frontiers in Education

TYPE Original Research
PUBLISHED 06 March 2026
DOI 10.3389/feduc.2026.1756945

OPEN ACCESS

EDITED BY
Nishant Kumar,
Jawaharlal Nehru University, India

REVIEWED BY
Suroyo Suroyo,
Riau University, Indonesia
Ygnacio Tomaylla-Quispe,
Universidad Nacional de San Agustin de Arequipa, Peru

*CORRESPONDENCE
Songni Xu
songnixu@suse.edu.cn
Norsafinar Rahim
norsafinar@usm.my

RECEIVED 29 November 2025
REVISED 09 February 2026
ACCEPTED 10 February 2026
PUBLISHED 06 March 2026

CITATION
Xu S, Rahim N and Zeng S (2026) The application of generative AI in university dance education: effects on dance skills, engagement and learning motivation. *Front. Educ.* 11:1756945. doi: 10.3389/feduc.2026.1756945

The application of generative AI in university dance education: effects on dance skills, engagement and learning motivation

Songni Xu[1]*, Norsafinar Rahim[2]* and Siyuan Zeng[3]

[1]Faculty of Education and Psychological Science, Sichuan University of Science and Engineering, Zigong, China, [2]Centre for Instructional Technology and Multimedia, Universiti Sains Malaysia, Penang, Malaysia, [3]College of Art, Southwest Minzu University, Chengdu, China

Introduction: Generative artificial intelligence (GenAI) is rapidly reshaping higher education. However, evidence remains limited regarding its pedagogical utility and learning benefits in university dance learning environments.
Methods: This study employed a quasi-experimental design with 60 university students who were randomly assigned to either an experimental group using a GenAI-based teaching tool (GEN Dance) or a control group using a conventional multimedia tool. GEN Dance supported real-time, interactive dance learning activities.
Results: The GenAI-supported condition (GEN Dance) demonstrated statistically significant advantages over the conventional multimedia condition across all three assessed learning-related domains.
Discussion: These findings suggest that GenAI can enhance learning outcomes in higher education dance contexts and support more interactive instructional experiences. This study extends the emerging literature on GenAI-enabled teaching and provides empirical evidence for the integration of GenAI tools in university dance learning environments.

KEYWORDS
dance education, generative artificial intelligence (GenAI), higher education, learning outcomes, quasi-experimental design

Introduction

Dance learning fundamentally relies on iterative practice, in which students repeatedly perform movement sequences, receive evaluation, and refine their performance based on identified errors. This cycle of performance, feedback, and improvement constitutes a core pedagogical mechanism in dance education. However, in higher education contexts particularly in classes with novice dancers instructors often face constraints in delivering timely, individualized feedback during repeated practice sessions (Kang et al., 2023). Such limitations can disrupt the feedback loop that underpins motor learning and skill acquisition. Prior observational studies and research on technology-assisted dance learning consistently indicate that feedback plays a critical role in enhancing movement accuracy, motor control, and learner engagement. Conversely, insufficient feedback has been associated with reduced learning effectiveness and lower levels of student involvement in the learning process (Hsia et al., 2016; Soerel et al., 2023; Tillmanns et al., 2025).

In order to deal with this kind of feedback bottleneck for practice-based learning in dance, it is possible that emerging interactive systems enabled by GenAI technologies can offer assistance with practice-based learning. In general, AI technologies have been increasingly used for learning support within higher education, as described by (Kamalov et al., 2023) Specifically, GenAI technologies have started to gain popularity, as they have shown potential for content generation and interactive feedback, especially for skill-based learning, as described by Ogunleye et al. (2024) and (Wang and Sun, 2025). In this study, GenAI is not introduced as a replacement for movement recognition; rather, it is examined as a pedagogical layer that can translate recognition outputs into interactive, individualized feedback to support iterative correction during practice.

Within dance education, emerging evidence indicates that technology- and AI-supported feedback can benefit learners. (Hsia et al., 2016) showed that online peer-feedback approaches can improve students' performance skills and enhance motivation and self-efficacy in a dance course. Kang et al. (2023) further reported that teacher AI cooperation in online dance learning can enhance learning efficiency and classroom interaction by providing more timely guidance during practice. More recently, Xu et al. (2025) developed the dance skills teaching, evaluation, and visual feedback (DSTEVF) system integrating GenAI with computer vision to recognize dance movements in real time and provide visual feedback; students using the system demonstrated better dance skill mastery and self-efficacy than those receiving traditional instruction. In asynchronous learning environments, AI-based analysis of uploaded practice videos (e.g., accuracy, fluency, and rhythm alignment) has also been used to deliver step-by-step corrective suggestions, which has been associated with increased learning motivation and participation (Li and Huang, 2024).

Nevertheless, there still lacks systematic research into the effects of GenAI-based real-time interactive dance learning environments on learners' performance in various aspects. Specifically, little systematic research has been conducted on the effects of such learning environments on college students' dance skills, engagement, learning motivation, as well as the possible mechanisms for such effects. Thus, the present research aims to design a learning environment by integrating GenAI technology with real-time interactive dance learning. A quasi-experimental research design is employed to investigate the effects of the designed learning environment on college students' dance skills, engagement, learning motivation. By exploring the function of GenAI-based interactive feedback in dance learning, the present research hopes to contribute to the understanding of the function of AI-based support for learners' embodied skills.

