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# The Impact of Hybrid Learning Integrating Mobile Interaction and AI Timely Feedback on Students' Dance Performance, Perceived Motivation, and Engagement

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**Abstract: Objectives:** The objective of this study is to explore the impact of integrating mobile interactive technology with artificial intelligence and timely feedback on dance education, particularly within a blended learning framework. The research aims to enhance students' dance skills, perceived motivation, and engagement, thereby fostering their all-round development and sustainable growth in dance. **Methods:** The study proposes a Mobile Interactive Technology Integrated with Artificial Intelligence and Timely Feedback Dance Training (MI-AI-TFDT) tool and applies it in dance teaching using a blended learning approach. Sixty college students were divided into an experimental group and a control group. The experimental group used the MI-AI-TFDT tool, while the control group employed traditional video learning within a blended teaching method. The study aimed to compare the effects of these two approaches on students' dance performance, perceived motivation, and learning engagement. **Results:** The study results indicated that students who used the MI-AI-TFDT blended learning approach demonstrated performance in dance, perceived motivation, and learning engagement compared to those who used the traditional video learning blended teaching method. The integration of mobile interactive technology and artificial intelligence with timely feedback proved to be more effective in enhancing dance education outcomes. Conclusions: The study concludes that the integration of mobile interactive technology with artificial intelligence and timely feedback significantly improves dance education outcomes in a blended learning environment. This approach not only enhances students' dance performance but also boosts their motivation and engagement, contributing to their overall development in dance. **Recommendations:** Future research should explore AI-integrated mobile learning across diverse dance genres and gamification to enhance engagement, motivation, and personalized learning in dance education.

**Keywords:** Mobile interactive technology; Artificial intelligence; Blended learning; Timely feedback; Learning method.

# تأثير التعلم الهجين الذي يدمج التفاعل عبر الهاتف المحمول والتغذية الراجعة في الوقت المناسب بالذكاء الاصطناعي على أداء الطلاب في الرقص، والدافع المتصور، والمشاركة

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**الملخص: الأهداف**: الهدف من هذه الدراسة هو استكشاف تأثير دمج التكنولوجيا التفاعلية المتنقلة مع الذكاء الاصطناعي والتغذية الراجعة في الوقت المناسب على تعليم الرقص، لا سيما في إطار التعلم المدمج. يهدف البحث إلى تعزيز مهارات الرقص لدى الطلاب، والدافع المتصور، والمشاركة، وبالتالي تعزيز تطورهم الشامل ونموهم المستدام في الرقص. **المنهجية:** تقترح وتطبيقها في تعليم الرقص باستخدام (MI-AI-TFDT) الدراسة أداة التدريب على الرقص بالتكنولوجيا التفاعلية المتنقلة المدمجة مع الذكاء الاصطناعي والتغذية الراجعة في الوقت المناسب بينما استخدمت المجموعة الضابطة التعلم ،MI-AI-TFDT نهج التعلم المدمج. تم تقسيم ستين طالبًا جامعيًا إلى مجموعة تجريبية ومجموعة ضابطة. واستخدمت المجموعة التجريبية أداة بالفيديو التقليدي ضمن طريقة التدريس المدمج. هدفت الدراسة إلى مقارنة تأثيرات هذين المنهجين على أداء الطلاب في الرقص، والدوافع المتصورة والمشاركة في التعلم. **النتائج:** أشارت نتائج الدراسة إلى أن الطلاب الذين استخدموا أسلوب التعليم المدمج للتعلم المدمج باستخدام تكنولوجيا المعلومات والاتصالات التفاعلية المتنقلة - تقنية التعلم التفاعلي المتنقل - تقنية التعلم المدمج للتعلم المدمج أظهروا أداءً في الرقص، ودافعية مدركة، ومشاركة في التعلم مقارنةً بالطلاب الذين استخدموا أسلوب التعليم المدمج التقليدي للتعلم بالفيديو. أثبت تكامل التكنولوجيا التفاعلية المتنقلة والذكاء الاصطناعي مع التغذية الراجعة في الوقت المناسب أنه أكثر فعالية في تعزيز نتائج تعليم الرقص. **الاستنتاجات:** خلصت الدراسة إلى أن تكامل التكنولوجيا التفاعلية المتنقلة مع الذكاء الاصطناعي والتغذية الراجعة في الوقت المناسب يحسن بشكل كبير من نتائج تعليم الرقص في بيئة التعليم المدمج. هذا النهج لا يعزز أداء الطلاب في الرقص فحسب، بل يعزز أيضًا من تحفيزهم ومشاركتهم، مما يساهم في تطويرهم بشكل عام في الرقص. **التوصيات:** يجب أن تستكشف البحوث المستقبلية التعلم المتنقل المدمج بالذكاء الاصطناعي عبر أنواع الرقص المتنوعة والتلعيب لتعزيز المشاركة والتحفيز والتعلم الشخصي في تعليم الرقص.

