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TOWARDS SUSTAINABLE INNOVATION IN LANGUAGE EDUCATION: EXPLORING KEY FACTORS INFLUENCING TEACHER SATISFACTION WITH MAN-MACHINE COLLABORATIVE TEACHING

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ABSTRACT

This study investigates the key factors influencing the implementation of man-machine collaborative teaching and explores college English teachers' satisfaction with this innovative pedagogical model. Drawing on a quantitative approach, data were collected from 250 college English teachers across 12 universities in China. The findings reveal five critical factors shaping the effectiveness of man-machine collaboration: teachers' artificial intelligence literacy, availability of teaching hardware and software support, preparation of teaching techniques, the presence of an effective incentive and evaluation system, and access to professional training. Among these, professional training was reported as the most satisfactory element, while other aspects—particularly technological infrastructure and institutional support—were rated significantly lower. These disparities highlight challenges in achieving sustainable integration of technology in language education. From the perspective of educational innovation, this research underscores the need for comprehensive, teacher-centered strategies that not only introduce technological tools but also ensure long-term support systems to foster equitable and effective digital transformation in education. The findings contribute to the discourse on sustainable educational models by identifying essential components for successful human-technology symbiosis in teaching practices.

Introduction

In Chinese universities, College foreign language course is a compulsory course for almost all college students who are not English majors or English- related majors, and most of them choose College English as their foreign language course(Su, 2022; Teng et al., 2022), indicating that College English learning is a course that essentially involves the majority of college students. However, many scholars have pointed out that traditional College English courses face numerous challenges, such as limited teaching and learning resources, monotonous instructional methods, lack of authentic and practical learning environments, and difficulties in achieving individualized instruction. (Hou, 2021; Yao et al., 2022; Zang & Wang, 2021; Zou et al., 2021).

The development of modern teaching technology has had a profound impact on front-line college English teaching, especially in recent years, the technology of language models represented by Deepseek, DouBao has achieved breakthrough progress. Undeniably, those applications empowered by large language models provide possible solutions in solving problems that faced by college English teaching. The man-machine collaborative teaching model is expected to break through the traditional teaching predicament, provide students with better learning resources and learning experiences, and enhance teaching effectiveness. Those

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AI generated instruments have been continuously expanding and gradually penetrating into the field of education and entering in the front-lines classrooms. This has not only brought about brand-new opportunities for foreign language education but also triggered numerous challenges. In this research, one of the challenges to be explored is college English teachers' satisfaction with implementing man-machine collaborative teaching.

The development and integration of modern teaching technologies into classroom teaching have gradually become a research hotspot and trend in recent years. Increasingly, scholars are focusing on the field of man- machine collaborative teaching. A review of existing studies reveals that current research primarily concentrates on the following two aspects. The first aspect explores the theories supporting man-machine collaborative teaching, focusing on its core concepts and definitions(Fang et al., 2023; Wang, 2022; Yang et al., 2025) . The second aspect mainly focuses on the construction and implementation of man-machine collaborative teaching(Chi, 2022; Wang, 2022; Xie et al., 2024; Yang et al., 2025). However, few studies have examined the influencing factors from the teachers' perspective. This research aims to fill that gap by investigating these factors and evaluating college English teachers' satisfaction with man-machine collaborative teaching.

Many researchers pointed out that conducting the man-machine collaborative teaching requires teachers' AI literacy(Fang et al., 2023; Mi & Li, 2024; Zhao & Yang, 2024) . Besides, the availability and quality of teaching hardware and software significantly influence the effectiveness of man-machine collaborative teaching(De Giorgio et al., 2017; Dengel et al., 2021). Furthermore, the development of specific teaching techniques also plays an important role in facilitating such collaboration(Shang & Sivaparthipan, 2022; Xie et al., 2024). The incentive mechanism and evaluation system influence the man-machine collaborative teaching positively(Liu et al., 2024). Since man-machine collaboration involves integrating modern teaching technologies into classroom instruction, timely and appropriate training for teachers is essential(Fissore et al., 2024; Henze et al., 2022).

Based on the previous studies, it can be found that teachers' artificial intelligence literacy, support from teaching hardware and software, preparation of the teaching techniques, Incentive mechanism and evaluation system, professional training for teachers are key factors influencing teachers' implementation of man-machine collaborative teaching. This study adopts these five factors to construct a questionnaire aimed at investigating college English teachers' satisfaction with conducting man-machine collaborative teaching.

Materials and Methods

This study adopted a quantitative method to explore the factors that influence English teachers in conducting man-machine collaborative teaching. This research tries to identify the objective factors instead of subjective factors; therefore, a quantitative method is deemed appropriate. The research instrument used was 5-point Likert scale questionnaire designed to investigate the influencing factors of implementing man-machine collaborative teaching. There are 5 dimensions in the instrument, namely teachers' artificial intelligence literacy, teaching hardware and software support, preparation of the teaching techniques, Incentive mechanism and evaluation system, professional training for teachers**.** Each dimension contains five items, resulting in a total of 25 items in the entire instrument.

