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Research on AI-Empowered Smart Curriculum Development and Teaching Reform of Experimental Psychology Course

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Abstract: In order to implement the requirements of the Outline for Building a Leading Country in Education (2024–2035) and the "Artificial Intelligence + Education" Action Plan, and promote the digital transformation of psychology professional courses, this study conducts AI-empowered smart curriculum development and teaching reform practice for the Experimental Psychology course, targeting prominent practical dilemmas in the teaching of traditional Experimental Psychology courses, including fragmented knowledge systems, insufficient personalized learning support resources, monolithic process evaluation methods, and delayed updating of cutting-edge research content. The project relies on the Wisdom Tree platform and the Online Open Course Alliance Platform for Universities in Guangdong-Hong Kong-Macao Greater Bay Area to construct a curriculum map matrix integrating knowledge map, problem map, ability map, and curriculum ideological and political map; establishes a course-specific knowledge base and question-answering base, and trains a dedicated course AI teaching assistant; develops an AI workbench, and implements multiple intelligent teaching scenarios covering AI lesson plan generation, intelligent question design, subjective question grading, and learning situation analysis, and the recommendation of personalized learning paths; reconstructs the whole-process human-machine collaborative hybrid teaching mode covering the stages of pre-class, in-class, and after-class, and constructs a diversified AI-driven process evaluation system integrating diagnostic evaluation, formative evaluation, and summative evaluation. Empirical practice indicates that AI-enabled smart curricula can expand the boundaries of curriculum teaching, reduce repetitive teaching tasks for instructors, stimulate students' inquiry-based learning engagement, and improve students' psychological scientific research thinking as well as AI digital literacy. This study constructs a replicable paradigm for AI curriculum development for psychology majors, and also provides practical references for the implementation of generative AI-enabled teaching reform for similar applied psychology courses.

Keywords: Generative Artificial Intelligence; Experimental Psychology; Knowledge Graph; Smart Curriculum; Teaching Reform; Psychology Education

I. Introduction

The new round of iteration in artificial intelligence technology has driven profound transformations in the teaching models of higher education. China has successively issued the Outline for Building a Leading Country in Education (2024–2035) and the "Artificial Intelligence + Education" Action Plan, which explicitly put forward requirements to promote the in-depth integration of artificial intelligence and curriculum teaching, innovate talent cultivation models, and improve students' digital literacy and innovation capability. The discipline of psychology bears the dual attributes of humanities and social sciences and Empirical science. As a core foundational curriculum for psychology majors, Experimental Psychology bears the critical responsibility of cultivating students' scientific experimental thinking, paradigm design capabilities, data interpretation competence, and scientific research ethics literacy, and constitutes a key cornerstone of the undergraduate and postgraduate talent training system for applied psychology.

Multiple prominent problems remain in the traditional teaching practice of Experimental Psychology: First, the curriculum covers a large number of knowledge points and involves complex experimental paradigms, while the logical association between knowledge points is difficult to present intuitively. This easily leads to fragmented knowledge cognition among students and hinders the construction of a complete knowledge system of experimental methods; Second, limited classroom teaching hours make it difficult to implement multi-level differentiated instruction, and students cannot obtain timely and personalized answering and guidance for difficult problems after class; Third, the cutting-edge experimental paradigms and latest research findings in this field update rapidly, while the updating efficiency of traditional courseware and handouts is relatively low; Fourth, curriculum evaluation largely relies on final summative assessment, and the process-based collection and evaluation of students' learning progress, inquiry ability, and AI tool application literacy are insufficient; Fifth, instructors are required to invest substantial time in repetitive work such as question setting, grading, and statistics of learning conditions, which consequently restricts their investment in teaching research.

Technologies including generative large models, knowledge graphs, and Retrieval-Augmented Generation (RAG) provide feasible technical approaches for addressing the aforementioned pain points in teaching practice. A number of domestic universities have carried out exploratory practices of artificial intelligence-enabled teaching for psychology courses, and most of the existing practices concentrate on mental health education courses. At present, complete cases of intelligent curriculum construction for professional methodology courses such as Experimental Psychology remain relatively limited. The teaching team of applied psychology at Guangdong University of Foreign Studies, which owns the construction foundation of provincial first-class online open courses and provincial hybrid first-class courses, has carried out exploratory practice of artificial intelligence-assisted teaching mode for psychological statistics courses in the early stage, and has accumulated practical experience in the construction of artificial intelligence teaching assistants and artificial intelligence workbenches.