**الكلمات المفتاحية:** التكنولوجيا التفاعلية المتنقلة؛ الذكاء الاصطناعي؛ التعلم المدمج؛ التغذية الراجعة في الوقت المناسب؛ طريقة التعلم.

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## Introduction

As the digital revolution is using communication technology to transform education, the policies and strategies of educational institutions are changing their mindsets, and mobile learning provides opportunities and new methods for active learning (Rajaram 2023). It is generally believed that technological development profoundly impacts education, mainly involving the delivery of teaching and the way knowledge is acquired. As an emerging technology, mobile technology has become a mature teaching system used by educational institutions worldwide and has undeniable advantages (Alotaibi and Alshehri 2023). In recent years, technological advances have led to the widespread availability of portable mobile devices, which have directly impacted how people access knowledge (Adnan et al. 2024). In particular, digital natives who have been exposed to the Internet, mobile devices and social networks since childhood can easily master and adapt to the teaching methods brought about by new technologies (Agárdi and Alt 2024). The development of mobile learning is based on the innovation of mobile technology, and it will also change with the development of teaching concepts and new technologies. For example, the innovative educational technology framework integrates mobile technology and artificial intelligence (Lai and Tu 2024; Moya and Camacho 2024).

Mobile interactive learning Artificial intelligence has a promising future, and the integration of artificial intelligence (AI) and mobile learning (m-Learning) has completely changed digital education, indicating a new transformation and reform of learning methods (Moya and Camacho 2024). AI technology greatly improves the efficiency and effectiveness of learning by analysing learning data and providing personalised learning support and intelligent feedback; while the popularity of mobile learning breaks the time and space constraints, making learning more flexible and convenient. The combination of the two not only provides rich information for educational research, but also brings new opportunities for optimising teaching design and practice. Research further indicates that the interactive nature of m-learning has already made it a popular pedagogically-driven approach and that integrating AI and mobile technologies can expand the attributes of m-learning to enhance the student learning experience (Alam and Mohanty 2023a). Some researchers consider AI-driven m-learning to be a promising educational change. However, some studies have questioned the negative impact of mobile learning on current education. Students may become distracted and addicted, resulting in reduced learning efficiency (Criollo-C et al. 2021).

Dance is an important part of human culture. It is a purposeful, meaningful, rhythmic series of non-verbal body movements with intrinsic aesthetic value (Vander Elst, Vuust, and Kringelbach 2021). It not only shows the historical, social and cultural characteristics of various ethnic groups and eras but also preserves and continues traditions and values through intergenerational transmission. In higher education dance courses, teachers generally choose the traditional teaching method, which combines theoretical explanations with dance demonstrations, followed by student imitation and learning. Students need to be aware of all their bodies' movements and remember the dance steps (Haas 2024). However, this single-mode teaching method is used throughout dance learning. In addition, the difficulty of the dance is high, and it is difficult for students to improve their dance performance with just a short period of practice in class, which hurts students' dance learning (Vander Elst, Vuust, and Kringelbach 2021; Sukel et al. 2003; Kuleto et al. 2021). Moreover, the difficulty of the dance is high, and it is difficult for students to improve their dance performance with just a short period of practice in class, which hurts students' dance learning (Pickett 2023). Hong and Nor (2023) state that teachers must target specific improvements and refine new dance teaching designs and techniques to solve the problem.

It is worth emphasizing that Pischetola, de Miranda, and Albuquerque (2021) pointed out that digital teaching technology disrupts the spatiotemporal existence of the teaching space for artistic performance. Moreover, Alexander, Boehm, and Glen (2023) believe that digital technology can affect students' kinesthetic experience and that individual differences in students' acceptance of new technologies have resulted in the late use of dance technology. Nevertheless, there have also been many studies in recent years that have applied technology to dance education and achieved positive results. For example, online technology choreography teaching (You 2022), and motion capture to promote dance learning (Dias Pereira dos Santos 2017). Briefly, the rise of technology-enhanced learning will promote the development of dance education technology. Although digital technology in dance education has raised concerns about teaching time, space, and kinesthetic experience, it has also shown potential to promote innovation in dance learning and teaching in recent years.

Iqbal and Sidhu (2022) emphasize that perceived motivation in dance learning must be considered as one of the important factors in teaching when developing a dance teaching system. Perceived motivation is an important factor in teaching effectiveness, and motivation is an essential element of quality education (Filgona et al. 2020). Moreover, high levels of learning motivation lead to higher comprehension and academic performance (Al Yakin and Seraj 2023). Dance teaching must, therefore, enhance students' learning motivation while maintaining it at a high level. It is worth noting that Alexander, Boehm, and Glen (2023) point out that completing dance tasks alone is challenging, and student engagement is crucial. However, the types and levels of student engagement revealed as the dance project unfolds must be explored further.

