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Research on Human-Computer Collaborative Teaching Mode in Intelligent Teaching Environment

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Abstract. The widespread application of emerging information technologies such as big data and artificial intelligence in the field of education has facilitated the development of human-computer collaborative classroom teaching models. Based on the definition and connotation of the elements of human-computer collaborative classrooms, this study distinguishes the differences in the knowledge characteristics of teaching content and combines the three major teaching phases before, during and after class to construct a human-computer collaborative classroom teaching model in an intelligent teaching environment. The research conclusions can provide a reference for front-line teachers and teaching managers to implement human-computer collaborative teaching.

Keywords: Intelligent Teaching; Human-Machine Collaboration; Teaching Model

1. Introduction

Emerging information technologies characterized by big data and intelligence have triggered a new round of technological revolution in human society, changed the way knowledge is produced and disseminated, and promoted the transformation of education to intelligence. The fundamental purpose of the transformation of education to intelligence is to promote learning, provide learners with diversified, accurate, and intelligent personalized learning support services, improve the efficiency of knowledge acquisition, stimulate learners' self-efficacy, and help achieve efficient learning [1]. With increasingly diversified forms of knowledge acquisition, an individual's learning experience may include classroom learning, family learning, and lifelong learning. For most people, classroom learning is still the most important form of learning. However, the "teacher-student" dual subject structure model of traditional classroom teaching is inefficient and ineffective in solving problems such as poor learning performance, insufficient learning investment, poor learning habits, low learning participation, and low self-efficacy in the learning process of students. It cannot meet the needs of a large number of students for more personalized and efficient learning. With the continuous deepening of the application

of intelligent technology in the field of education, intelligent education products tend to diversify and gradually mature, and humans and machines are establishing a close collaborative learning relationship [2]. Machines have begun to share the teaching activities that were completed by the human brain in traditional classroom teaching, changing the classroom teaching process and learning mechanism. As classroom teaching enters the era of artificial intelligence, human-computer collaborative learning will also become an inevitable form of classroom learning [3]. However, in the field of education, there is a lack of systematic reflection and discussion on key issues such as the teaching form, teaching scenario, teaching process design, and teaching evaluation of the "teacher-student-computer" collaborative teaching model. Therefore, it is necessary to conduct an in-depth analysis of the human-computer collaborative teaching model and explore its connotation and construction elements, so as to provide support for the practical application of the human-computer collaborative teaching model.

2. Review of relevant research

The idea of human-machine collaboration emerged as early as the industrial age. Machines were used to replace some of the human physical labor to liberate productivity and improve industrial production efficiency. Human-machine collaboration at this time emphasized the effective use of machines by humans. With the rapid development of information technologies such as big data and artificial intelligence, the level of machine intelligence has been continuously improved. Machines have gradually evolved from simply replacing human physical labor to comprehensively supporting human thinking, perception, and decision-making [4]. The core of human-machine collaboration is to allow humans and machines to play to their strengths in their respective areas of expertise to achieve effective solutions to complex problems [5, 6]. Human-machine collaboration in education refers more to the collaboration between humans and computers. The advantages of computers in rapidly acquiring and efficiently processing data make it possible to achieve effective instruction that is both personalized and scaled [7]. In the field of education, the human-computer collaboration includes the use of computers to assist learners in performing routine and repetitive learning tasks [8], and the use of intelligent educational products to collect learning data, diagnose learning behavior, and intervene in the learning process [9]. Human-computer collaborative classroom teaching is an important part of the reconstruction of the smart learning ecosystem.

The current literature on human-computer collaborative classroom teaching focuses on three aspects. The first aspect is collaborative teaching based on human-computer interaction. This type of collaborative teaching refers to the use of cameras, eye-tracking devices, electroencephalographs and other data collection devices and intelligent analysis devices to help teachers effectively diagnose students' learning behavior and learning status [10], accurately analyze the characteristics of students' learning styles and learning preferences, and provide students with personalized learning programs [11]. This type of collaborative teaching mainly involves teachers collaborating with intelligent devices and resources to improve teachers' teaching efficiency, and students' participation is relatively low. The second aspect is collaborative teaching that focuses on human-computer collaborative work. This type of collaborative teaching refers to artificial intelligence taking on the role of a tutor or companion in the teaching process [12]. Through the text, speech, vision and other recognition and rule matching and other technical means