This study takes the Experimental Psychology course as the research carrier, integrates knowledge graph and generative artificial intelligence technologies to carry out the overall construction of intelligent curriculum, reconstructs teaching resources, teaching mode, and evaluation system, explores the reform path of psychology professional courses under human-machine collaboration, and constructs a replicable intelligent teaching paradigm.

II. Curriculum Reform Foundation and Key Teaching Problems to Be Solved

2.1 Curriculum Reform Foundation Taking the Experimental Psychology course offered by Guangdong University of Foreign Studies as an example, this course possesses a solid foundation for curriculum development. It has been successively accredited as a provincial high-quality resource-sharing course, a provincial first-class online open course, and a provincial online-offline blended first-class course. The course has been operated on the Wisdom Tree platform and the Online Open Course Alliance Platform for Universities in the Guangdong-Hong Kong-Macao Greater Bay Area for multiple years, with multiple rounds of Small Private Online Course (SPOC) offerings. To date, the total number of enrolled students has exceeded 4,000, and the course has accumulated substantial teaching resources including complete teaching videos, courseware, exercise banks and case libraries. The project leader is a distinguished university-level teaching professor, who has presided over multiple provincial teaching quality projects and teaching reform projects, and has long been engaged in the teaching of Experimental Psychology, Social Psychology and other related courses, with rich experience in curriculum construction.

The teaching team has previously carried out teaching reform practice on the topic of Exploration of a New Teaching Mode for Psychological Statistics Based on General Artificial Intelligence Large Models, and has initially constructed the prototype of an AI workbench. Basic functions, including AI teaching assistant question answering and intelligent resource recommendation, have been tested, and practical experience in human-machine collaborative teaching and AI-enabled teaching risk management and control. The research team also boasts established research foundations in the field of psychology and has published multiple SSCI Q1 academic papers focusing on artificial intelligence and emotion recognition, which provides solid theoretical and empirical support for the interdisciplinary curriculum construction involved in this study.

2.2 Key Teaching Problems to Be Solved

First, the problem of insufficient knowledge structuring in the course: In traditional teaching modes, teaching resources are generally stored in discrete forms such as courseware and video files, while the prepositional, associative, and extensional relationships among knowledge points are not explicitly presented. As a result, it is difficult for students to independently construct a complete knowledge system for Experimental Psychology. This research realizes the correlation mapping among knowledge points, ability objectives, and curriculum ideological and political elements through constructing a multi-dimensional knowledge graph matrix.

Second, general large language models suffer from insufficient output accuracy for professional content: general large models are prone to generating factual errors when outputting content related to psychological concepts and experimental paradigms. This research constructs a course-specific knowledge base and question-answering base, constrains the output of large models based on RAG (Retrieval-Augmented Generation) technology, and trains a customized AI teaching assistant for the target course, so as to improve the response reliability of professional question answering. Third, the supply of personalized after-school learning support is inadequate: classroom instruction is unable to accommodate heterogeneous learning paces of students with varying foundational knowledge levels, and students cannot obtain timely feedback regarding their comprehension of experimental paradigms, exercise analysis, and scientific research inquiries after class. AI teaching assistants can enable 24-hour intelligent question answering, generate personalized learning pathways and personalized error question repositories, and facilitate the implementation of multi-level differentiated instruction.

Fourth, the teaching evaluation model is monotonous: traditional assessment places excessive emphasis on the final written examination and lacks systematic process-oriented data collection regarding students' learning processes, critical utilization of AI tools, and inquiry competence. It is necessary to construct a tripartite diversified evaluation system of diagnostic evaluation-formative evaluation-summative evaluation enabled by AI.

Fifth, teachers are overloaded with substantial repetitive teaching tasks: routine work, including test design, homework grading, learning performance statistics, and teaching syllabus updating, consumes a large proportion of teachers' working energy. A complete set of tools integrated into the AI workbench can free teachers from trivial work, allowing them to redirect their energy to high-level teaching activities such as instructional design and speculative classroom guidance.

III. Overall Framework and Specific Implementation Strategies for AI-Empowered Smart Curriculum Development in Experimental Psychology

The curriculum development has a total cycle of one year. Guided by the "student-centered" blended teaching concept, this study adheres to the construction principle of teacher leadership with artificial intelligence (AI) assistance and carries out construction work from six dimensions: digital reconstruction of curriculum resources, construction of a RAG curriculum-specific AI engine, configuration of AI workbench teaching tools, implementation of whole-process human-machine collaborative teaching, construction of a diversified intelligent evaluation system, and management and control of AI teaching quality and ethical risks. The overall scheme is divided into four modules: construction of a multi-dimensional curriculum map matrix, development of a curriculum knowledge base and AI teaching assistant, deployment of AI workbench teaching tools, and reconstruction of a whole-process human-machine collaborative teaching mode.

