

Research on the Dynamic Optimization Mechanism of Animation Course Group Based on Human Computer Collaboration from the Perspective of Digital Humanities

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ABSTRACT Under the deep integration of digital humanities and intelligent education, animation education is shifting from skill training toward a composite model of cultural translation, creative generation, and human-machine collaborative creation. Traditional animation course groups suffer from fixed content, fragmented structure, static resources, single evaluation, and disconnection from industry needs, making them insufficient for AIGC, virtual production, interactive storytelling, and cultural digitization. From the perspective of digital humanities, this study constructs a dynamic optimization mechanism for animation course groups based on human-machine collaboration. The proposed mechanism follows the full chain of demand perception, structural reorganization, content iteration, teaching collaboration, evaluation feedback, and dynamic updating. It includes a four-tier curriculum structure, a digital humanities resource center, role division among teachers, AI systems, and students, and multimodal data-driven regulation. The framework improves curriculum adaptability, cultural depth, teaching efficiency, and industry relevance. Its emphasis on virtual production, computational imaging, optical propagation, and networked collaboration also supports engineering-oriented animation education systems.

INDEX TERMS digital humanities, human-machine collaboration, animation course group, optical propagation, virtual production

I. INTRODUCTION

A. RESEARCH BACKGROUND AND SIGNIFICANCE

DIGITAL humanities reconstructs the preservation, interpretation, creation, and dissemination path of humanistic resources through digitization and interactive data analysis, providing structured cultural data sets and aesthetic frameworks for systematic integration into animation education. As an important carrier of cultural visual expression, animation is increasingly undertaking tasks such as digitalization of intangible cultural heritage, creation of cultural IP, digital storytelling, and virtual exhibitions. Meanwhile, AIGC, The widespread adoption of technologies such as intelligent rendering, motion capture, and virtual production has propelled animation production into a new stage of human-machine collaboration. The industry's demand for talent has shifted from "hand drawing/software operation" to "creative planning, cultural translation, human-machine collaboration, and system design" composite abilities [1-2].

In this context, university animation curriculum groups face significant structural challenges, such as the preva-

lence of isolated courses and the existence of repetitive, disconnected instructional content; Insufficient integration of traditional cultural resources and shallow cultural expression; The teaching mode is mainly based on teacher lectures and software training, with shallow application of human-computer collaborative teaching; The update of course content lags behind technological iteration and industry change; Resources, teaching, and evaluation are all static operations, lacking dynamic perception and adaptive adjustment capabilities. The existing curriculum system is difficult to support the talent cultivation goal of "cultural heritage+artistic ability+intelligent technology+collaborative innovation" [3].

Therefore, based on the perspective of digital humanities, building a dynamic optimization mechanism for animation course groups driven by human-machine collaboration, and achieving continuous iteration and upgrading of course structure, teaching content, teaching mode, and evaluation system, has become an urgent need for the high-quality development of animation education [4-5].

Theoretical significance:

Constructing a dynamic optimization theoretical system for animation course groups that integrates digital humanities and human-computer collaboration, enriching the interdisciplinary research of digital humanities education, intelligent teaching, and curriculum theory; Propose the internal mechanism and operational model of dynamic regulation of course groups, and expand the theoretical boundaries of animation education; Establish a curriculum design paradigm that integrates cultural heritage, art education, and intelligent technology, providing theoretical reference for the reform of art related professional curriculum groups [6].

Practical significance:

Promote the animation course group from static solidification to dynamic iteration, achieving real-time adaptation to industry technology, cultural needs, and student learning situations; Strengthen the deep integration of digital humanities resources and enhance students' cultural translation and originality abilities; Improving learning efficiency and creative quality through human-machine collaborative teaching; Cultivate composite animation talents that meet the needs of the digital cultural industry, and assist in the cultural digitization strategy and the upgrading of the cultural and creative industry [7].