of feedback on the degree of knowledge mastery and cognitive development level of students, not only for the students to optimize the learning materials and learning paths [13], but also for the teacher to provide intelligent recommendation and optimization of teaching strategy services. This type of collaborative teaching integrates teachers, students, and intelligent teaching resources and equipment into a teaching whole. The third aspect is collaborative teaching based on human-computer integration. This type of collaborative teaching integrates the teaching data and teaching strategies of multiple independent teaching classrooms, and with the help of big data and intelligent analysis technology, it can better restore the real learning process [14] and provide heuristic intelligent education decision-making. However, the practical application of this type of collaborative teaching is still relatively low.

In summary, human-computer collaborative classroom teaching is one of the most common forms of learning in the era of artificial intelligence. However, the research on the practical application of human-computer collaboration in classroom teaching in the existing literature mainly focuses on theoretical discussions and lacks practical exploration of the human-computer collaborative classroom teaching model. This study aims to construct a human-computer collaborative classroom teaching model in an intelligent teaching environment from a practical perspective.

3. Components of the human-computer collaborative instructional mode

3.1. Teacher wisdom

Teacher wisdom is being redefined in the intelligent era, which requires teachers to integrate the logic of teaching practice with emerging technologies and reconstruct teaching practice and teaching value in an intelligent teaching environment to meet the needs of intelligent transformation of education. The role of the teacher has expanded from a learning guide to a technology integrator and an innovator of teaching practice. In human-computer collaborative classroom teaching, the teacher's wisdom is embodied at the knowledge transfer level by being responsible for knowledge understanding and application, at the emotion transfer level by being responsible for emotion expression and understanding, and at the value judgment level by being responsible for belief expression and creativity cultivation [15].

3.2. Student wisdom

In traditional classroom teaching, the participation of students' wisdom is low, and the results of students' wisdom development are more often evaluated through course evaluation. This evaluation is mainly reflected as a single result-based evaluation. In human-computer collaborative classroom teaching, the application of emerging information technology to collect learning data in real-time forms the data basis for human-computer collaboration. Monitoring and feedback of the learning process and learning behavior enable teachers to adjust teaching strategies according to students' knowledge formation and wisdom development. The evaluation of learning will also be transformed from a single result-based evaluation to a process-based feedback evaluation.

3.3. Intelligent technology product

Intelligent technology product is the basic condition for the realization of human-computer collaborative classroom teaching, including intelligent hardware devices and intelligent educational products. Intelligent hardware devices include eye trackers, sensors, electroencephalograms, intelligent wearable devices, and intelligent mobile terminals. These intelligent devices collect explicit data such as learning time, learning difficulty, error rate, etc. for the teaching process, and also obtain implicit data such as learning interest, learning motivation, learning style, etc. by combining the learning law through intelligent analysis technology. Intelligent educational products will use these data to match appropriate learning resources, teaching strategies and learning interventions. This series of processes still needs to be guided by teachers' practical experience and cannot be detached from real teaching scenarios [16].

3.4. Learning content

Learning content is a key element in the design of human-computer collaborative instruction. Learning content in human-computer collaborative instruction does not refer to individual knowledge points or knowledge units, but is a sequential knowledge map organized into knowledge units using knowledge fusion technology. The knowledge map is adapted to students' learning goals. According to the characteristics of the knowledge structure of different disciplines and the logical connection between knowledge units, and according to the characteristics of the learning data of different learners, the knowledge subgraphs that conform to their cognitive laws are divided, and appropriate learning resources and learning paths are matched through intelligent technology products.