Literature review

The application of generative artificial intelligence in dance education

The very nature of dance learning is that it involves a process of embodied iteration as individuals repeat actions, make mistakes, and seek to improve their skills through a process that requires great accuracy, expressiveness, and engagement. In a higher education setting, dance learning may also be compromised by a lack of contact hours and a high teacher-to-student ratio, particularly in large-class settings. This is significant because a lack of individualized support may negatively impact practice as well as learners' confidence and motivational factors, both of which are significant determinants of continued learning.

One possible reaction to these constraints is video-based learning, which can increase the reach of learning demonstrations while still generally failing to be adaptive and provide strong support for practice sequencing, goal-setting, and self-monitoring. GenAI has been proposed as a potentially scalable form of pedagogical scaffolding, allowing for the possibility of interactive support (Haroud and Saqri, 2025). (Zhang, 2025) further emphasizes that, in the context of the dance industry's increasing transition toward intelligent development, dance educators in higher education urgently need to explore innovative ways to integrate generative artificial intelligence technology into teaching practices in order to meet better the challenges of cultivating artistic talent in the new era.

In recent years, the academic community has begun to pay close attention to the application and effectiveness of GenAI in dance education (Xu et al., 2025) developed and empirically tested an AI system (DSTEVF) that integrates teaching, assessment, and visual feedback. The results showed that the system significantly enhanced university students' dance performance and self-efficacy, students with low motivation and low self-efficacy. Meanwhile, Fitas (2025) conducted a systematic evaluation, concluding that AI-assisted immersive teaching technologies can improve students' motor performance, motivation, and classroom engagement, particularly in resource-constrained large-class settings. Classroom designs based on the TPACK model were also validated by Zhang (2025) as an effective approach. In a university dance classroom experiment conducted under AI-enabled conditions throughout the day, experimental group students demonstrated significantly superior outcomes in skill mastery, classroom satisfaction, and progress compared to the control group. Additionally, the Afford Dance system proposed by Han et al. (2025) combines augmented reality with visual affordances to provide students with personalized and timely movement guidance. Their empirical study confirmed that this approach significantly enhances movement perception and engagement experiences.

In dance education, GenAI demonstrates transformative potential. It holds promise for alleviating these learning challenges motion generation, real-time error correction feedback, and personalized suggestions, it holds promise for alleviating these learning challenges. (Xiaohui, 2024)noted that GenAI can analyze learners' motion data in real time and provide customized guidance, thereby enhancing students' skill acquisition efficiency and self-monitoring abilities (Liu and Sra, 2024) further found that AI intervention optimized the choreography teaching process significantly enhancing students' creative generation and performance confidence. Although current research findings have preliminarily validated the advantages of GenAI in dance instruction, overall, this field still lacks large-scale, systematic empirical exploration in real classroom settings. Therefore, future

comparative studies are urgently needed to conduct in-depth assessments of the multidimensional impacts of GenAI on dance learning outcomes, laying the theoretical and practical foundation for its deep integration into dance education. Consequently, the present study seeks to address the identified research gaps through an investigation of the differences between a GenAI-supported mobile learning system, referred to as GEN Dance, which facilitates individualized practice plans and interactive support, and traditional video-based multimedia instruction. With the support of three research questions, the present study seeks to investigate the differences in the acquisition of dance skills, student engagement, and learning motivation.

Engagement and motivation

Motivation not only plays an important role in the initiation and maintenance of learning behavior, but it also has a direct effect on the level of learners' engagement and learning performance (Inácio et al., 2023).According to the theory of self-determination, learning motivation is one of the most important psychological factors for individuals' behavioral participation in learning tasks. Specifically, the positive relationship between intrinsic motivation, autonomy motivation, and cognitive engagement is of great importance (Zhou et al., 2021). Singh et al. (2022) employed structural equation modeling to investigate the relationship between learning motivation, motivation deficiency, students' behavioral participation, and students' cognitive participation. The research found that the presence of positive learning motivation had a significant predictive effect on students' behavioral participation and students' cognitive participation, while motivation deficiency was found to have a negative correlation with students' participation.

Furthermore, the enhancement of participation is often moderated by the type of teacher support provided Li et al. (2025) found in their study of Chinese university students that the autonomous support and structural support provided by teachers indirectly strengthened students' intrinsic motivation by satisfying their basic psychological needs autonomy, competence, and relatedness, thereby significantly improving classroom engagement levels. This mediating mechanism demonstrates that motivation is not an isolated variable but is regulated by multiple environmental factors within the educational ecosystem. Furthermore, the influence of learning motivation on participation varies depending on the learning context. In a blended learning environment, (Carmona-Halty et al., 2024) found that intrinsic and extrinsic motivation not only independently influence emotional engagement and psychological capital but also indirectly affect academic performance through these variables, revealing a complex and dynamic causal relationship between motivation and engagement.