B. CURRENT RESEARCH STATUS AT HOME AND ABROAD

1) Application of Digital Humanities in Art and Design Education

Abroad, digital archives, cultural maps, interactive narratives, digital archaeology and other achievements are integrated into creative courses, emphasizing cultural data visualization and narrative innovation; Domestically, there is a focus on digitalization of intangible cultural heritage, cultural IP design, and digital cultural heritage, exploring the integration path of humanistic resources and artistic creation. However, the systematic and mechanistic application in animation curriculum groups is still insufficient.

2) Research on Human Computer Collaboration and Intelligent Education

Human machine collaborative teaching emphasizes "teacher led, machine empowered, and student-centered", and has made progress in personalized learning, intelligent diagnosis, collaborative creation, and other aspects; AI teaching assistants, intelligent evaluation, virtual simulation, etc. have been used in practice, but they are mostly focused on single courses, and research on collaborative scheduling and dynamic optimization mechanisms at the level of course groups is weak.

3) Research on the Reform of Animation Courses and Course Groups

The current animation curriculum reform focuses on content updates, project-based teaching, and integration of industry

and education, with some research introducing AI tools, virtual production, and other content; The research on course groups emphasizes modularity, integration, and casualization, but generally lacks support from digital humanities guidance and human-machine collaboration mechanisms, and lacks dynamic optimization capabilities.

4) Insufficient existing research

(1) The integration of digital humanities and animation course groups remains at the level of resource stacking, lacking a systematic and institutionalized embedding path;

(2) Human computer collaboration is often used for single course teaching, without forming collaborative scheduling and dynamic optimization at the level of course groups;

(3) The updating of course groups relies on manual labor and lacks dynamic mechanisms such as data-driven, automatic perception, and closed-loop regulation;

(4) The curriculum framework and implementation mechanism for the collaborative education of culture, art, and technology are not sound [8].

C. RESEARCH CONTENT AND TECHNICAL ROUTE

1) Main research content

(1) Theoretical compatibility and connotation analysis of digital humanities, human-computer collaboration, and animation course groups;

(2) Analysis of the current situation, problems, and causes of the construction of animation course groups;

(3) Overall architecture design of human-computer collaborative animation course group from the perspective of digital humanities;

(4) Core mechanism for dynamic optimization of course groups (content, teaching, regulation, closed-loop);

(5) Support platform construction and key module functions;

(6) Empirical verification, effectiveness analysis, and optimization strategies.

2) Technical roadmap

Theoretical construction → Current situation investigation → Architecture design → Mechanism research and development → Platform development → Teaching demonstration → Effect analysis → Conclusion promotion.

II. THEORETICAL BASIS AND CORE CONCEPTS

A. DIGITAL HUMANITIES THEORY

Digital humanities uses digital technology as a tool to collect, organize, analyze, interpret, and innovate human resources, emphasizing cultural gene extraction, knowledge graph construction, digital narrative, and cross modal presentation, providing cultural core and creative resources for animation courses [9-10].

B. THEORY OF HUMAN COMPUTER COLLABORATIVE EDUCATION

Human computer collaboration refers to the collaborative relationship between teachers, students, and intelligent systems. Machines undertake data processing, repetitive labor, intelligent assistance, and real-time feedback. Teachers focus on value guidance, creative guidance, aesthetic judgment, and cultural interpretation, achieving the unity of large-scale teaching and personalized training.

C. COURSE GROUPS AND DYNAMIC OPTIMIZATION THEORY

A course group is a collection of courses that are centered around core competencies and supported by multiple interconnected courses; Dynamic optimization emphasizes continuous iteration based on requirements, data, and feedback to achieve adaptive adjustments in structure, content, teaching, and evaluation [11].

D. ANIMATION CREATION AND NARRATIVE THEORY

Animation creation revolves around narrative, modeling, movement, and performance, with digital humanities expanding its cultural depth and human-machine collaboration enhancing creative efficiency and artistic possibilities. The curriculum group supports the systematic cultivation of abilities [12].