To address these gaps, this study developed a mobile interactive AI-timely feedback dance training tool (MI-AI-TFDT) and applied it to a mixed learning approach. This study will explore the impact of MI-AI-TFDT in a blended learning educational environment on dance performance. The goal of this study is to construct an effective instructional framework for dance teaching. The results of the experiment will be used to evaluate changes in student performance, motivation, and participation in dance courses. With these aims in mind, this study aims to answer the following three questions through experimentation and analysis. The research questions are as follows:

1. In terms of dance performance, do students utilizing the mobile interactive AI feedback dance training tool outperform those utilizing traditional video-based learning tools?
2. Is there a significant difference in students' perceived motivation between those using traditional video learning tools and those using the mobile interactive AI feedback dance training tool?
3. Is there a significant difference in students' engagement in dance learning between those using traditional video-based learning tools and those using the mobile interactive AI feedback dance training tool?

## Literature review

**Mobile Interactive Technology in Education :** With the continuous advancement of Internet mobile technology and the popularity of mobile devices, mobile devices are becoming a new tool for distance learning (Alam and Mohanty 2023b).In higher education, mobile interactive technology shows a year-on-year growth trend, driving a huge change in teaching models (Chen 2024). New teaching technologies help higher education cultivate students' innovative abilities and encourage students to cultivate personal skills to cope with social changes. Mobile interactive technology uses mobile phones, tablets and other devices to deliver knowledge, allowing students to participate in classroom interactions anytime, anywhere, breaking traditional classrooms' time and space constraints (Feroz Khan and Samad 2024). Research on teaching content based on mobile interactive technology not only improves the utilization of educational resources but also cultivates students' initiative in learning, thereby improving teaching effectiveness (El-Sofany and El-Haggar 2020). Using mobile interactive technology in teaching can take advantage of the tool's flexibility, which is convenient for teachers and student (Alam and Mohanty 2023a). It is noted that mobile devices can also be used to communicate with experts, write and share experiences and learn through social media (Sivakumar, Jayasingh, and Shaik 2023) .Mobile interactive technology positively impacts learning and deepens understanding of specific educational subjects. Technological advances have made the learning experience more mobile, ubiquitous and flexible. However, researchers believe that mobile learning faces challenges, mainly in reasonably allocating teaching tasks and arranging teaching objectives inside and outside the classroom (Almufarreh and Arshad 2023).In addition, existing mobile interactive technologies cannot meet the requirements of students' personalized and intelligent learning due to the diversification of teaching scenarios, and there is a need to promote the integration of new technologies for mobile teaching(Z. Chang and Liu 2023).

In an era of rapid technological iteration, choosing technological innovation and integration is crucial to adapting to new teaching objectives. Mobile interactive technology can significantly improve students' learning efficiency and collaboration skills, enhance their dance learning outcomes, and promote a wider range of learning. Nevertheless, current research indicates that the effectiveness of mobile interactive technology in dance teaching and people's satisfaction with the development of technology remain challenges that have not been fully explored.

**Artificial intelligence timely feedback in dance education:** AI is developing rapidly, especially in the field of learning, where AI systems can tailor teaching and feedback to students' individual needs, thereby optimizing the learning experience (Hayat et al. 2024). Furthermore, Wisniewski, Zierer, and Hattie (2020) claim that the most promising area for AI is feedback, as AI improves learning outcomes by providing timely and appropriate responses to learner confusion. Research has already confirmed the positive impact of AI feedback on education. The AI Grade scope tool helps to assess students' learning and uses a wide range of materials to grade assignments. Students can reflect on the content of their work immediately and effectively (Hansel et al. 2024). AI monitors students' learning to provide instant feedback, which motivates students to improve in areas where they need it (Hooda et al. 2022). AI feedback practices can improve student learning outcomes (Hooda et al. 2022). Xiaohui (2024) pointed out in his study that artificial intelligence feedback can improve the efficiency of college students' line dance training and the innovation and method of dance posture by 7% to 13%. Notably, the development of artificial intelligence feedback technology for learning dance is lacking. It remains challenging to use artificial intelligence to provide effective augmented feedback in dance teaching (Trajkova 2021).