Likewise, the difference in the type of motivations may also affect the quality of students' engagement. Saeed and Zyngier (2012) discovered through their study that intrinsic motivations are more likely to facilitate students' authentic engagement, while controlled extrinsic motivations are only effective in maintaining "ritualistic participation" or "compliant participation" and are not effective in promoting learning. This process may be more evident in certain cultural contexts. The study by Li et al. (2025) also confirmed that students in classrooms with high levels of teacher autonomy support have high levels of motivation and are more willing to engage in class, which shows the role of the educational context in the relationship between motivation.

This study was designed to develop the GenAI dance real-time interactive system (GEN Dance) for the enhancement of learning in dance fundamentals courses. In addition, the study was designed to evaluate the effectiveness of the system in the development of students' dance skills, engagement, and learning motivation. To achieve the research goals, the following research questions were explored:

RQ1: Do students using the GenAI dance real-time interactive system (GEN Dance) in dance classes demonstrate higher levels of dance skill acquisition compared to those taught using traditional multimedia instruction?
RQ2: Does the use of the GenAI dance real-time interactive system (GEN Dance) in dance classes lead to higher levels of student engagement compared to traditional multimedia instruction?
RQ3: Does the use of the GenAI dance real-time interactive system (GEN Dance) in dance classes enhance students' learning motivation more effectively than traditional multimedia instruction?

Conceptual framework

Building upon the theoretical underpinnings and the variables explored in this research, the researcher has developed a conceptual framework. Figure 1 visually represents this framework, illustrating how the GEN Dance is a persuasive technology tool within the mobile learning environment.

GEN Dance was developed with reference to CTML, Experiential Learning Theory, and key persuasive design concepts such as tunneling and suggestion. These are all aimed at improving the performance, engagement, and motivation of learners. Dance skills are used as a case for this research since they involve all three senses: auditory, visual, and kinesthetic. In addition, GEN Dance is aimed at improving learners' attention, filtering, and organizing of information using working memory. Persuasive elements are also incorporated to ensure that learners are always engaged. In that case, multimedia cues are incorporated to ensure that learners are not missing any key information. Tunneling is also incorporated to ensure that learners are not overwhelmed by complex tasks. In addition, prompts are incorporated to ensure that learners are always engaged. All these elements are aimed at improving skill development, a sense of achievement, and a rich learning experience.

Method

Research participants

This study involved 60 first-year preschool education majors' students from a public undergraduate university in China. All

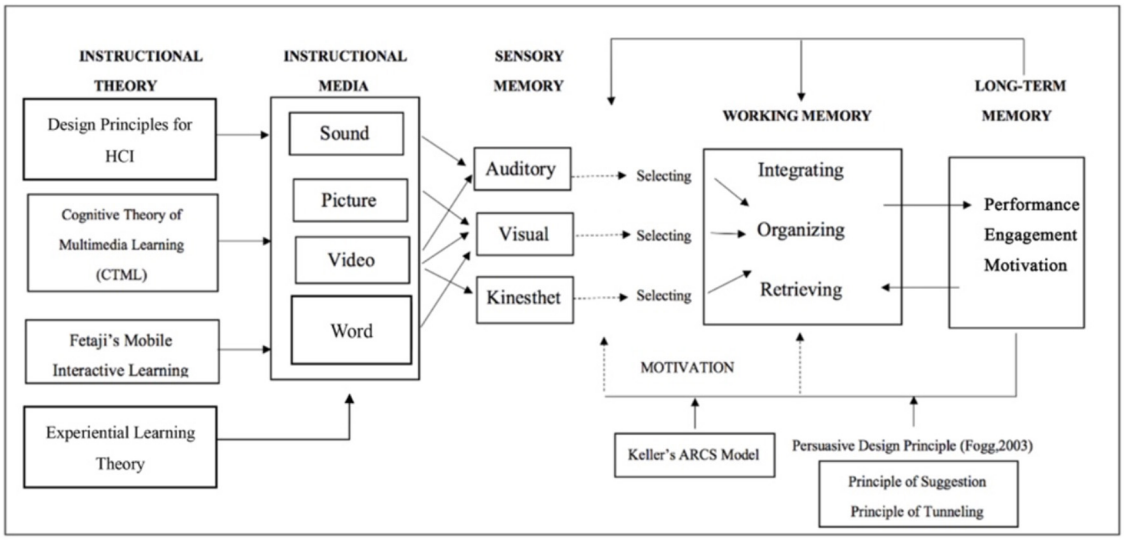

FIGURE 1
Conceptual framework.

participants were enrolled in a compulsory professional course designed to cultivate basic dance literacy, covering ballet training and the study of representative Chinese dance pieces. Prior to the experiment, all students signed informed consent forms, clearly acknowledging the purpose and process of the study, and voluntarily participated in the research. The 60 students were randomly assigned to two different learning systems: the experimental group (EG) using the GEN Dance and the control group (CG) using traditional multimedia learning. The EG group consisted of 32 students, including 1 male and 31 females. The CG group consisted of 28 students, including 3 males and 25 females.