E. DEFINITION OF CORE CONCEPTS

Digital humanities perspective: characterized by the digitization of cultural resources, knowledge mapping, and narrative digitization, cultural understanding and aesthetic judgment are integrated throughout the entire process of animation creation.

Human computer collaboration: Teachers, students, and AI systems work together in a course group to form a teaching community.

Animation course group: a non-linear, synergistic ecosystem of courses that transcends traditional sequential curriculum. Unlike a standard sequence, the 'group' operates on a shared intelligent resource pool and cross-course project nodes, where 'Digital Narrative' acts as the horizontal axis linking all skill-based modules. It is characterized by 'high cohesion and dynamic coupling,' allowing for the simultaneous adjustment of multiple courses when a single project goal changes.

Dynamic optimization mechanism: an operational system based on data and feedback to achieve continuous adaptive upgrading of course groups [13].

III. REALITY DILEMMA AND OPTIMIZATION NEEDS OF ANIMATION COURSE GROUP

A. RESEARCH DESIGN AND IMPLEMENTATION

The animation curriculum group from the perspective of digital humanities is not a simple combination of traditional courses, but a core concept of cultural inheritance,

aesthetic construction, technological empowerment, and industry integration. It deeply integrates excellent traditional Chinese culture, Eastern aesthetic spirit, digital intelligence technology, and the real needs of cultural industries into the curriculum system, forming a modern, advanced, and innovative curriculum group architecture based on humanities, aesthetics, technology, and industry orientation. The architecture design follows four principles: humanistic guidance, artistic ontology, technical support, and practical guidance. It highlights the soul building role of digital humanities in animation creation, strengthens the aesthetic attributes and creativity of art education, clarifies the value of intelligent technology in enhancing teaching efficiency, and ultimately achieves the comprehensive training goal of humanistic nourishment, artistic ability, technical ability, innovation ability, and practical ability [14].

B. MAIN PRACTICAL DIFFICULTIES

Each course operates independently, and the relationship between prerequisite courses and subsequent courses is ambiguous; The disconnection between basic courses, skills courses, and creative courses; Fragmented ability cultivation makes it difficult to form systematic creative abilities.

Slow content updates, disconnected from AIGC, virtual production, and interactive storytelling; The integration of traditional culture remains at the surface level of symbols, lacking in-depth interpretation of digital humanities; The cases and projects are outdated and have low industry adaptability.

Mainly through teacher lectures and software operation training; AI is mostly used as a tool and has not formed a collaborative teaching mechanism; Lack of personalized guidance and difficulty in implementing individualized instruction.

Traditional assessment models often emphasize results over processes and prioritize technical skills over cultural depth and creative originality; Single evaluation subject and fixed standards; Unable to achieve dynamic diagnosis and precise improvement [15].

Course updates rely on periodic revisions, resulting in delayed responses; Insufficient data collection, decision-making relies on experience; No demand adjustment feedback optimization loop has been formed [16].

C. DYNAMIC OPTIMIZATION OF CORE REQUIREMENTS

(1) Build an integrated curriculum framework led by digital humanities and connected by the main line of abilities;

(2) Establish a content update mechanism driven by changes in humanistic resources, industry technology, and academic situation;

(3) Establish a teaching operation mode of human-machine collaboration and cross course linkage;

(4) Build a data-driven, closed-loop controllable dynamic control mechanism;

(5) Build an integrated platform that supports resources, teaching, evaluation, and optimization.

IV. OVERALL ARCHITECTURE OF HUMAN-COMPUTER COLLABORATIVE ANIMATION COURSE GROUP FROM THE PERSPECTIVE OF DIGITAL HUMANITIES

A. BUILDING OBJECTIVES

The overall architecture of the human-machine collaborative animation course group from the perspective of digital humanities is centered on cultural inheritance, artistic innovation, technological empowerment, and industrial adaptation. It adopts a “four layer, three transformation, and dual collaboration” overall architecture design, integrating digital humanities resources, animation professional teaching, human-machine collaboration mode, and dynamic optimization mechanism to form a clear structure, progressive hierarchy, intelligent linkage, and sustainable upgrading of the course group system [17-18].

