A Study on Innovative Paths and Practical Effectiveness of AI Technology in Enabling Dance Teaching in Higher Education Institutions

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ABSTRACT Artificial intelligence (AI) technologies are increasingly transforming higher education by enabling data-driven and personalized teaching paradigms. To overcome limitations in conventional dance instruction related to subjective assessment, insufficient individualized guidance, and restricted interactive feedback, this study establishes an AI-enabled teaching framework integrating motion capture, computer vision, adaptive learning recommendation, and intelligent virtual assistants. A semester-long teaching experiment was conducted in which multidimensional indicators, including movement accuracy, choreography complexity, classroom interaction, and learning motivation, were quantitatively analyzed. Experimental results demonstrate that students in the AI-supported group achieved significantly greater improvements in standardized skill assessments and exhibited superior originality and structural coherence in dance improvisation tasks. The proposed framework enhances teaching precision and learner engagement while providing a methodological reference for multimodal motion analysis, intelligent sensing, and human–machine interaction. The findings also offer insights into data-driven signal acquisition and real-time perception technologies applicable to intelligent monitoring and advanced sensing systems.

INDEX TERMS artificial intelligence, motion capture, adaptive learning, intelligent sensing, multimodal signal analysis

I. INTRODUCTION

DANCE as an art form which uses the body as a medium and emotional expression as a core, since the beginning, followed the model of teachers passing down traditional knowledge to their students, a teacher-apprentice model of oral teaching. The theoretical contribution, and the practical value, of this study is that it goes beyond merely cursory discussion of the technological applications. This research intends to build a systematic theoretical framework and practical model for the inherent mechanisms of AI-empowered dance teaching, integrating intelligent production technologies and high-performance material informatics to evaluate comprehensive instructional effectiveness. By leveraging smart sensors for real-time motion capture, this approach deepens the convergence of digital pedagogy and functional material engineering. Specifically, the contributions of this paper mainly manifest in the following three aspects: At the theoretical level, this paper combines the technological logic of computer vision, the adaptive learning and human-computer interaction to learn dance pedagogy, extracting three typical empowerment paths : "precise movement correction", "personalized path adaptation" and "intelligent environment enhancement". This offers us a new analytical framework to understand the deep integration of AI and dance education. Second, at the empirical level, this study overcomes the shortcomings of crude technical descriptions or theoretical inventions. Through the design and implementation of a demanding one-semester comparative teaching experiment, it generates a multi-dimensional data on the motor skills of the learners, creative expression, learning motivation, and classroom interaction of the learners. This offers scientific and objective quantitative evidence and qualitative evidence in favour of the practical effectiveness of AI empowerment, practically helping fill the imbalance to empirically research this field. Third, at the practical level, the conclusions and findings of this study give definite advice and operable implementation plans to the reform and innovation of college dance teaching in the intelligent era.

Based on the above research approach, this paper is structured as follows: First, it reviews the current state of research on dance teaching methods, technology applications, and related theories both domestically and internationally, clarifying the logical starting point of this study; second, it elab-

orates on the design scheme of the teaching experiment, the deployment of AI technology tools, and the data collection and processing process; third, it presents and analyzes the experimental results, discussing the practical effectiveness of AI empowerment from three dimensions: skill mastery, creative ability, and teaching interaction; finally, it proposes corresponding countermeasures and suggestions, and looks forward to future research directions.

II. RELATED WORK

Contemporary dance teaching research is showing a trend of diverse methodologies and rich perspectives. The teaching strategy proposed by Wenjia[1] can significantly improve students' aesthetic perception ability, especially in the three dimensions of aesthetic sensitivity, emotional resonance and creative expression. Zhao et al. [2] focused on the impact of traditional Chinese dance teaching on the performance development of primary school students in Luoyang, China, aiming to explore the role of traditional dance in the educational environment. Jefferson[3] practiced story-guided dance teaching in primary school classrooms, observing and recording students' learning responses and creative processes. Azmi and Ha[4] supported gamified learning as an effective tool for dance teaching, believing that it can create a more attractive and interactive learning environment . Based on the current situation of sports dance teaching in Chinese universities, Yu[5] analyzed the problems existing in the current sports dance teaching in universities, and proposed teaching reform strategies and development paths based on this theory.