Research design and procedure

This study explores the impact of GenAI on students' dance skills, engagement and learning motivation in dance courses at Chinese universities. The experimental procedure is shown in Figure 2. Before the course officially began, the instructor explained the research process in detail to all participants to ensure they fully understood the purpose of the experiment and the operational requirements. The experimental group received a 20 min training session on the GenAI dance real-time interaction system (GEN Dance) before the learning task, which included an introduction to its functions and a demonstration of its operation, to ensure they could use the platform effectively. Subsequently, we employed course-cohort convenience sampling. Specifically, all first-year undergraduates enrolled in the compulsory dance course for the Preschool Education (Early Childhood Education) programme during the study term were invited to participate. Inclusion criteria were: (1) enrolment in the course, (2) voluntary participation with written informed consent, and and (3) physical ability to safely engage in routine course activities. All enrolled students who consented completed the study procedures; therefore, there were no absences and no missing data in the final dataset and then completed a pre-test to assess their initial level of dance skills. Participants were randomly allocated to the GEN Dance condition or the conventional multimedia instruction condition using a random allocation procedure to achieve comparable group sizes. To minimize potential bias, both conditions were implemented within the same course cohort in the same term with the same instructor, contact hours, learning objectives, teaching materials, and assessment schedule; the only difference was the learning-support mode (GEN Dance vs. video-based instruction). In the formal experiment phase, a dance learning activity is carried out for each individual for a period of 90 min. The experimental group learned dance content through the GEN Dance, and the control group learned dance content through traditional multimedia teaching methods such as videos. The dance teaching materials used for both groups were consistent in terms of content but varied in terms of presentation style and interaction level. After conducting the dance learning activities for both groups, a *post-test* is carried out for each individual to assess their changes in dance skills and their levels of engagement and learning motivation.

Data collections and measurements

The research tools used in this study include a dance skill assessment scale, a learning motivation scale, and engagement scale. Among these, the dance skill assessment was conducted by three lecturers with over 15 years of experience in university dance education, who served as evaluators. The assessment was based on the dance performance evaluation scale proposed by R campus (2018). This scale originally included four dimensions: dance choreography knowledge, technical skills, performance ability, and rhythm and tempo sense. After discussion among the three experts, it was determined that the "dance choreography knowledge"

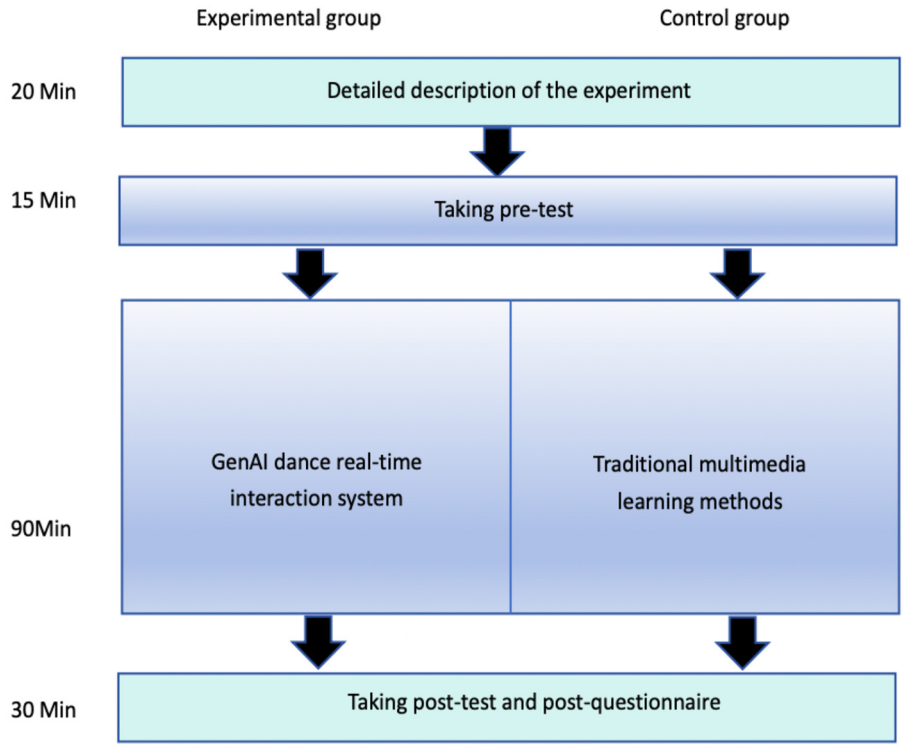

FIGURE 2
Experimental procedures.

dimension did not apply to the basic course content covered in this study, so it was excluded. The final assessment dimensions are technical skills, performance ability, and rhythm and beat sense. Each dimension is scored on a five-point scale: excellent (5 points), good (4 points), average (3 points), partially meeting standards (2 points), and lowest level (1 point). The Kuder-Richardson 20 (KR-20) split-half method was used for reliability analysis to test the internal consistency of the dance skill scale. The results showed a reliability coefficient of 0.844, indicating that the assessment tool has good internal consistency and acceptable reliability levels.