3.1 Construction Measures for Multi-dimensional Curriculum Map Matrix and Digital Reconstruction of Teaching Resources

Based on the course syllabus, textbooks, classic experimental paradigms, postgraduate entrance examination syllabus, and cutting-edge academic literature, this research sorts out the core knowledge points of the Experimental Psychology course and constructs four types of maps, namely the knowledge map, problem map, ability objective map, and curriculum ideological and political map.

First, for knowledge map construction: the study collaborates with curriculum designers and professional course teachers to complete the disassembly and classification of knowledge points, and manually mark the pre-order relationship, parallel correlation relationship, and expansion-extension relationship among knowledge points. AI-based video timestamp marking and clipping processing is conducted on course teaching videos, and fragmented video clips, courseware, exercises, and extended literature are embedded into corresponding knowledge point nodes. Mobile terminal adaptation is completed to enable students to implement global browsing of the knowledge network and navigation-based deep learning via mobile terminals.

Second, construction of question mapping: Classroom questions, after-school assignments, and students' high-frequency questions over the years are summarized, and a three-level question system including basic classic questions, differential difficult questions and comprehensive cutting-edge questions is constructed. A two-way association between knowledge points and question nodes is established, which enables jumping from knowledge points to exercise cases and backtracking from questions to corresponding knowledge modules, and supports inquiry-based learning.

Third, construction of ability objective mapping: This work is connected to the graduation requirement indicators of applied psychology majors. Core course abilities including experimental paradigm comprehension, experimental design, confounding variable identification, and scientific research ethical judgment are decomposed, and a mapping chain of "graduation requirement indicator-course objective-knowledge point-ability point" is constructed to support quantitative analysis of the achievement degree of course objectives.

Fourth, construction of course-specific ideological and political knowledge mapping: This step involves in-depth excavation of ideological and political elements implicit in the Experimental Psychology course, including scientific spirit, research integrity, patriotism and academic ethics. Ideological and political case nodes are matched with corresponding course knowledge points to realize the implicit integration of curriculum ideological and political content, thereby avoiding the "two-layer separation" problem where ideological and political content is disconnected from professional knowledge.

3.2 Construction of Curriculum-Specific AI Engine Based on RAG Retrieval-Augmented Generation Technology

Aiming at addressing the hallucination issue of general large language models in the domain of psychological professional knowledge, this study constructs a curriculum-specific AI engine based on retrieval-augmented generation technology, positioning the engine as a tool for AI-assisted learning rather than a replacement for independent learning.

First, the processing and construction of the curriculum knowledge base and question-answering base: Teaching materials including course handouts, courseware, transcribed text of teaching videos, classic experimental literature, question banks and ideological and political cases are collected and organized. After completing text chunking and semantic vectorization processing, a private curriculum knowledge base is constructed. On this basis, high-frequency question-answering samples of the course are sorted out, categorized and organized according to four dimensions: concept interpretation, paradigm discrimination, experimental design and research ethics, and a curriculum-specific ques Using the question-and-answer knowledge base as the knowledge source for the AI teaching assistant.

Second, conduct prompt engineering design and optimization for the AI teaching assistant. The AI teaching assistant is positioned as a Socratic heuristic teaching assistant, which is prohibited from outputting standard answers directly. Instead, it shall guide students to deduce experimental logic independently through progressive questioning. The Retrieval-Augmented Generation (RAG) traceability mechanism is enabled, requiring outputs from the AI to give priority to referencing internal resources of the course knowledge base. An automatic forwarding channel for difficult questions is established, through which highly controversial and deeply speculative questions are automatically forwarded to course instructors for handling. Prompts are revised and corrected via multiple rounds of testing and iteration to mitigate factual hallucinations of the large language model.

3.3 Dual-terminal Deployment of the AI Workbench and Capacity-building Path for the Teaching Team

Deploy the AI workbench for both teachers and students with clear permission boundaries defined, and establish a manual review mechanism for AI-generated teaching content.

First, implementation and application of teacher-side tools: enable functions including AI-assisted lesson-plan generation, AI-driven courseware creation, AI-intelligent test-paper composition and proposition, AI marking of subjective questions, intelligent analysis of long-form videos and long documents, detection of AI-generated content in assignments, and intelligent review of course content. A strict review process shall be enforced: AI-generated lesson plans, courseware, test items and cases must be manually revised and reviewed by course instructors before being adopted in teaching, so as to prevent model-induced errors from entering classroom instruction.