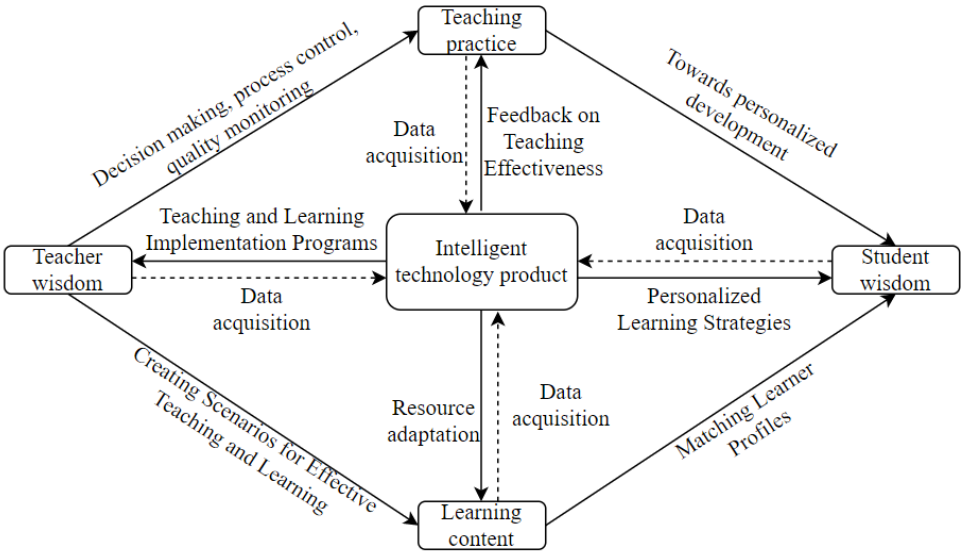

Figure 1: Components of the Human-Computer Collaborative Instructional

4. Construction of human-computer collaborative classroom model

4.1. The pre-course stage of classroom teaching

The pre-course stage of human-computer collaborative classroom teaching includes three important teaching links, pre-course learning diagnosis, completion of instructional design,

and accurate resource development. Pre-course learning diagnosis refers to the analysis and diagnosis of students' learning situation before the start of formal classroom instruction, which provides support for subsequent sessions [17]. Pre-course learning diagnosis is the link with the highest degree of student participation in the pre-course stage, where students need to complete learning assignments such as introductory content, video learning, and pre-course tests. The computer collects the data generated by students in the process of completing learning tasks, and cleans, classifies, and integrates the data to form a visual analysis report and feedback it to the teacher. The teacher analyzes and diagnoses the learning situation based on previous experience data and machine feedback data to understand the learning situation. When designing teaching, the teacher designs the teaching framework based on the pre-course semester diagnosis results, including teaching topics, teaching steps, and evaluation methods. The computer synchronously generates a preliminary teaching framework for the reference of classroom teachers. At the same time, the computer establishes the mapping relationship between the resources and the teaching objectives and learning needs according to the label of the digital resources, and pushes the resources to the teachers according to the results of the pre- course diagnosis of the learning situation. Then teacher redevelops and optimizes the resources, reconstructs the structured teaching content, and pushes the resources to students or classroom use.

4.2. The during-course stage of classroom teaching

The during-course stage of human-computer collaborative instruction includes two important instructional links, learning monitoring and classroom instructional organization. Learning monitoring is a prerequisite for accurate classroom teaching interventions. The computer automatically collects and analyzes data on students' learning behaviors in the classroom, and the teacher analyzes and diagnoses the data based on classroom observation, communication, and computer feedback to carry out classroom organization and management.

Embedded human-computer collaborative instruction is appropriate when learning in the classroom is dominated by declarative knowledge. Declarative knowledge in subject areas includes facts, definitions, concepts, and principles. This type of knowledge can help learners construct a basic cognitive framework for a subject, which is the basis for learning other knowledge. The mental process by which declarative knowledge enters the original knowledge system is mainly memorization. The learning needs of this type of knowledge are accuracy of information transfer and efficiency of knowledge acquisition. The embedded human-computer collaborative teaching mode refers to the setting of learning task objectives by the teacher and the embedding of intelligent educational products into the existing teaching process, which is used to enhance or automate the functions or links in the existing teaching process. In this model, teachers are responsible for setting instructional goals, developing lesson plans, designing course content, and ensuring the accuracy and depth of knowledge transfer. As an extension of the teacher's functions, the machine is mainly responsible for two parts of work. First, it replaces the teacher to perform repetitive instructional tasks, such as explaining definitions and correcting exercises. Second, it collects data from the learning platform to assist teachers in analyzing student learning data, helping teachers understand students' learning habits and difficulties, so as to design and intervene in teaching more accurately.