For the measurement of student engagement in learning dance skills, the Engagement Test (ET) questionnaire was utilized. This instrument evaluates the cognitive, emotional, and behavioral dimensions of learning engagement. The engagement questionnaire used in this study was adapted and modified from the original scale developed by Fredricks et al. (2004) and Govindasamy (2011) to align with the study's specific requirements. The constructs of cognitive, emotional, and behavioral engagement were selected for this study in accordance with the research objectives. Certain items within the ET were tailored to suit the university dance environment of this study. This instrument is a Likert scale. The learners' response scale ranges from 1 (strongly disagree) to 5 (strongly agree). Prior to the main study, the adapted items were reviewed for clarity and relevance and were further examined through a pilot test with 30 students. Based on pilot feedback, minor wording refinements were made to improve comprehensibility in the university dance setting.

For this study, the Cronbach's alpha internal consistency reliability coefficient is 0.956. The coefficient of stability of the instrument was reported as 0.89 by (Annamalai et al., 2014), and the alpha value of the Engagement Test (ET) instrument was reported as 0.79 to 0.92 by the National Centre for School Engagement (NCSE). It was therefore concluded that the ET instrument used in this study fulfilled the required reliability level.

This study adopted the Chinese version of the Instructional Materials Motivation Survey (IMMS) developed by Keller and Keller (2010) to explore learners' perceived motivation toward the GenAI dance real-time interactive system used in this study. The IMMS is based on a five-point Likert scale with four dimensions: attention, relevance, confidence, and satisfaction, with a total of 36 items. In order to test the reliability for this study, an internal consistency test was conducted, which yielded a Cronbach's alpha value of 0.96, indicating a high level of reliability.

Data analysis

The data collected in this study were analyzed using Statistical Packages for Social Sciences (SPSS) version 27. ANCOVA was selected to assess the potential disparity in student dance skills between the two groups. *Pre-test* scores were also taken as covariates to account for initial skill differences. ANOVA was utilized to ascertain any significant distinctions in student engagement and learning motivation between the two groups.

Results

Results for RQ1: Impact on dance skills

To address Research Question 1, we conducted an analysis of covariance (ANCOVA) to examine the effect of GEN Dance system on students' academic achievement. Prior to the ANCOVA, key analytic assumptions were evaluated. Normality of the outcome variable was assessed using the Shapiro–Wilk test; the non-significant result indicated that the normality assumption was satisfied. Homogeneity of variances was examined with Levene's test, which was also non-significant, supporting the assumption of equal variances across groups.

Table 1 presents the ANCOVA results after controlling for the relevant covariate(s). Controlling for pretest scores, the adjusted mean of the experimental group (Adj. M = 3.599) was significantly higher than that of the control group (Adj. M = 2.508), $F = 74.868$, $p < 0.01$, with a large effect size (partial $\eta^2 = 0.390$). These findings indicate that the GEN Dance system has a significant positive impact on students' dance skills in early childhood education programme.

Results for RQ2: the impact on engagement

To examine whether the GenAI dance real-time interactive system (GEN Dance) enhanced students' engagement (RQ2), a one-way ANOVA was conducted to compare engagement scores between the experimental group and the control group. Prior to the analysis, the ANOVA assumptions were assessed. Engagement scores were approximately normally distributed (Shapiro–Wilk test), and Levene's test indicated homogeneity of variances; thus, the assumptions for one-way ANOVA were met. The results revealed a statistically significant difference in engagement between the two groups, $F = 61.581$, $p < 0.001$, with a very large effect size ($\eta^2 = 0.515$). As reported in Table 2, descriptive statistics showed that the experimental group achieved higher engagement scores ($M = 3.867$, $SD = 0.362$, $SEM = 0.064$) than the control group ($M = 3.371$, $SD = 0.430$, $SEM = 0.081$). In addition to significantly greater engagement, the lower standard deviation in the experimental group suggests more consistent engagement responses. Overall, these findings indicate that GEN Dance significantly enhances students' engagement compared to traditional multimedia instruction.

Results for RQ3: the impact on learning motivation

To investigate the effect of the GenAI dance real-time interactive system on students' learning motivation (RQ3), a one-way ANOVA analysis was carried out. The analysis results show that there was a significant difference between the experimental group and control group, $F = 55.505$, $p < 0.001$, with a large effect size, $\eta^2 = 0.410$. Table 3 presents the descriptive statistics show that, on average, students using the GenAI dance real-time interactive system group scored higher than those in the control group. The experimental group scored an average of $M = 3.924$, with a standard deviation of 0.263, while the control group scored an average of $M = 3.451$, with a standard deviation of 0.319. The standard deviation was lower for the experimental group, indicating that the experimental group was more consistent with regard to learning motivation.

Discussion

The objectives of this study are to create a real-time interactive learning system with GenAI to improve students' dance skills, engagement, and motivation in dance education. The main objective of this study is to explore, through a quasi-experimental research design, how the GenAI-based real-time interactive dance system can improve students' dance skills in basic dance courses. Additionally, this study aims to explore how the system can improve students' engagement and motivation in dance learning.

Discussion of the results of RQ1

The results obtained for RQ1 indicate a marked improvement in dance skills using the GenAI real-time interactive learning system compared to the conventional multimedia learning system. This is important because learning dance is a process of practice and feedback. In conventional learning situations, students may not be provided with adequate feedback. One of the most significant findings is that GEN Dance could be used as a learning tool to help students practice by going through the process more efficiently.