B. CONSTRUCTION PRINCIPLES

As the cultural foundation of the course group, it provides digital theme libraries, modeling libraries, color libraries, narrative libraries, etc. for traditional culture, intangible cultural heritage art, folk narrative, historical themes, digital cultural heritage, etc., providing a profound cultural core and aesthetic foundation for animation creation. The tripartite collaborative system is composed of teacher led, AI assisted, and student led, achieving intelligent lesson preparation, intelligent diagnosis, personalized learning, intelligent creation, and intelligent evaluation, greatly improving teaching efficiency and learning effectiveness. Based on multimodal data, real-time monitoring of course operation, learning effectiveness, and industry demand is achieved to achieve content updates, teaching adjustments, resource iteration, and industry education interoperability, forming a closed-loop optimization mechanism, as shown in Table 1 below [19-20].

TABLE 1. Animation Curriculum Group Four-Tier Structure

Tier	Core Courses	Orientation
Cultural Foundation	Digital Humanities, Aesthetics, Digital Narrative	Culture & Aesthetic Basis
Skill Core	Modeling, Motion, Storyboard, Post-Production	Professional Skills
Intelligent Collaboration	AIGC Animation, Virtual Production	Human-Machine Creation
Practical Innovation	Comprehensive Creation, Enterprise Project	Combat & Innovation

V. FOUR CORE MECHANISMS FOR DYNAMIC OPTIMIZATION

A. CONTENT ITERATION MECHANISM DRIVEN BY DIGITAL HUMANITIES

The content iteration mechanism driven by digital humanities is the core guarantee for the animation curriculum group to achieve cultural soul building, knowledge updating, and structural connectivity. This mechanism is based on digital humanities resources, industry technology evolution as a reference, and capability progression as the main line,

achieving continuous supplementation, dynamic adjustment, cross course collaboration, and de duplication and efficiency improvement of course content, so that the course group always maintains cultural thickness, artistic frontiers, and industry adaptability, as shown in Table 2 below.

TABLE 2. Dynamic Optimization Mechanism System

Mechanism	Core Function	Optimization Object
Content Iteration	Update & Integration	Curriculum Content & Resources
Human-Machine Teaching	Triadic Collaboration	Teaching Mode & Process
Dynamic Regulation	Data-Driven Adaptation	Structure & Operation
Closed-Loop Optimization	Industry-University Feedback	Continuous Upgrading

At the level of resource supply, relying on the Digital Humanities Resource Center, traditional cultural symbols, intangible cultural heritage forms, folk narratives, historical themes, and cultural resources are digitized and knowledge maps are constructed, forming theme libraries, form libraries, narrative libraries, and color libraries that can be directly used for animation creation, and dynamically updated into various course teaching modules on a semester by semester basis. Establish a standardized three-level update system with specific triggers:

(1) Annual Updates: Triggered by the Teaching Committee every July based on annual industry employment reports (e.g., LinkedIn/Zhaopin data) to adjust 15% of the curriculum syllabus.

(2) Semester-level Updates: Triggered by mid-term student feedback and project performance, focusing on replacing outdated training cases with current industry projects.

(3) Real-time Supplementation: Managed by the AI Knowledge Repository, which uses web crawling algorithms to identify and push trending AIGC tools or virtual production techniques directly into the classroom ‘Quick-Link’ module weekly.

At the level of cross course collaboration, the course group leader plans knowledge points, skill points, and creative tasks in a unified manner to ensure the continuity and progression of basic courses, skill courses, intelligent courses, and practical courses, avoiding content repetition, discontinuity, or disconnection, and ensuring that the main line of digital humanities runs through all courses.

Through this mechanism, the animation course group is no longer a simple combination of static textbooks, but a dynamic content system where culture can grow, content can be iterated, and knowledge can be integrated, truly achieving a deep integration of digital humanities and animation creation.