Huang and Noknoi[6] focused on the application of Chinese folk ritual dance in teaching, and explored how to introduce this dance form rich in cultural genes into the classroom so as to achieve the organic combination of cultural identity inheritance and educational innovation. Focusing on the group of Vietnamese dance teachers, Pham and Phan[7] found that the professional motivation, daily experience and challenges faced by Vietnamese dance teachers present a complex and diverse picture . Wang[8] pointed out that college dance teaching is an important way and effective carrier for implementing college students' art quality education. It not only imparts dance skills, but also subtly enhances students' aesthetic taste, humanistic qualities and comprehensive abilities . Liu[9] quantitatively explored the cross relationship and mutual influence between teachers' personal abilities and classroom teaching efficiency in dance teaching. Alshemmari et al. [10] believe that social identity leadership theory provides a new perspective for dance teaching. The above studies have enriched the theoretical and practical picture of dance teaching from multiple dimensions such as technology application, cultural inheritance, motivation stimulation, teacher development and leadership construction, and provided important academic references for this study. However, the study has failed to explore how artificial intelligence technology can be deeply integrated into the entire process of dance teaching in universities. Especially in today's rapidly evolving technological landscape, the specific pathways for AI technology to empower dance teaching in universities remain unclear. This paper aims to address these research gaps through both theoretical construction and practical verification.

III. METHODS

A. DESIGN AND IMPLEMENTATION OF TEACHING EXPERIMENTS

This study conducted a 8-week comparative teaching experiment in the "Fundamentals of Classical Dance" course for first-year students majoring in dance at a university. The experimental subjects were two classes. With the consent of the school, teachers and students, one class was randomly assigned as the experimental group (n=82) and the other class as the control group (n=80). Both classes were taught by the same associate professor with more than ten years of teaching experience, and used the same syllabus, textbooks and core teaching content. The only independent variable was whether AI technology was systematically introduced to empower teaching. The teaching in the control group strictly followed the traditional model, which mainly relied on teacher oral instruction, student imitation practice and teacher guidance. The teaching in the experimental group, on the basis of the traditional model, fully integrated the empowerment scheme consisting of the following three AI technology modules. During the entire experiment, the students in both groups were pre-tested to ensure that there was no statistically significant difference in their average scores in the entrance professional examination, so as to control the initial ability variable [11,12] . This study was approved by the Ethics Committee of Lishui University, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

B. DEPLOYMENT AND APPLICATION PATH OF AI TECHNOLOGY TOOLS

The AI technology empowerment scheme used by the experimental group is built around three core paths and has deployed specific software and hardware tools. The first path is "precise action correction", and its technical carrier is a computer vision motion capture and analysis system based on deep learning. Multiple high frame rate cameras are deployed in the dance classroom to collect student practice video streams in real time. The system has a library of standard movements of classic dance segments marked by professional dance teachers. The system extracts key points of the student skeleton through OpenPose and compares them with the spatiotemporal features of the standard movements in real time. The system can instantly visualize and provide feedback on movement deviations on the video playback screen by superimposing bone lines and highlighting deviations (such as red markings for joint angle errors exceeding 5 degrees), and generate a quantitative analysis report containing "maximum angle error", "rhythm

consistency score", and "movement fluency index". This path is mainly applied to classroom practice and after-class self-review [13] . The second path is "personalized path adaptation," whose core technology is an adaptive learning recommendation algorithm. The algorithm constructs a dynamic student ability profile based on data accumulated in the motion analysis system regarding weaknesses (such as insufficient wrist flexibility in the "cloud hand" movement), viewing and replaying records of instructional videos on the online learning platform, and scores from completed quizzes. Based on this profile, the algorithm pushes personalized reinforcement practice packages (decomposition videos and follow-up programs targeting weak movements), expanded learning resources (such as comparative videos of different styles, articles on relevant cultural background knowledge), and creative inspiration materials to each student. This path integrates pre-class preparation and post-class extension, aiming to achieve a "personalized" learning content delivery for each student.