These findings are in line with the results of more recent research that points to the potential of technology-supported guidance in enhancing the performance of movements. For instance, Han et al. (2025) found that technology-based learning platforms that support both augmented reality and GenAI have the potential to provide synchronous visual guidance, thus enhancing the execution of movements. In the same vein, (Liu and Sra, 2024) found that generative AI has the potential to facilitate interactive processes in the process of choreography or imitation, thus enhancing learners‘ understanding of the structure of movements (Zhou et al., 2022) also found that AI systems that support visual feedback have the potential to enhance learners' responses to feedback, thus enhancing the refinement of movements. The current research extends these findings in the sense that the results of the current research provide evidence of the added value of GenAI in the process of course integration, suggesting that the added value of GenAI is in the support of the feedback correction process.

Discussion of the findings of RQ2

For RQ2, GenAI was found to elicit higher levels of student engagement than the traditional multimedia-based approach. This

TABLE 1 The analysis of the ANCOVA on students' dance skill.

Group	*N*	*M*	*SD*	Adj.M	Std. error	*F*	η^2
Experimental group	32	3.636	0.464	3.599	0.136	74.868**	0.390
Control group	28	2.472	1.050	2.508	0.185		

**p <0.01.

TABLE 2 The One-way ANOVA results for engagement between the two groups.

Group	*N*	Mean	*SD*	SEM	*F*	*P*	η^2
Experimental group	32	3.867	0.362	0.064	61.581	0.000	0.515
Control group	28	3.371	0.430	0.081			

TABLE 3 The One-way ANOVA results for learning motivation between the two groups.

Group	*N*	Mean	*SD*	SEM	*F*	*P*	η^2
Experimental group	32	3.924	0.263	0.047	55.505	0.000	0.410
Control group	28	3.451	0.319	0.060			

is important because it was found that engagement was a pre-requisite for practice, while disengagement was also found to hinder practice in settings where students had to persevere through repeated errors. This advantage of GenAI in promoting student engagement could imply that interaction and personalization helped students remain cognitively and emotionally engaged during practice.

Consistent with (Garcia et al., 2025), the present results support the view that real-time interaction and personalization can promote deeper involvement. In a movement-based domain such as dance, GEN Dance may strengthen engagement by aligning with embodied learning principles learners receive multimodal cues and feedback that connect perception and action (Seo et al., 2021) and by increasing learner agency through more responsive guidance and clearer next-step actions (Becker et al., 2025). Furthermore, the more stable engagement responses observed in these learners suggest that the system could potentially reduce the usual disparities in engagement that are typically seen in students who rely exclusively on non-adaptive resources, which is another concern in the larger context of technology-based learning (Zawacki-Richter et al., 2019). This study is relevant because it shows the actual classroom results of engagement, and it implies that the value of GenAI in the classroom is not necessarily the technology itself, but the interactivity and the use of feedback.

Discussion of the findings of RQ3

For RQ3, it can be seen that the Gen AI-supported system greatly promoted students' learning motivation compared to the control group. Learning motivation is a critical factor, as it is closely related to students' persistence and willingness to repeat practice, which are crucial for improving students' performance in embodied learning. For this study, it is suggested that the features of the system may facilitate students' motivational processes by providing visibility, reducing uncertainty regarding performance quality, and enhancing students' competence and control.

This understanding is in line with the finding that motivation is a significant psychological factor in skill-based learning (Xu et al., 2025). Trajkova (2021) found that the use of mobile interaction and AI-based real-time feedback also enhanced the willingness to participate and the sustainability of motivation in dance learning. Zhou et al. (2021) found that the use of AI-based visual feedback can facilitate more accurate movements and increase learners' positive perceptions of the learning outcomes, which might further support self-motivation. The present study extends the existing research by showing that the motivational effect can be observed when GenAI is used as a practice support in the normal course of teaching and is compared with a widely used alternative (video-based multimedia instruction), thus making it clear that the motivational effect is due to the enhanced feedback and more structured and goal-oriented practice rather than the additional information itself.

Limitation

It is worth noting that the current study has a number of limitations. First, the current study had a relatively small sample size. It is possible that the current study would benefit from a larger sample size. Additionally, the current study was conducted in a specific basic dance course. It is possible that the current study would benefit from a broader range of course types.

Implications for future research and practice

The significant findings of the GenAI real-time interactive system in the course-integrated quasi-experimental research design pertained to the *post-test* findings of the students' dance skills, engagement, and motivation. These findings validated the potential of the GenAI system to add value to the students' learning process by regulating the students' practice through real-time feedback, facilitating the identification and correction of error, and monitoring the students' progress through the iterative process of learning. With regard to the limitations of the current study, the

following suggestions for future study have been proposed: (1) conduct the study with a larger and diverse number of participants, (2) extend the study to examine the generalizability of the study's findings to other types of courses, (3) use more advanced research design and examine the moderating effect of learner characteristics on the GenAI system's effect, and (4) extend the scope of the study's findings to the long-term effect of the GenAI system, i.e., retention of the students' learning of dance skills. Moreover, the hypothesized learning processes should be examined through process-oriented measures, as well as the moderating effect of learner characteristics.