The Agent mode of human-computer collaborative instruction is appropriate when learning in the classroom is dominated by procedural knowledge. Procedural knowledge consists primarily of operational skills, processes, strategies, algorithms, and guidelines for determining when to use appropriate procedures. The incorporation of procedural knowledge into a prior knowledge system is typically achieved by experiencing multiple applications of rules to solve problems from different perspectives and in different ways. The learning requirements for this type of knowledge are extensive practice with variation, accurate discrimination of processes and outcomes, and feedback for procedural optimization. The Agent-based human-computer collaborative teaching mode means that the teacher sets the learning objectives and task flow, provides the learning resources, and the computer independently performs task release, monitoring, judgment, and feedback in the teaching process, and finally the teacher supervises the teaching process as well as evaluates the final learning effect. In this model, the teacher assumes the roles of supervisor and evaluator, and is responsible for the front-end design and back-end evaluation of the entire teaching process. The computer performs the teaching tasks autonomously on behalf of the teacher. On the one hand, the machine uses the learning resources and rules provided by the teacher to generate a large number of variations examples to expand the learning resource base. On the other hand, the machine assists the student in solving the task without the direct intervention of the teacher, providing learning support and academic advice.

The co-pilot mode of human-computer collaborative instruction is appropriate when learning in the classroom is dominated by strategic knowledge. Strategic knowledge emphasizes the application of knowledge and cultivates students' ability to flexibly choose or creatively apply the most appropriate methods and strategies to solve specific problems in different situations. In the co-pilot mode of human-computer collaborative instruction, the teacher and the computer are partners who participate in the classroom teaching process and play their respective roles. Teachers and computer work together to develop a personalized learning task list, and students complete the learning assignments through independent investigation and group collaboration. For students' common problems, the teacher sets solutions to be explained by the computer, students' simple individual problems are answered by the computer on a one-to-one basis, and students' complex individual problems are guided by the teacher on a personalized basis. Based on the completion of the primary teaching objectives, the machine generates challenging research assignments by analyzing data on the completion of learning assignments and the learning process of students. Teachers improve the tasks based on classroom observations, exchanges, and computer feedback data. During the instructional phase of research assignments, teachers should inspire students' ideas, supplement their knowledge, introduce methods and cues, and guide them to question, explore, and innovate. Teachers should also observe students' emotions and provide timely encouragement and guidance. The machine can provide discursive scenarios and clues for students to discuss. Finally, the teacher acts as a hub of information exchange in the organization and delivery of instruction, carrying out the necessary learning interventions, creating a learning atmosphere and regulating students' learning behavior.

4.3. The after-course stage of classroom teaching

Effective after-course evaluation must be based on a scientific and reasonable evaluation index system [18]. When designing the evaluation index system, the subject characteristics

of the course should be considered, and the evaluation index framework should be built in combination with the subjective experience of teachers, subject leaders and teaching management personnel. The computer then subdivides the index framework into measurable detailed indicators according to the teaching evaluation rules, and associates the evaluation index system with the learning data labels. Finally, teaching experts in relevant fields evaluate the applicability of the index system to the teaching scenario. During the evaluation, the computer can first conduct a preliminary evaluation according to the evaluation index system, and then restore the classroom based on the collected student learning behavior data and teacher teaching behavior data, and analyze the causes of the evaluation results. The teacher conducts a secondary verification of the evaluation based on the information collected manually during the teaching process, and provides students with after- course learning intervention measures based on the evaluation results, such as setting homework and arranging review tasks.

5. Conclusion

Human-computer collaboration is not a simple superposition of human intelligence and machine intelligence, but a collaborative approach of human-machine integration [19]. Whether human-computer collaborative classroom teaching can make computer an extension of teacher wisdom depends on the reliability of the decision-making provided by intelligent educational technology and the rationality of the human-computer collaboration model. This study argues that there are four major components of the human-computer collaborative teaching model in a smart teaching environment: teacher wisdom, student wisdom, intelligent technology product, and learning content. The way these four interact with each other will determine the efficiency and effectiveness of classroom teaching. For the three major teaching sessions before, during and after class, this study elaborates the work that should be done by teachers' wisdom and intelligent educational product according to different learning contents and the development pattern of students' wisdom. It should be noted that the effectiveness of the practical application of the human-computer collaborative classroom teaching model also relies on the degree of development of intelligent teaching information technology and the degree of improvement of the relevant ethical statutes. These two will affect the degree of mutual trust between teachers and computer in classroom teaching and hinder the effective implementation of human-computer collaboration in classroom teaching.

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