Adarkwah (2021) argues that the timeliness of feedback significantly impacts students and that the feedback teachers give students is of great importance. Feedback has been identified as central to learning because its purpose is to help learners minimise errors and gaps. Research further suggests that timely feedback improves a safe learning environment, effective communication, and clear learning objectives, as well as enhances effective learning (Mahjoubi, Brini, and Al-Qutaish 2025). Male students are more aware of constructive feedback than female students (Younis, Imdad, and Rahman 2021). However, teachers still face challenges in providing instant feedback, especially in large class teaching environments with too many students (Paris 2022). Importantly, suppose students wait too long for feedback from the teacher. In that case, the effectiveness of the feedback will be reduced, thereby missing the opportunity to correct mistakes immediately, leading to students being less efficient in their learning (Hayat et al. 2024).

**Blended Learning in Dance Education:** Blended learning is a teaching method that integrates online and offline teaching methods. This learning method integrates both offline and online teaching advantages, innovatively breaks the time and space constraints of teaching activities, and maximizes students' learning efficiency (Bayyat 2020). However, traditional classroom learning is no longer sufficient to meet students' learning demands. Dance education is not limited to the actual classroom to reduce the cognitive load on students when learning dance in the classroom. It also extends to cyberspace, providing students a more agile and convenient learning environment (Zhang and Wang 2024).Research further points out that online teaching of sports has the challenge of "insufficient feedback" or "difficult feedback" for errors (Yu and Jee 2020). Researchers have conducted preliminary studies on blended learning dance methods in recent years. Lina and Brahmakasikara (2021) Explored the impact of using a Chinese dance web application in a blended learning environment on students' Chinese dance performance. The results showed that students' dance performance improved, and their interest in learning was stimulated by using blended learning dance learning.

The advantages of blended learning break through the limitations of time and space in teaching, providing students with a flexible and efficient learning experience. However, existing research shows that individual differences in students' learning abilities in the blended learning mode can lead to very different final results. It is difficult to provide emotional communication and error correction feedback online.

**The interrelationship between perceived motivation and engagement:** Perceived motivation is a multidisciplinary concept in human psychology that plays a crucial role in determining how much effort and time a person devotes to various activities, including learning (Gan, Liu, and Nang 2023). In education, Perceived motivation is generally considered a key determinant of learning outcomes. The higher the motivation, the more effective the acquisition of knowledge and the more pleasant the experience of pupils and educators in the classroom. (Filgona et al. 2020). Conversely, a lack of motivation hinders learning outcomes, leading to feelings of frustration and disengagement (Qureshi 2023). Recent research also suggests that the combination of digital tools and gamification strategies can increase perceived motivation by making learning more interactive and engaging (Shin and Bolkan 2021).

Engagement is another key factor in the learning process, which is closely related to learning motivation and significantly affects students' academic performance. Bowden, Tickle, and Naumann (2021) conceptualised engagement as a multidimensional construct, including behavioural, affective and cognitive dimensions. (Tao et al. 2022) . Affective engagement reflects students' emotional responses to learning, while cognitive engagement involves the mental effort involved in understanding complex concepts, both of which contribute to learning success (Wong and Liem 2022; Siddiqui and Abuhasan 2024). Importantly, engagement acts as a mediator between motivation and performance, as highly perceived motivated students are more likely to engage deeply with learning tasks and thus achieve better outcomes (Wu, Hsieh, and Wu 2022).

## Methodology

In order to evaluate the effectiveness of the MI-AI-TFDT tool for dance learning, a quasi-experimental design was implemented in a dance course at a university in Sichuan, China. The study sample consisted of 60 first-year university students aged between 18 and 19 in a dance course. The sample was divided into two classes, A and B, with 30 students in each class. None of the students participating in this study had received formal professional dance training and had little dance learning experience.

In this study, all students participating in the experiment were female. The experimental group, class A, had 30 students who used the mixed teaching method of MI-AI-TFDT. Class B's control group had 30 students who used traditional blended learning based on video tools. These students were taught dance movement knowledge through traditional lectures by the instructor in class. The teacher provided dance teaching videos for the students outside of class, and the students practiced imitating themselves against the videos. The experiment in this study was conducted under the guidance of a senior professor with 15 years of teaching experience, focusing mainly on dance teaching. All students in the experimental and control groups were informed of the study's purpose and process before participating. They signed an informed consent form to ensure the transparency of the study and the right to know of the participating students. The academic ethics committee has strictly reviewed the research plan, and all operations comply with academic research ethics standards. All students completed the experiment throughout the research process, and no students dropped out.

In this study, it should be noticed that informing the research purpose may trigger a particular psychological expectation effect and the Hawthorne effect. Therefore, to reduce the impact of these effects on the study outcome, the research design uses a vague research purpose, and students are informed of broad research objectives rather than specific research hypotheses. In addition, due to certain practical difficulties in implementing a double-masked design in research in the field of education, this study strives to reduce the potential interference of observation on student behaviour by extending the research cycle and strictly controlling experimental variables to ensure the scientific and objective nature of the experimental results.