The results of the research also reveal the potential of the GenAI real-time interaction system to be used as an adjunct for the basic dance courses in which the correction of the movements of the students is restricted. However, the deployment of the GenAI real-time interaction system should be made in the following manner: (1) the structuring of the practice tasks and the criteria for the performance of the students, (2) the provision of formative feedback to the students in real-time regarding the techniques and the rhythm/tempo of the dance, and (3) the provision of the facility for the students to self-monitor their movements prior to the verification of the correctness of the movements by the teacher. To make the deployment of the GenAI real-time interaction system pedagogically valid, the feedback provided should match the rubric for the course, and the process should also be standardized.

Conclusion

The current study attempted to investigate the efficacy of the "Gen AI-Supported Real-Time Interactive Dance Learning System," also called "GEN Dance," using the quasi-experiment with course-integrated design, comparing students who learned dance skills with the aid of the system with students who learned the same with conventional multimedia instruction using the video-based approach. The results revealed that students who learned dance skills with the aid of the GEN Dance scored higher than students who learned the same with conventional multimedia instruction using the video-based approach, both in terms of performance of dance skills, as well as their level of engagement and motivation for learning. The current study has provided important implications for understanding the efficacy of the GEN Dance system in assisting students with the learning of dance skills, which may provide important insights for understanding the potential of the "Gen AI-Supported Real-Time Interactive Dance Learning System" for helping address some of the common problems confronting large classes with the instruction of dance skills, particularly with regards to providing opportunities for individualized correction, which are often limited with conventional large classes. The current study has provided important implications for understanding the potential of the GEN Dance system for helping address some of the common problems confronting large classes with the instruction of dance skills, particularly with regards to providing opportunities for individualized correction, which are often limited with conventional large classes.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

SX: Writing – original draft. NR: Writing – review & editing. SZ: Writing – review & editing.

Funding

The author(s) declared that financial support was not received for this work and/or its publication.

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

References

Annamalai, S., Muniandy, B., and Samsudin, Z. (2014). Learning Engagement, Perceived Motivation and Reception of mE-book in language learning among Polytechnic students. *J. ICT Educ.* 1, 19–28.

Becker, E., Wünsche, J., Veith, J., Schrader, J., and Bitzenbauer, P. (2025). From cognitive relief to affective engagement: an empirical comparison of AI chatbots and instructional scaffolding in physics education. *PsyAxiv preprint.*

Carmona-Halty, M., Alarcón-Castillo, K., Semir-González, C., Sepúlveda-Páez, G., Mena-Chamorro, P., Barrueto-Opazo, F., et al. (2024). How study-related positive emotions and academic psychological capital mediate between teacher-student relationship and academic performance: a four-wave study among high school students. *Front. Psychol.* 15:1419045. doi: 10.3389/fpsyg.2024.1419045

Fitas, R. (2025). Inclusive education with AI: supporting special needs and tackling language barriers. *PsyAxiv preprint.* doi: 10.1007/s43681-025-00824-3

Fredricks, J. A., Blumenfeld, P. C., and Paris, A. H. (2004). School engagement: potential of the concept, state of the evidence. *Rev. Educ. Res.* 74, 59–109. doi: 10.3102/00346543074001059

Garcia, M. B., Goi, C. L., Shively, K., Maher, D., Rosak-Szyrocka, J., Happonen, A., et al. (2025). "Understanding student engagement in AI-powered online learning platforms: a narrative review of key theories and models," in Cases on Enhancing P-16 Student Engagement With Digital Technologies (London: IGI Global), 1–30. doi: 10.2139/ssrn.5074608

Govindasamy, M. (2011). *The effects of embodied pedagogical agent integrated with students' commonly asked questions in the learning of science among low achievers*. Universiti Sains Malaysia, Penang, Malaysia.

Han, H., Jang, J., Shim, K., and Yoon, S. H. (2025). AfforDance: Personalized AR Dance Learning System with Visual Affordance. *PsyAxiv preprint*

Haroud, S., and Saqri, N. (2025). Generative ai in higher education: teachers' and students' perspectives on support, replacement, and digital literacy. *Educ. Sci.* 15:396. doi: 10.3390/educsci15040396

Hsia, L.-H., Huang, I., and Hwang, G.-J. (2016). Effects of different online peer-feedback approaches on students' performance skills, motivation and self-efficacy in a dance course. *Comput. Educ*. 96, 55-71. doi: 10.1016/j.compedu.2016.02.004

Inácio, A. L. M., Boruchovitch, E., Cunha, N., d,. B., and Miranda, L. d. R. C. d. (2023). Predictive Potential of Motivation to Learn in the use of Learning Strategies. *Psicol. Teoria e Pesq*. 39:e39nspe02. doi: 10.1590/0102.3772e39nspe02.en

Kamalov, F., Santandreu Calonge, D., and Gurrib, I. (2023). New era of artificial intelligence in education: Towards a sustainable multifaceted revolution. *Sustainability* 15:12451. doi.org/doi: 10.3390/su151612451