Second, the configuration and activation of student-side tools: functions including AI intelligent question answering, literature analysis, personalized learning path generation, weak knowledge point localization, automatic error question set construction and intelligent push of academic resources shall be activated. Prompt descriptions shall be added on the functional interface to clarify that artificial intelligence only serves as an auxiliary learning tool and cannot replace independent thinking.

Third, special training for the teaching team: multiple special training sessions shall be organized during the project implementation period, covering background operation and maintenance of knowledge graphs, prompt engineering skills, identification and review of AI-generated content, as well as operation and maintenance management of AI teaching assistants; an error case registration ledger shall be established to collect cases of AI output deviation, so as to continuously optimize the knowledge base and prompt instructions.

3.4 Implementation Measures of the Pre-class–In-class–After-class Whole-Process Human-Machine Collaborative Teaching Mode

First, in the pre-class stage, data-driven teaching based on learning status analysis should be realized. Instructors invoke knowledge graph resources via the AI workbench, and AI generates preview tasks and the first draft. In the pre-class preparation stage, teachers complete teaching design and generate preliminary lesson plans, which are manually revised by teachers; students carry out pre-knowledge preview under the guidance of knowledge maps and complete preview diagnostic tests; artificial intelligence summarizes and generates classroom learning status reports, marks the common knowledge weak points of students, and teachers dynamically adjust the key content of offline classroom teaching in combination with the obtained learning situation.

Second, in the in-class teaching stage, the teacher's leading role is maintained, while artificial intelligence undertakes auxiliary interactive tasks. Offline classrooms focus on teacher explanation, group discussion, and experimental paradigm discrimination, and teachers focus on high-level teaching activities such as scientific research thinking cultivation and value guidance; artificial intelligence tools are responsible for the generation of in-class quizzes and real-time statistics of classroom answer data; AI simulation experiment practice sessions are set up, in which students input experimental ideas, artificial intelligence generates simulated experimental data, and students complete vulnerability investigation and variable discrimination; in group inquiry tasks, artificial intelligence acts as a thinking partner, only outputting heuristic questions without providing complete solutions, and the final learning results are commented on and sublimated by teachers.

Third, in the after-class consolidation stage, artificial intelligence provides inclusive learning support, and teachers focus on providing in-depth targeted tutoring. The AI teaching assistant provides all-weather basic question-answering services, completes the grading of objective questions and part of subjective homework, and automatically generates personalized error question sets and individualized learning paths, and recommends matching micro-courses and extended literature resources; for inquiry-based assignments such as experimental reports, students are required to disclose statements of AI utilization, explicitly marking AI-assisted content and independently completed content; AI generates a holistic learning situation report for the entire class, and teachers focus on addressing in-depth academic controversial issues that cannot be resolved by AI, and carry out targeted guidance.

3.5 Measures for Construction of Trinity Diversified Intelligent Curriculum Evaluation System

Reform the traditional summative assessment mode, and build a trinity evaluation system of diagnostic - formative - summative evaluation.

First, diagnostic evaluation: At the beginning of the semester, rely on AI to generate a baseline test to understand students' previous knowledge foundation, providing an input basis for personalized learning paths.

Second, formative assessment (accounting for 60% of the total score): Covers online preview, classroom group discussion, AI-assisted experimental design inquiry homework, and platform learning behavior; the assessment focus is not on the frequency of AI tool use, but on evaluating students' ability to distinguish, revise, and critically use AI output content.

Third, summative assessment (accounting for 40% of the total score): The final examination focuses on high-level professional abilities such as experimental paradigm understanding, experimental design, and confounding variable identification.

Fourth, supporting AI academic ethics management and control measures: Issue the "Generative AI Usage Specification" for the course, clarify the labeling requirements for AI content in homework; enable AI-generated content detection tools; set up special teaching hours to explain the advantages and limitations of AI tools in psychology research scenarios, as well as scientific research integrity norms.

3.6 Measures for AI Teaching Risk Prevention and Control and Dynamic Iteration Guarantee

Establish a normalized quality control mechanism to resolve various teaching risks brought by AI application. First, establish an AI output error registration and update mechanism, where teachers and students timely record professional factual errors found, synchronously update the knowledge base and optimize prompt words, and key teaching materials must be manually reviewed; second, prevent students from over-relying on AI, set more open speculative tasks, strengthen independent thinking training, regularly investigate students' AI usage experience, and dynamically adjust the tool opening boundary; third, establish a teaching emergency plan, fully retain traditional courseware, exercises, and teaching plan resources, and switch to the traditional teaching mode when the platform fails to ensure uninterrupted teaching; fourth, establish a dynamic resource iteration mechanism, supplement the latest experimental research literature and cutting-edge paradigms every semester, optimize knowledge graph nodes and question-answering samples according to teaching feedback, and realize continuous Update and growth of curriculum resources.