**Data collection instruments:** This study used a pre- and post-test method to assess students' dance performance. The test refers to the dance performance assessment criteria proposed by Rcampus (2018). To ensure the validity and content validity of the scoring criteria, we invited three experts with at least 15 years of dance teaching experience to evaluate and verify the scoring criteria. The reliability of the scale was tested with a Cronbach's alpha of 0.844. The original criteria included four dimensions, such as dance knowledge, technical skills, performance skills, and rhythm and beat. The three experts reviewed the scoring criteria to ensure that they were suitable for assessing

dance skill performance, and the dance knowledge dimension was ultimately removed. All performance levels in scoring are divided into five levels, namely full marks (5 points), good (4 points), acceptable (3 points), partial (2 points) and lowest (1 point).

This study used the Student Learning Engagement Scale developed by Fredricks, Blumenfeld, and Paris (2004) to measure engagement. The Learning Engagement Scale demonstrated excellent internal consistency, with an overall Cronbach's alpha coefficient of 0.956. If the internal consistency reliability coefficient is higher than 0.90, the value is considered to be highly reliable (Robert and DeVellis 2003). In addition, the scale is a well-established scale that has been rigorously tested in multiple experiments to confirm its validity and reliability(Ramos-Díaz, Rodríguez-Fernández, and Revuelta 2016; Ramadhani and Purwono 2023; Gunuc and Kuzu 2015).

In particular, the learner's motivational perception is based on the adapted Instructional Material Motivation Survey (IMMS), which uses the ARCS model (Keller, 1987). The IMMS consists of 36 items and uses a 5-point Likert scale. The response range is 1 (not true) to 5 (very true). The overall reliability of the IMMS, as measured by Cronbach's alpha, was 0.96.

**Experimental Procedures:** The study lasted for three weeks. The experimental process is shown in Figure 1. Before the experiment, all students were required to take a 20-minute pretest of dance performance. After the pretest, the teacher spent 10 minutes introducing the learning objectives. During the second week of offline face-to-face teaching, the teacher demonstrated and explained the dance movements of Dai dance. In addition, the teacher introduced the students to the use and process of the Mobile Interactive Artificial Intelligence Timely Feedback Dance Training Tool (MI-AI-TFDT). After class, the experimental group practiced their dance skills using the MI-AI-TFDT, while the control group practiced their dance moves using traditional video learning. In the third week, a post-dance performance test, a participation test (LES), and a perceived motivational test (IMMS) were administered. Figure 1 shows the experimental process. The experimental and control groups had 45-minute classes, as the standard class time at the university is 45 minutes, for a total of 90 minutes per week.

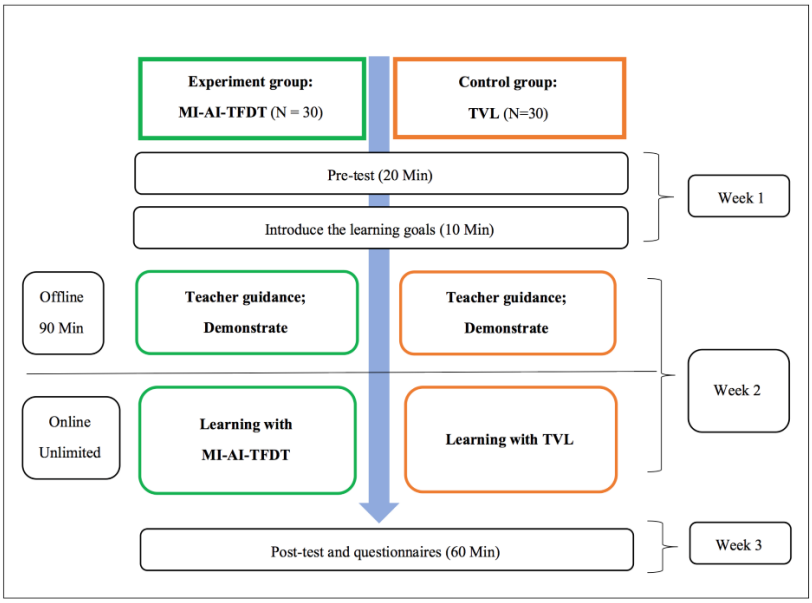


**Figure (1):** Experimental process.

Firstly, offline teaching is conducted in both groups During this stage, the teacher teaches basic movements through face-to-face teaching. After the offline class is over, students enter the online consolidation stage. The experimental group uses the mobile interactive artificial intelligence timely feedback dance training tool (MI-AI-TFDT), as shown in Figure 2. The consent of the person in the photo has been obtained for publication.