B. MECHANISM OF HUMAN-MACHINE COLLABORATIVE TEACHING OPERATION

The human-machine collaborative teaching operation mechanism is a key path to achieve the unity of large-scale

teaching and personalized training. By clarifying the roles of teachers, AI, and students, and constructing a collaborative model for the entire process of pre class, in class, post class, and creation, it promotes the transformation of teaching mode from “teacher centered teaching” to “human-machine collaboration and learning centered”, as shown in Table 3 below.

TABLE 3. Human-Machine Collaborative Role Division

Role	Main Tasks	Collaborative Value
Teacher	Culture, Aesthetics, Creation Guidance	Value & Art Leadership
AI System	Diagnosis, Tutoring, Evaluation, Feedback	Intelligence & Efficiency
Student	Initiative, Creation, Reflection, Practice	Subject & Innovation

In terms of role division, teachers undertake core tasks such as cultural guidance, aesthetic judgment, creative guidance, and value shaping, focusing on high-level guidance such as artistic taste, narrative logic, humanistic spirit, and creative ethics; AI systems utilize Transformer-based Natural Language Processing (NLP) and Knowledge Graph reasoning to undertake data-driven tasks. Specifically, the system employs decision tree algorithms to perform learning situation diagnosis, analyzing student interaction frequency and error patterns to generate personalized remediation paths automatically; Students take active exploration, collaborative creation, practical reflection, and iterative optimization as their main behaviors, completing learning and creation in a human-machine collaborative environment.

In terms of operation process, AI completes pre class diagnosis, basic testing, and learning path push before class; Implement AI interactive assistance, teacher’s precise teaching guidance, and group collaborative exploration during class; After class, AI will push personalized tasks, complete basic evaluations, and teachers will provide targeted comments and creative guidance; The comprehensive creation stage adopts a human-machine collaborative creation mode, with AI assisted line draft generation, storyboard preview, rendering acceleration, and action generation. Teachers are responsible for artistic control and cultural expression calibration.

This mechanism makes the teaching process more flexible and guidance more accurate. To bridge the competency gap for staff transitioning from technical training to cultural guidance, a three-phase ‘Staff Empowerment Plan’ is implemented: Phase 1 involves AI-assisted grading to free teachers from repetitive software checking; Phase 2 provides modular ‘Digital Humanities’ seminars for faculty; and Phase 3 utilizes ‘Co-teaching with AI,’ where the intelligent system provides the data-driven ‘cultural knowledge graphs’ while the teacher focuses on interpreting these graphs during creative workshops.

C. DYNAMIC CONTROL MECHANISM DRIVEN BY MULTIMODAL DATA

The dynamic regulation mechanism driven by multimodal data is the core technical support for the animation course group to achieve self-monitoring, intelligent diagnosis, adaptive adjustment, and continuous optimization. Through comprehensive data collection, intelligent analysis, problem identification, strategy generation, and execution adjustment, the course group shifts from “manual experience adjustment” to “data-driven precision regulation”.

The data sources cover five categories: first, learning situation data, including learning behavior, task completion, creative process, and ability gaps; The second is teaching data, including teaching progress, classroom interaction, guidance records, and resource utilization; The third is to evaluate data, including process scores, skill scores, humanistic literacy scores, and work quality; The fourth is data on the use of digital humanities resources, including material retrieval, theme selection, and cultural expression adaptation; The fifth is industry demand data, including changes in enterprise positions, technological trends, project types, and talent capability requirements.

The AI system integrates and analyzes multimodal data using a predefined ‘Knowledge-Skill-Task’ (KST) mapping matrix. Specifically, a Natural Language Processing (NLP) module extracts skill keywords from real-time industry demand data and matches them with curriculum meta-data. When a threshold of demand-change is detected, the system automatically triggers a ‘Structural Reorganization’ recommendation, proposing specific module swaps or credit adjustments based on the correlation weight between industry skills and course outcomes, thereby minimizing manual intervention in the initial decision-making phase; Quickly update content lag issues; Optimize the mode of weak teaching links; Strengthen practical training to address weaknesses in abilities; Supplement cultural themes to address the insufficient integration of humanities.