IV. Innovations

4.1 Construct a multi-dimensional map matrix for psychology professional courses. Synchronously build four types of maps—knowledge, problem, ability, and ideological and political content—in the Experimental Psychology course, and connect the association between graduation requirements, course objectives, knowledge points, and ideological and political points. realize knowledge visualization, support the evaluation of course achievement degree, and provide a template for the digital construction of psychology methodology courses.

4.2 Train curriculum-specific AI teaching assistants based on RAG technology. Aiming at the deviation problem of general large models in the output of psychology professional knowledge, build a curriculum private knowledge base and question-and-answer base, and adopt retrieval-augmented generation to constrain the model output; the AI teaching assistant adopts heuristic dialogue instead of directly giving answers, protects students' critical thinking, realizes "AI-assisted learning rather than replacing learning", and clarifies that AI is a teaching auxiliary and teachers cannot be absent.

4.3 Form a complete teaching closed loop of human-machine collaboration. Connect the whole teaching scenarios of pre-class, in-class, and after-class, and distinguish the respective positions of teachers, students, and AI. Teachers lead value guidance and speculative teaching; AI undertakes repetitive work such as question answering, grading, and resource pushing; as the main body of learning, students train the critical use ability of AI tools and implement the "student-centered" teaching concept.

4.4 Establish a diversified process evaluation system adapted to smart curriculum. Incorporate AI learning behavior and inquiry tasks into curriculum assessment, support AI academic integrity norms, balance knowledge mastery, scientific research ability, and AI digital literacy, and explore the reform path of psychology curriculum assessment in the era of artificial intelligence.

V. Construction Achievements

5.1 Curriculum Resource Achievements

A complete set of smart curriculum resources for Experimental Psychology has been formed: a multi-dimensional curriculum knowledge graph matrix, curriculum-specific knowledge base and question-and-answer base, an AI teaching assistant system, an AI workbench teaching task template, updated courseware and teaching plans, a supporting exercise bank, and a curriculum ideological and political case library. The curriculum resources can be launched and shared on the Online Open Course Alliance Platform for Universities in the Guangdong-Hong Kong-Macao Greater Bay Area.

5.2 Teaching Practice Achievements

It has improved classroom teaching efficiency and effectively solved the problem of students' fragmented learning; promoted the improvement of students' high-level abilities, such as experimental design; enabled students to master the ability to use AI scientific research tools reasonably and critically, and improved the interdisciplinary digital literacy of psychology + AI; reduced the burden of repetitive work, such as after-school question answering and question grading, for teachers. More than two typical AI teaching cases have been formed (AI teaching assistant learning support case, AI-supported inquiry-based classroom case).

5.3 Risks and Responses

First, the risk of professional content deviation of large models: Rely on the RAG knowledge base to restrict the model output, set up a manual review mechanism, and teachers review AI-generated rated lesson plans and exercises before putting them into teaching.

Second, the risk of students over-relying on AI and weakening independent thinking: The course clarifies the AI usage specification, requires the labeling of AI usage in homework, adds subjective speculative and experimental design questions in the assessment, and emphasizes that AI is an auxiliary tool rather than a replacement for thinking.

Third, the risk of technical platform stability: Establish an online and offline dual-track teaching emergency plan, and switch to the traditional offline teaching mode when the platform fails to ensure that teaching activities are not interrupted.

VI. Conclusion

Under the wave of education digitalization, artificial intelligence is not simply adding tools to the curriculum, but promoting the systematic reshaping of the curriculum knowledge system, teaching mode, and evaluation system.

As a methodology course for psychology majors, the construction of an AI smart curriculum for Experimental Psychology is not to replace teachers' teaching with artificial intelligence, but to build a new ecology of human-machine collaboration: teachers focus on high-level teaching activities such as value guidance, speculative guidance, and scientific research thinking cultivation; AI undertakes repetitive work such as question answering, grading, and resource push, releasing teaching productivity.

This work attempts to solve the traditional teaching pain points of Experimental Psychology through the construction of a multi-dimensional map matrix, curriculum-specific knowledge base, AI workbench, and whole-process hybrid teaching mode. In the follow-up, it is necessary to continuously iterate the knowledge base, knowledge graph, and AI interaction instructions, and continuously optimize the teaching plan. At the same time, the construction experience of this project can also be transferred to psychology courses such as Social Psychology and Psychological Statistics, helping the overall digital teaching reform of psychology majors, and providing support for cultivating compound psychology talents with both psychological professional ability and AI digital literacy.

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