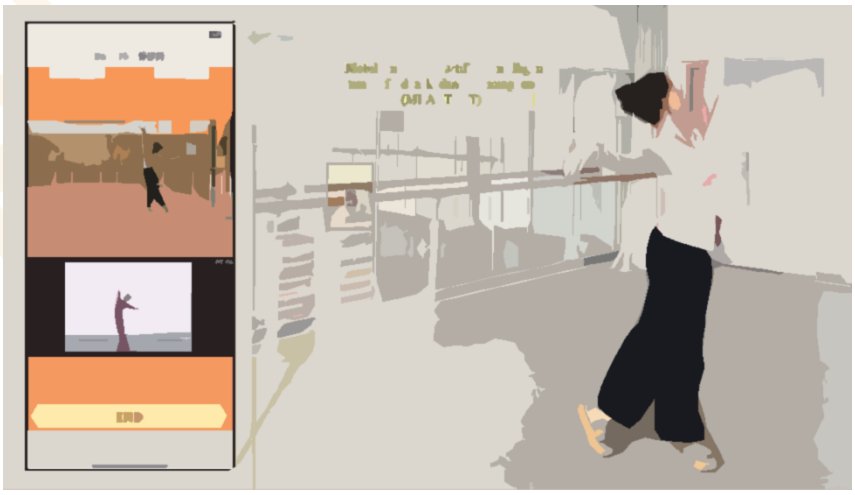

**Figure (2):** MI-AI-TFDT Diagram of usage.

The control group uses the traditional video learning (TVL) model, and the online consolidation phase is arranged like the experimental group but without the MI-AI-TFDT tool. Online learning in the after-class phase allows students to repeatedly watch videos and practice movements according to their interests to consolidate further and improve learning achievement.

**Data analysis and results**

The primary purpose of this study was to assess the effectiveness of the intervention by comparing the post-intervention outcomes of the two groups. Since the two groups were randomly assigned and assumed to be identical at baseline, we focused on post-test scores as

the primary measure.This study conducted quantitative analysis on the pre-test and post-test scales and questionnaires for student engagement, and motivation. This study used a sample t-test to evaluate the impact of the MI-AI-TFDT tool on students' dance performance, perceived motivation, and affective engagement. To determine whether there were significant differences in dance performance, pre-test and post-test scores were compared. In addition, the number of subjects in the experimental group and the control group was the same—30 students in each group. The dance performance was designed to consider pre- and post-treatment order testing to reduce the potential threat of the scale to students' memory.

**Dance Performance:** In the post-test, the mean value of the control group scores was M=11.10, SD=1.86, and the mean value of the experimental group was M=13.90, SD=4.13, t = -3.385, p = 0.002 (p < 0.001, indicating a highly significant result). Effect size d = 0.874 (large effect size, indicating a significant intervention effect). The 95% CI = (−4.47, −1.13), which does not include 0, shows that the post-test scores of the experimental group are significantly higher than those of the control group. It shows that the mobile interactive artificial intelligence instant feedback dance training MI-AI-TFDT significantly impacts students' dance scores.

**Table (1):** T-tests comparing the post-test scores of students dance performance.

| | | CTR: TVL | | EXP: MI-AI-TFDT | | t | p | d | 95% CI | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | M | SD | M | SD | | | | lower | Upper |
| performance | Post-test | 11.10 | 1.86 | 13.90 | 4.13 | -3.385 | 0.002*** | 0.874 | -4.47 | -1.13 |

*Abbreviations SD* standard deviation; *M* mean; *CTR* control group ; *EXP* experimental group; *Note* ***$p < 0.001$

The result answers the research question, “In terms of learning outcomes, do students who receive MI-AI-TFDT perform better in dance than students who receive traditional video learning tools?” The research question is answered on this basis. Comparing the pre- and post-test scores of the dance learning course students shows that the experimental group using MI-AI-TFDT performed significantly better than the control group using TVL. The t-test results show that there is a significantly statistical difference in the two groups ($p < 0.001$), which indicates that the improvement in dance performance in the experimental group is not due to chance. The results show that using MI-AI-TFDT in dance courses will assist college students in their dance learning.

**Perceived Motivation:** Table 2 compares the perceived motivation scores of the experimental and control groups and shows the t-test analysis results. The results show that the TVL of the control group (M=101.83, SD=20.20) is compared with the MI-AI-TFDT of the experimental group (M=118.90, SD=23.40), and t =-3.024, p<0.01, d=0.781. This indicates that the perceived motivation score of the experimental group was significantly higher than that of the control group and that using MI-AI-TFDT to teach dance can significantly improve students' motivation levels.