The third path is "enhanced intelligent environment," achieved through an intelligent virtual teaching assistant (embedded in the course WeChat group and learning platform in the form of an AI-driven chatbot). This teaching assistant has natural language processing capabilities and can answer students' common questions about course arrangements, action terms, and assignment requirements 24/7. It can also automatically recommend relevant teaching video clips or literature based on chat keywords. In the classroom creation process, the teaching assistant can receive thematic keywords input by the teacher (such as "autumn wind" and "farewell") and quickly generate a series of related poems, imagery, or music clips [14,15] . This path aims to reduce the burden of repetitive Q&A for teachers and enrich the forms of teaching interaction and creative guidance. To accurately assess the teaching effectiveness of the AI tool itself, the control group also used WeChat groups as a platform for teacher-student communication and information dissemination during the teaching process, but no intelligent virtual teaching assistants were deployed in these groups. This was intended to ensure that both groups of students used the same communication tools, thereby attributing any differences observed in the experimental group to the core functions of the AI teaching assistant, rather than simply the Hawthorne effect resulting from the introduction of a new communication tool.

C. DATA ACQUISITION AND PROCESSING FLOW

This study collected data from three dimensions: skill mastery, creative ability, and learning process and attitude. Skill mastery data came from weekly quantitative reports generated by the motion analysis system. Three representative movements—Arabesque, Goose Leap, and Cloud Shoulder Turn—were selected as standard assessment movements, and their average score was used as the weekly skill score. The "Standardized Motor Skills Test" used in this study was a set of motor assessment standards jointly developed by the research team and three senior dance education experts with the title of associate professor, based on the curriculum syllabus and classical dance basic skills training standards. To ensure the objectivity and consistency of the assessment, the standard was tested in a two-week pre-experiment and reliability test (inter-rater reliability ICC > 0.85) in non-experimental classes before the start of the experiment. Creative ability data was obtained through two impromptu creation tasks set during and at the end of the semester. Three dance teachers (not the instructors) unaware of the group assignments independently and blindly evaluated the students based on four dimensions: "theme relevance," "movement originality," "structural integrity," and "emotional expressiveness" (using a 5-point Likert scale). The average score was used as the creative score. Data on the learning process and attitude was obtained through classroom observation records (recording the number of times students actively asked questions and discussed with each other within a unit of time), learning platform logs (recording personalized resource click-through rates and viewing durations), and the "Dance Learning Motivation and Experience Questionnaire" distributed to both groups of students before and after the experiment. This questionnaire was adapted for dance contexts based on the Academic Self-Regulation Scale. To ensure its reliability and validity in dance teaching settings, a pre-test was conducted before the experiment. The results showed that the overall internal consistency reliability (Cronbach's α) of the questionnaire and each dimension ranged from 0.82 to 0.91, indicating good reliability. Exploratory factor analysis (KMO=0.86, Bartlett's test of sphericity $p< 0.001$) extracted the factor structure consistent with the theoretical framework, verifying its construct validity.

IV. RESULTS AND DISCUSSION

A. QUANTITATIVE IMPACT OF AI TECHNOLOGY ON THE ACCURACY AND LEARNING EFFICIENCY OF MOTOR SKILLS

Quantitative information on the mastery of motor skills makes it possible to understand the practical effectiveness of the approach used AI. Repeated measures ANOVA was used to track the weekly scores of the experimental and control group on three standardized assessment movements that indicated significant main effects of group and time and a significant interaction between group and time. This shows that both groups improved their skill scores as the teaching cycle progressed, but the rate of improvement and final level of improvement of the experimental group was much higher than the control group. Specifically, in the post-test at the end of eighth weeks of teaching, the average comprehensive score of three specialist movement was 86.4 standard deviation 4.2 for the experimental group and 76.8 standard deviation 5.7 for the control group. Independent samples t-test results indicated that the difference in the score for the two groups was highly statistically significant. In terms of improvement, compared with the pre-test, it could be

concluded that the total skill score of the experimental group increased on average by 18.7%, whereas the improvement in the control group was 9.3%. To further quantify the actual significance of this effect, the effect size Cohen's d was calculated. The results showed that the Cohen's d value for the post-test score was 1.92, indicating that the experimental intervention had a very large effect size. The result is given in Table 1:

The data from Table 1 is a very convincing indication of the effectiveness of the "precision movement correction" approach. The immediate, visual, and quantitative feedback received by the experimental group allowed the students to move beyond the level of subjective "feelings" and to "see" (more objectively) the millimeter-level and angle-level differences between their movements and the standards. The immediacy of this feedback prevented the solidification of incorrect movements as well as the precision of the feedback assisted students to engage in targeted practice which significantly improved the efficiency and accuracy of skill acquisition. In contrast, the students of the control group fell mostly back on limited teacher-guidance and imprecise evaluations of their self; the delayed and imprecise feedback led to rather sluggish improvement. This result confirms that the use of AI as an extension of "super senses" can achieve the good complement to the deficiencies of the old teaching such as the limit of teacher attention resource and the difficulty of unification and quantification of evaluation standards.

B. QUALITATIVE EVIDENCE OF THE POSITIVE IMPACT OF AI TECHNOLOGY ON DANCE CREATION AND PERFORMANCE

In terms of the ability to create dances and in assessing the ability to experiment, the experimental group also demonstrated a significant advantage. Analysis of scores assessed blindly from two improvisational creation tasks completed during and at the end of the semester, as seen in Table 2, showed a significant average score of the experimental group in both "movement originality" and "structural integrity" compared to the control group. Particularly in the second creation task the work of the experimental group also demonstrated a significant improvement in "emotional expression." In order to understand this result, the classroom observation records and the interviews conducted with the students showed that there was a close correlation with the "enhanced intelligent environment" and "personalized path adaptation" pathways.

Table 2 shows that the experimental group showed significant advantage with regards to the originality of movement and the structural integrity. Classroom observation notes show that during the creative process, students from the experimental group were often able to make use of "inspiration resource packages" created by the intelligent virtual teaching assistant. These cross-modal materials (including text, images and music) successfully shattered their fixed mindsets and evoked novel movement imagery associations. At the same time, the "extended learning resources" (such as dance clips of different styles and choreography notes) of the adaptive system forced on the basis of students' original personality and skill composition subtly expanded students' movement vocabulary and structural organization perspective. This shows that AI technology, through rich and personalized creative stimulation and nourishment, not only did not suppress the creativity of students, but also effectively promoted the divergence and combination of their thinking in creative fields by lowering the cognitive threshold of the starting point of creation and providing various references, so as to achieve better performance in the originality and structural integrity of students' works. Students in the control group on the other hand relied more on their limited existing experience and classroom memory which limited the breadth of materials and the diversity of inspiration they received.

C. THE OPTIMIZING EFFECT OF AI TECHNOLOGY ON TEACHING INTERACTION MODES AND LEARNING MOTIVATION

Analysis of data on the learning process shows a profound effect of AI technology on the ecology of the class and learner psychology (Table 3) . First, interaction records from the classroom indicate that in the experimental group, the students were actively asking questions and participating in peer discussions an average of 8.5 times per class period, which was significantly higher than the control group, which had only 5.2 times. Further analysis of question types showed that questions by the experimental group were more straightforward on deeper issues in the, expressiveness, cultural integration and creative fusion including "how to connect the emotional expression of movement A with movement B" and "the differences in the interpretation of this movement in different plays". In contrast, the questions of the control group were more technical ones about simple details like "where exactly the hand positions are for this movement." Second,

pre and post-test comparisons of "Dance Learning Motivation and Experience Questionnaire" indicated that the scores of sub-scale "intrinsic motivation" of the experimental group showed the significant improvement while the control group showed no significant changes.