Kang, J., Kang, C., Yoon, J., Ji, H., Li, T., Moon, H., et al. (2023). Dancing on the inside: a qualitative study on online dance learning with teacher-AI cooperation. *Educ. Inform. Technol.* 28, 12111-12141. doi: 10.1007/s10639-023-11649-0

Keller, J. M., and Keller, J. M. (2010). *The Arcs Model of Motivational Design. Motivational Design for Learning and Performance: The ARCS Model Approach.* NewYork, NY: Springer43–74. doi: 10.1007/978-1-4419-1250-3_3

Li, H., and Huang, X. (2024). Intelligent dance motion evaluation: an evaluation method based on keyframe acquisition according to musical beat features. *Sensors* 24:6278. doi: 10.3390/s24196278

Li, Y., Sueb, R., and Said Hashim, K. (2025). The relationship between parental autonomy support, teacher autonomy support, peer support, and university students' academic engagement: the mediating roles of basic psychological needs and autonomous motivation. *Front. Psychol.* 16:1503473. doi: 10.3389/fpsyg.2025.1503473

Liu, Y., and Sra, M. (2024). "Dancegen: supporting choreography ideation and prototyping with generative AI," in *Proceedings of the 2024 ACM Designing Interactive Systems Conference* (New York, NY: ACM), doi: 10.1145/3643834.3661594

Ogunleye, B., Zakariyyah, K. I., Ajao, O., Olayinka, O., and Sharma, H. (2024). A systematic review of generative AI for teaching and learning practice. *Educ. Sci.* 14:636. doi: 10.3390/educsci14060636

R campus (2018). *IRubric: Dance Performance Evaluation Rubric*.

Saeed, S., and Zyngier, D. (2012). How motivation influences student engagement: a qualitative case study. *J. Educ. Learn*. 1, 252-267. doi: 10.5539/jel.v1n2p252

Seo, K., Tang, J., Roll, I., Fels, S., and Yoon, D. (2021). The impact of artificial intelligence on learner–instructor interaction in online learning. *Int. J. Educ. Technol. High. Educ.* 18:54. doi: 10.1186/s41239-021-00292-9

Singh, M., James, P., Paul, H., and Bolar, K. (2022). Impact of cognitive-behavioral motivation on student engagement. *Heliyon* 8:e09843.doi: 10.1016/j.heliyon.2022.e09843

Soerel, B. F., Plaatsman, L. A., Kegelaers, J., Stubbe, J. H., van Rijn, R. M., and Oudejans, R. R. (2023). An analysis of teachers' instructions and feedback at a contemporary dance university. *Front. Psychol.* 14:1133737. doi: 10.3389/fpsyg.2023.1133737

Tillmanns, T., Salomão Filho, A., Rudra, S., Weber, P., Dawitz, J., Wiersma, E., et al. (2025). Mapping tomorrow's teaching and learning spaces: a systematic review on GenAI in higher education. *Trends High. Educ*. 4:2. doi: 10.3390/higheredu4010002

Trajkova, M. (2021). *aiDance: a non-invasive approach in designing ai-based feedback for ballet assessment and learning*. Indiana University-Purdue University Indianapolis.

Wang, G., and Sun, F. (2025). A review of generative AI in digital education: transforming learning, teaching, and assessment. *Int. J. Inform. Commun. Technol.* 26, 102-127. doi: 10.1504/IJICT.2025.146701

Xiaohui, W. (2024). Artificial Intelligence-driven training and improvement methods for college students' line dancing. *Int. J. Adv. Comput. Sci. Appl.* 15:0150184. doi: 10.14569/IJACSA.2024.0150184

Xu, L.-J., Wu, J., Zhu, J.-D., and Chen, L. (2025). Effects of AI-assisted dance skills teaching, evaluation and visual feedback on dance students' learning performance, motivation and self-efficacy. *Int. J. Hum. Comput. Stud.* 195:103410. doi: 10.1016/j.ijhcs.2024.103410

Zawacki-Richter, O., Marín, V. I., Bond, M., and Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education–where are the educators? *Int. J. Educ. Technol. High. Educ.* 16, 1-27. doi: 10.1186/s41239-019-0171-0

Zhang, Y. (2025). Teaching reform of dance major based on TPACK learning theory and AI classroom. *J. Comput. Methods Sci. Eng.* 25,1747-1759. doi: 10.1177/14727978241303825

Zhou, Q., Chua, C. C., Knibbe, J., Goncalves, J., and Velloso, E. (2021). "Dance and choreography in HCI: a two-decade retrospective," in *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (New York, NY). doi: 10.1145/3411764.3445804

Zhou, X. M., Zou, L. B., Liao, H. Y., Luo, J. Q., Yang, T. W., Wu, J., et al. (2022). Abrogation of HnRNP L enhances anti-PD-1 therapy efficacy diminishing PD-L1 and promoting cell-mediated ferroptosis in castration-resistant prostate cancer. *Acta Pharm. Sinica B* 12, 692–707. doi: 10.1016/j.apsb.2021.07.016