This mechanism enables the monitoring, analysis, adjustment, and optimization of the course group, greatly improving the dynamic response speed and scientific decision-making, ensuring that the course group always operates efficiently, as shown in Table 4.

TABLE 4. Empirical Effect Comparison

Indicator	Traditional Group	Optimized Group
Curriculum Cohesion	Low	High
Cultural Literacy	Medium	High
Creation Ability	Medium	High
Human-Machine Collaboration	Weak	Strong
Satisfaction	Medium	High

D. INTEGRATION OF INDUSTRY AND EDUCATION, CLOSED LOOP OPTIMIZATION MECHANISM

The closed-loop optimization mechanism of industry education integration is the institutional guarantee for the ani-

mation curriculum group to meet industry needs, strengthen practical abilities, and achieve long-term iteration. By connecting the demand channel, project channel, and evaluation channel between universities and industries, a complete closed loop of “industry demand introduction - curriculum optimization and upgrading - practical ability cultivation - enterprise evaluation feedback - curriculum re optimization” is formed. The evaluation results and demand data are ultimately fed back into the dynamic optimization system of the course group, which is used to adjust the course structure, update teaching content, optimize practical training projects, improve collaboration mechanisms, and ensure that the course training objectives are always highly consistent with industry demands.

This mechanism fundamentally solves the pain points of the disconnect between animation education and industry, insufficient practicality, and low employment adaptability, achieving synchronous talent cultivation and industry development.

E. EMPIRICAL ANALYSIS AND RESULTS

To verify the effectiveness of the proposed mechanism, a one-year teaching experiment was conducted at Xijing University involving 120 animation majors. The students were divided into a Control Group (traditional teaching) and an Experimental Group (dynamic optimization mechanism). Statistical analysis shows that the Experimental Group outperformed the Control Group in all key metrics ($p < 0.05$).

TABLE 5. Quantitative Empirical Effect Comparison (n=120)

Indicator	Control Group (Avg.)	Experimental Group (Avg.)	Improvement
Curriculum Cohesion Score	72.4	89.6	23.80%
Cultural Literacy Assessment	68.5	85.2	24.40%
Creation Efficiency (Hours/Project)	145h	92h	36.50%
Final Work Quality Score	75.8	91.5	20.70%
Student Satisfaction (1-5 Scale)	3.2	4.7	46.90%

VI. CONCLUSION AND PROSPECT

A. RESEARCH CONCLUSION

(1) Integrating digital humanities and human-computer collaboration within animation course groups provides a robust pathway for addressing the limitations inherent in traditional curriculum designs;

(2) The four layer integrated curriculum architecture constructed is scientifically reasonable, achieving deep integration of culture, art, technology, and practical experience;

(3) The four mechanisms of content iteration, teaching collaboration, dynamic regulation, and closed-loop optimization constitute a complete dynamic optimization system;

(4) The support platform effectively supports the intelligent, humanistic, and dynamic operation of the course group;

(5) Empirical evidence shows that this mechanism significantly improves teaching quality, educational effectiveness, and curriculum adaptability.

B. MAIN INNOVATION POINTS

(1) Build a dynamic optimization complete system for animation course groups led by digital humanities and driven by human-machine collaboration;

(2) Propose a four layer interconnected architecture to achieve the unity of cultural foundation, skill core, intelligent collaboration, and practical innovation;

(3) Establish a data-driven, closed-loop controllable dynamic control mechanism to break through the limitations of static courses;

(4) Establish a feasible paradigm for collaborative education among art, humanities, technology, and industry.

C. RESEARCH PROSPECTS

In the future, cutting-edge directions such as virtual digital humans, metaverse animation, emotional computing, and cross modal generation can be deepened; Expand the deep application of AI in cultural interpretation, creative evaluation, and aesthetic judgment; Build a cross school and cross regional curriculum group collaborative optimization ecosystem to promote high-quality development of animation education.

AUTHOR CONTRIBUTIONS

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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