**Table (2):** T-test on perceived motivational scores for TVL and MI-AI-TFDT.

| | Group | N | M | SD | t | d |
|---|---|---|---|---|---|---|
| Motivation | TVL | 30 | 101.83 | 20.20 | -3.024** | 0.781 |
| | MI-AI-TFDT | 30 | 118.90 | 23.40 | | |

*Note* **$p < 0.01$

Overall, the results of the study answered the question of “Is there a difference between traditional video learning tools and MI-AI-TFDT in terms of students' perceived motivation?” The research results clearly answer this question: The experimental group using the MI-AI-TFDT tool had a significantly greater impact on students' perceived motivation than the TVL control group, and the difference was significant.

**Engagement:** Table 3 compares the scores of the experimental group with those of the control group and presents the results of the t-test analysis. The results show that the TVL of the control group (M = 83.63, SD = 14.26), while the experimental group used MI-AI-TFDT (M = 99.63, SD = 18.13), and t = -3.024, p < 0.001, d = 0.981. This means that the engagement score of the experimental group was significantly higher than that of the control group, indicating that dance teaching using MI-AI-TFDT significantly improved student engagement.

**Table (3):** Results of the t-test for the TVL and MI-AI-TFDT engagement scores.

| Variable | Group | N | M | SD | t | d |
|---|---|---|---|---|---|---|
| Engagement | TVL | 30 | 83.63 | 14.26 | -3.799 *** | 0.981 |
| | MI-AI-TFDT | 30 | 99.63 | 18.13 | | |

*Note* ***$p < 0.001$

In summary, the research results answer the question “Is there a difference between traditional teaching methods and the mixed learning of MI-AI-TFDT in terms of students' dance learning engagement?” and give a clear answer: There is a significant difference between the experimental group using MI-AI-TFDT and the traditional control group, and the experimental group is superior to the control group.

**Discussion**

This study developed a mobile interactive learning AI timely feedback dance training tool and a blended learning teaching method to bring students a new learning experience. We designed a quasi-experimental study at a college in Sichuan to evaluate this innovative approach and compare it with traditional learning methods in terms of students' dance performance results, engagement, perceived motivation. In terms of dance performance, Dance performance post-test results show that the MI-AI-TFDT tool significantly improved students' dance performance scores than TVL. In addition, the results show that the new tool enhanced students' engagement and perceived motivation.

Mobile learning is a complex learning approach that requires careful design by educators and technologists to improve student learning outcomes (Gedik et al. 2012; Kukulska-Hulme and Shield 2008). Metafas and Politi (2017) point out the great value and potential use of mobile learning, where mobile devices support and facilitate learning. In recent years, mobile learning researchers have developed mobile application technologies for learners suitable for different learning environments (Hwang and Fu 2020). In addition, mobile learning has been developed and used in various fields, such as language learning, museum learning, and special education (Ozer and Kılıç 2018; Hou et al. 2014; Kokkalia and Drigas 2016). Online dance teaching can improve students' mood (Rugh et al. 2024). It is worth noting that technological advances have promoted the flexibility of education (Haleem et al. 2022). In recent years, Cevikbas and Kaiser (2022)、Bernacki, Greene, and Crompton (2020) and Troussas, Krouska, and Sgouropoulou (2020) have explored mobile learning in combination with psychological theories, gamified learning, virtual reality (VR), and other new technologies and interdisciplinary theories to construct new teaching models and expand the space of education. However, the application of mobile learning in dance performance education is extremely limited, and dance learning that integrates mobile learning AI and uses a blended learning approach has not yet been explored.

In addition, new technologies promote innovation and development in teaching. Due to the single-performance evaluation method of dance learning, individual differences in the acceptance of new technologies by different students, and the lag in the use of new technologies in dance teaching (Wang and Zheng 2020). It is worth noting that (You 2022) pointed out that to keep up with technological progress and improve training effectiveness, new technologies and teaching methods need to be integrated into dance and other courses.

Müller and Mildenberger (2021) Research indicates that mobile learning can change the learning environment and no longer be confined to traditional fixed teaching venues. The research further points out that educational institutions can provide blended learning without fundamentally compromising the quality of the education provided. Previous research has shown that mobile interactive learning can improve student dance performance and self-efficacy and enhance learners' strategies for using mobile device experiences (C.Y. Chang, Hwang, and Gau 2022; Sophonhiranrak 2021). However, few studies have explored using mobile interaction to integrate AI to enhance students' perceived motivation and affective engagement in dance performance. In the experimental treatment, students used the MI-AI-TFDT tool to learn dance. When the tool was applied, the camera was turned on to record the student's dance movements in real-time. The AI would score and rate the student's dance at key nodes and provide suggestions for correction. Experimental results show that MI-AI-TFDT significantly improves students' dance performance scores and significantly enhances students' active participation in dance courses. Students' perceived motivation for dance learning course materials is enhanced; this shows that the mobile learning AI-based feedback tool developed in combination with blended learning can promote the effectiveness of dance teaching and have a positive impact.