The data changes in Table 3 illustrated that the introduction of AI technology has transformed the teaching interaction model and increased learning motivation. Intelligent virtual teaching assistants have managed much of the repetitive, factual Q&A to free up the teachers to partly transform from "knowledge transmitters" and "discipline maintainers" to "creative guides" and "thinking stimulators." This frees up more energy to have more organizational higher-level discussions and respond to deeper questions that lead directly to higher quality interaction in the classroom. Students are provided with personalized learning paths as well as immediate, positive and precise feedback. Their learning process changes from "passively receiv-

TABLE 1. Comparison of Motor Skill Standardization Assessment Scores between Experimental Group and Control Group

Group	Sample size (n)	Pre-test average score (Mean ± SD)	Post-test mean score (Mean ± SD)	Score improvement
Experimental group	32	72.8 ± 5.1	86.4 ± 4.2	+18.7%
Control group	30	73.1 ± 4.9	76.8 ± 5.7	+9.3%
t/p value	–	t(60)=0.24, p=0.81	t(60)=7.89, p<0.001	–

TABLE 2. Comparison of average scores for the impromptu creative task between the experimental group and the control group (out of 5 points)

Evaluation Dimensions	Experimental group (n=32)	Control group (n=30)	t-value	p-value
Theme relevance	4.1 ± 0.5	3.9 ± 0.6	1.52	0.13
Action originality	4.3 ± 0.4	3.7 ± 0.7	4.28	<0.001
Structural integrity	4.0 ± 0.6	3.5 ± 0.8	2.89	0.005
Emotional expressiveness	3.9 ± 0.7	3.6 ± 0.8	1.61	0.11

TABLE 3. Changes in learning motivation and classroom interaction of students in the two groups before and after the experiment

Measurement indicators	Group	Pre-test mean	Post-test mean	Change	Statistical test
Intrinsic motivation (out of 5)	Experimental group	3.4	4.1	+0.7	t(31)=4.12, p<0.001
Intrinsic motivation (out of 5)	Control group	3.5	3.6	+0.1	t(29)=0.45, p=0.66
Classroom interaction frequency (sessions/class period)	Experimental group	4.8	8.5	+3.7	Based on observation records
Classroom interaction frequency (sessions/class period)	Control group	4.6	5.2	+0.6	Based on observation records

ing uniform guidance" to "actively exploring personalized maps." This increased sense of autonomy and competence is a crucial source of increased intrinsic motivation. Data from the learning platform shows that the students of the experimental group had an average click-through rate of 78% for the personalized resources pushed to them, and a high completion rate, reflecting the fact that the path was well matched with students learning needs and they would retain engagement. AI empowerment by optimizing the teaching process frees both teachers and students to more creative, interactive, and satisfying teaching which creates a virtuous cycle of mutual learning and growth.

V. CONCLUSION

The results indicate that the deep empowerment of AI technology is mainly achieved in three operable and replicable paths. The synergistic effect of these three paths led to a great comprehensive effectiveness in practices. At the skill acquisition level, students in the experimental group gained higher speed and more accurate mastery of the movements; at the artistic creativity level, the originality of students' works was higher and the structures of their works were more solid; at the teaching interaction and psychological level the higher-order classroom interactions increased in frequency, and the students' intrinsic motivation for learning was well stimulated. All of this leads to a fundamental conclusion : the value of AI technology in the empowerment of college dance teaching is far beyond the instrumental benefits of technology, but lies in the reconstruction of the teaching process through "human-machine collaboration", which promotes the evolution of teaching from an "experience-driven, uniform teaching" paradigm to a "data-driven, individualized teaching" and "intellectual stimulation, personalized creation" paradigm.

Of course, with the integration comes new challenges as well, including the issue of privacy and security of motion capture data, the issue of convergence in the artistic expression that can result from algorithmic evaluation, and the issue of new technological integration skills required of teachers. Future research and practice must accept technology at the same time as formulating the corresponding ethical norms, strengthening the training of teachers in the use of technology, and continuously creating a new generation of AI teaching tools that have a better understanding of the aesthetic characteristics of dance art and are more consistent with education principles.

AUTHOR CONTRIBUTIONS

Ping Du designed, collected and analyzed the data, and drafted the manuscript. Ping Du conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Ping Du participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

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HUMAN RESEARCH SUBJECTS

This study was approved by the Ethics Committee of Lishui University, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

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