer seems to benefit from the preparatory structure of flipped learning even without active teacher interaction. Students exposed to pre-class materials may have had more opportunities to explore knowledge application independently, thereby surpassing the purely lecture-based approach (Lo & Hew, 2017). This aligns with Bloom's (1956) taxonomy, which emphasizes that higher-order thinking skills require both exposure to content and opportunities to practice application. However, the substantial additional advantage of teacher interaction suggests that scaffolding and dialogic feedback are indispensable for maximizing transfer performance (Zainuddin, 2018).

5.4 Implications

This study contributes to the growing body of flipped classroom research in both theoretical and practical dimensions. Theoretically, it offers three key insights. First, it demonstrates that the effectiveness of the flipped classroom is not inherent but depends critically on teacher–student interaction. This finding advances the interaction model of flipped classroom learning proposed by Jiang et al. (2020), highlighting the central role of dialogic processes in transforming pre-class preparation into meaningful in-class learning. Second, the differentiated effects observed across recall, comprehension, and transfer extend existing knowledge by showing that interaction exerts varying influences across cognitive domains (Jang & Kim, 2020). Third, the study provides empirical evidence linking flipped classroom practices to theories of engagement, self-regulation, and deep learning, thereby reinforcing theoretical integration across multiple frameworks.

Practically, the findings carry several important implications for instructional design and policy. For educators, implementing flipped classrooms should not be reduced to providing pre-recorded videos or pre-class readings; rather, teachers must deliberately design opportunities for dialogue, scaffolding, and feedback to sustain engagement and foster self-regulation (Ni et al., 2023). At the institutional level, schools and universities should offer professional development that equips teachers with strategies for creating interactive learning environments—for instance, training in questioning techniques, formative assessment, and collaborative learning structures that stimulate in-class discourse. Policymakers and administrators should likewise recognize that investment in video-based technologies alone is insufficient; equal emphasis must be placed on building teachers' pedagogical capacity to orchestrate interactive, student-centered learning.

6. Conclusion

In summary, this study demonstrates that the benefits of flipped classrooms are not uniformly realized; rather, they are contingent on the presence of sustained teacher–student interaction. While pre-class preparation provides a foundation for learning, it is through interaction that students engage deeply, regulate effectively, and achieve meaningful cognitive gains. These findings underscore the importance of moving beyond the mere structural inversion of flipped classrooms toward an interactive pedagogy that prioritizes dialogue, feedback, and co-construction of knowledge.

As most empirical studies, we acknowledged three limitations of this study: first, the learning content of higher music education only involved declarative knowledge (e.g., history and background of musicians, composing technique of music) while neglect the procedural knowledge, i.e., instrumental playing. Therefore, further research aims to applying flipped class into instrumental playing to expand the scope of results from this study. Second, the study focused on short-term outcomes within a limited instructional unit; future research should examine long-term effects of interaction in flipped classrooms, including retention and transfer over extended periods. Third, the study operationalized teacher–student interaction in a specific manner, but interaction is a multidimensional construct encompassing feedback, questioning, and affective support. Future work should disentangle which specific interactional practices most effectively promote engagement, self-regulation, and higher-order learning. Future research may also explore the role of peer interaction as a complement to teacher guidance, as collaborative learning has been shown to facilitate knowledge co-construction.

Declarations

Ethics approval:

This study was performed in line with the principle of the Declaration of Helsinki. This study commenced on 3rd May 2024, approval was granted by the institution the School College of Education, Longyan University, under approval number LYC-MD-2025-010, data of approvals: 13th January 2025. Moreover, all participants signed an informed consent form before the study, and their personal information and data were anonymized.

Informed consent:

Before the data collection (from 30th February 2025 to 30th June 2025), all participants were informed of the purpose and scope of the study and how the data would be used. They all signed the informed consent and agreed to participate in this research, data use, and consent to publish. Moreover, all participants were also assured that their anonymity would be maintained and that no personal or identification information would be disclosed.

Consent to participate/Consent for publication

Before the data collection, all participants were informed of the purpose and scope of the study and how the data would be used. They all signed the informed consent and agreed to participate in this research, data use, and consent to publish. Moreover, all participants were also assured that their anonymity would be maintained and that no personal or identification information would be disclosed.

Funding Declaration

No funding support this study.

Conflicts of interest/Competing interests:

On behalf of both authors, the corresponding author states that there is no conflict of interest.