**Implications and suggestions**

Some studies have shown that the problems faced by mobile learners in online education include insufficient communication and face-to-face interaction with teachers, as well as low learning satisfaction, and some students even express serious dissatisfaction with online courses (Garlinska et al. 2023; Pikhart and Al-Obaydi 2023). However, interaction and feedback are essential to the activities of the educational process (Jaekel, Fütterer, and Göllner 2023). Timely feedback from the teacher is very important. It is worth noting that current research has not provided students with a mobile teaching dance learning tool with timely feedback. Teachers also do not have a systematic mobile learning-based dance curriculum approach. The demand for art learning and software development is bound to increase (Pang 2020). Therefore, this study develops a mobile teaching tool for higher education dance teaching to help solve the problem of how students can interact face-to-face with teachers and how to provide feedback on learning.

Previous studies have discussed the benefits of mobile interactive learning for dance performance. However, many areas still have not been covered (Fan et al. 2020; Iqbal and Sidhu 2022). Previous studies have discussed the benefits of mobile interactive learning for dance performance. However, there are still many areas that have not been covered, such as a comparison of mobile interactive technology integrated with AI real-time feedback technology and traditional video mobile learning. In addition, mobile interactive technology integrated with AI uses different teaching methods. These are worth exploring by researchers. Furthermore, mobile interactive technology integrated with AI has great potential for teaching different dance genres, such as ballet, classical, and modern dance. Or different national and regional dance genres, such as Chinese classical dance, Indian dance, and tap dance. Therefore, mobile interactive technology integrated with AI and real-time feedback tools has great potential for teaching different dance genres.

The results of this study show that MI-AI-TFDT improves students' dance performance, perceived motivation, and engagement in blended learning. Based on this, further research is needed to explore integrating AI with timely feedback in mobile interactive learning and the evaluation criteria for AI. In addition, the learning methods of integrating AI with mobile interactive learning can also be explored. For example, it is possible to integrate game-based teaching with mobile interactive AI feedback to diversify the educational methods of dance teaching further. With its particular characteristics, gamification can enhance the entertainment, diversion, and interactivity of teaching in formal and informal teaching and increase user participation to generate new information and experiences (Lamrani and Abdelwahed 2020; Wardoyo et al. 2021). In addition, gamification-based teaching offers the possibility of a personalized approach, enhancing motor and social or cognitive and social, which has similar ultimate goals as dance teaching (Gallud et al. 2023). Combining mobile interactive AI with gamified teaching can increase students' emotional engagement and interactivity, enhancing their motivation in dance classes.

**Limitations**

This study highlights the positive impact of integrating mobile interactive technology, AI real-time feedback, and hybrid learning on university dance teaching. However, limitations include a small sample size from a single university, restricting generalizability, and a focus on traditional Chinese folk dance, which may bias results due to cultural familiarity. Future research should expand to diverse samples, disciplines (e.g., sports, music), and dance types (e.g., ballet, modern dance) to validate broader applicability. Additionally, developing tailored AI assessment systems for varied dance styles, increasing curriculum difficulty, and enriching theoretical foundations are essential to enhance accuracy and address potential biases in findings.

**Conclusion**

This study demonstrates the significant advantages of integrating mobile interactive technology with artificial intelligence (AI) in dance education. By combining AI with a blended learning model, the system enables real-time feedback, personalized learning, and unlimited practice opportunities, addressing the limitations of traditional face-to-face teaching. Students can receive instant evaluations, correct mistakes, and improve performance, while shy or unsociable learners benefit from enhanced convenience and increased participation. The AI system, utilizing mobile device cameras, records and scores dance movements in real time, allowing students to compare their performance with standard videos and deepen cognitive understanding. This innovative approach balances personalized learning with improved outcomes, enhancing students' perceived motivation, emotional engagement, and behavioral participation. The study's integration of mobile interactive AI and timely feedback into dance education is pioneering, offering high recognition accuracy and objective evaluation methods. It provides valuable insights for future research and practical applications in dance education, encouraging further exploration of its impact on diverse variables and paving the way for advancements in teaching practices and learning outcomes.

**Disclosure Statement**

- **Ethical approval and consent to participate:** This study has been cleared by the ethics committee.
- **Availability of data and materials:** The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.
- **Author contribution** : XSN, NS, and WAJWY contributed to the design and implementation of the research, the analysis of the results, and writing of the manuscript. All authors contributed to the article and approved the submitted version.
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