Author Contribution

Chen Zhou was responsible for the data collection, data analysis, and manuscript preparation.Xing Ding was responsible for the study conception and design, data collection, data analysis, and manuscript preparation.

Data Availability

All data and materials associated with this study are openly available via the Open Science Framework (OSF) repository ([https://osf.io/mswvy/](https:/osf.io/mswvy)). The repository contains the datasets and supporting documentation required to replicate the analyses presented in this article.

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Figures



Figure 1

The first theme melody of Kamarinskaia Fantasia by Glinka



Figure 2

The first theme melody of Kamarinskaia Fantasia by Glinka

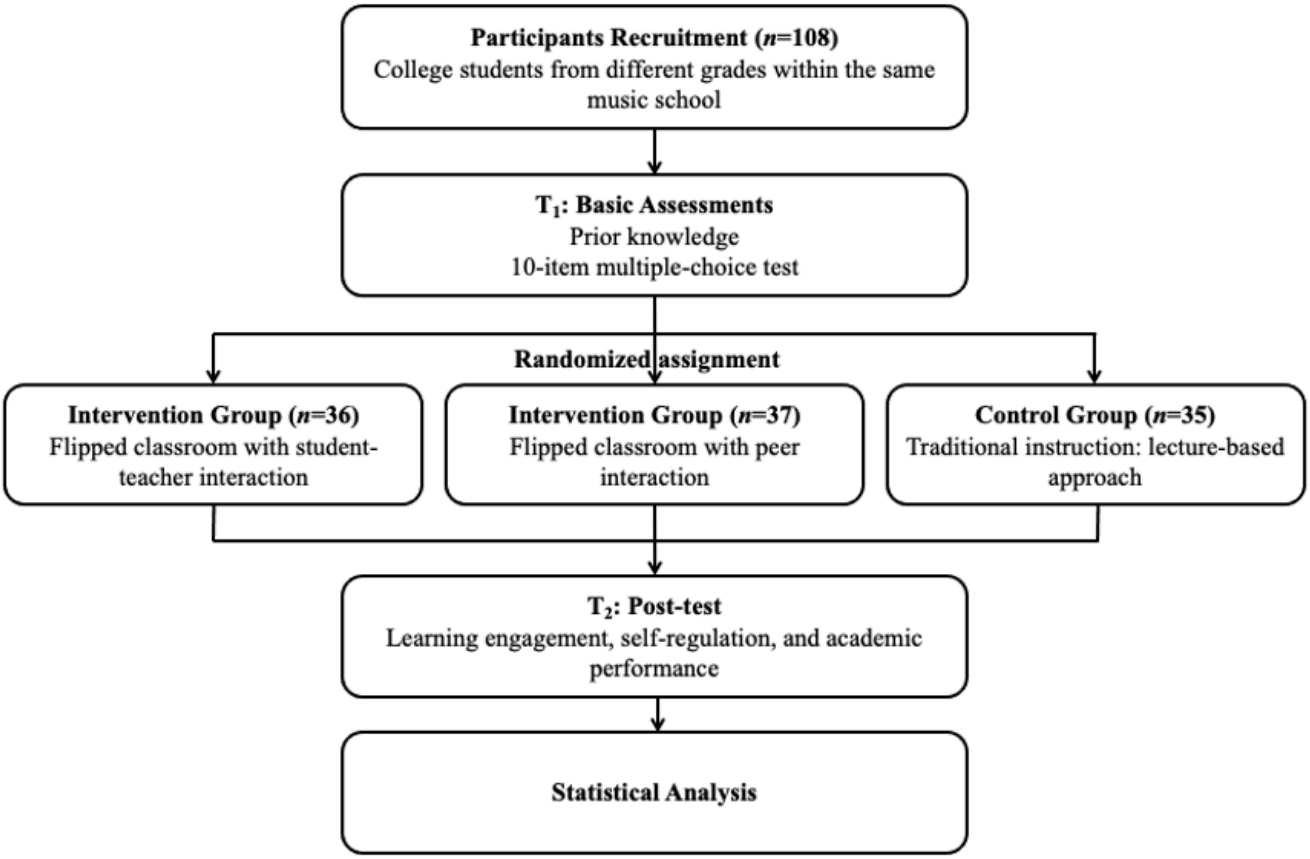


Figure 3

Flow chart of procedure

Supplementary Files

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- Appendix.docx