Participants

Generally speaking, universities can be categorized into two types: public and private. This study selects 6 public universities and 6 private universities, totaling 12 institutions as the research targets. Among these 12 universities, a total of 702 college English teachers are involved. According to Krejcie and Morgan (1970), the minimum required sample size for this population is 249. This research randomly chooses 250 college

English teachers as participants to investigate the factors influencing their implementation of man-machine collaborative college English teaching. The purpose of the research, the data collection process, and the use of data will be clearly explained to the participants. Most importantly, their rights throughout the research process will be emphasized. In short, this study will strictly follow ethical guidelines, ensuring voluntary participation, informed consent, confidentiality, and the right to withdraw at any stage.

Pilot study

The 5-point Likert scale used to explore the factors that influencing College English teachers conducting man-machine collaborative teaching was developed for this research. As this instrument would be used to collect primary data, conducting a pilot study before formal investigation was quite necessary. Prior to its formal use, a pilot test was conducted to verify the reliability and validity of the instrument. A pilot study is commonly used to evaluate the reliability and validity of a questionnaire before large-scale data collection. Generally, the sample size for a pilot test should be at least one-tenth of that used in the formal study. In this research, 250 participants were selected for the main study; therefore, 30 participants were chosen for the pilot test (Praharaj & Ameen, 2024).

For the validity test, expert validation is used to ensure the validity of the instrument(Elangovan & Sundaravel, 2021). Experts pointed out the second item in teachers' artificial intelligence literacy part, the sixth item in teachers' personal development in part, the fifth item in professional training for teachers' part had a weak correlation to the purpose of this investigation and were recommended for deletion. After the removement, the expert feedback indicated that the remaining items in the instrument were clear and easy to understand. The number of items was considered appropriate—neither too many to cause respondent fatigue, nor too few to insufficiently address the research objectives. The questionnaire contained relatively few obscure or overly technical terms. Overall, expert validation confirmed that the instrument demonstrated good content validity. For the reliability test, Cronbach's alpha was used to assess internal consistency of the instrument(Ahmad et al., 2024). Normally, the value of Cronbach's alpha is higher than 0.6, indicating that the instrument has an acceptable reliability(Suhartini et al., 2021) . In addition, the KMO (Kaiser- Meyer-Olkin) measure and Bartlett's test were used to assess construct validity. According to Kaiser (1970), a KMO value above 0.6 indicates acceptable validity. In this research, the value of KMO was 0.626, and the p value was 0.004 which was lower than 0.05, indicating that the instrument was suitable for conducting factor analysis(Kaiser, 1970). To conclude, the results of the pilot test suggest that the instrument used in this study possesses good reliability and validity and is therefore appropriate for use in the formal research.

Results and Discussion

A total of 250 college English teachers were randomly selected to participate in the investigation. Among them, 224 participants were female and only 26 were male, indicating that the number of female participants was significantly higher than that of male participants. This aligns with the actual situation in college English teaching, where female teachers significantly outnumber male teachers. Regarding age distribution, 24 participants were aged 20–29, 132 were aged 30–39, 91 were aged 40–49, and 3 were aged 50–59. It can be observed that the 30–39 age group represents the largest proportion of participants, followed by the 40–49 age group. The smallest group comprises participants aged 50–59. Overall, more than half of the respondents are between the ages of 30 and 49. In terms of university affiliation, 128 participants were from public universities, while 122 were from private universities. In summary, the 250 participants in this study represent a range of demographic variables, including gender, age group, and university type. The details of the demographic variables are presented in table 1.

Demographic Information	Variables	Numbers	Percentage (%)
Gender	Female	224	89.6%
	Male	26	10.4%
Age group	20-29 years old	24	33.6%
	30-39 years old	132	40.3%
	40-49 years old	91	24.0%
	50-59 years old	3	2.1%
Type of universities	Public University	128	51.2%
	Private University	122	48.8%

Table 1. demographic variables in this research

A total of 250 questionnaires were distributed in this research, and all were successfully retrieved, resulting in a 100% response rate. Among the 250 returned questionnaires, 238 were considered valid, while 12 were deemed invalid based on manual screening (due to highly consistent answers and excessively short response times). Therefore, the valid response rate was 95.2%. This study first analyzes the mean scores of college English teachers' satisfaction with conducting man-machine collaborative English teaching. The detailed mean values for each dimension are presented in Table 2.

	Professional training for teachers	Teaching techniques	Teachers' artificial intelligence literacy	Incentive mechanism and evaluation system	Teaching hardware and software support
Mean	3.866	2.350	2.369	2.498	2.312
N	238	238	238	238	238
Std. Deviation	.3762	.3568	.3508	.3561	.3324

Table 2. the mean value of English teachers' satisfaction

As is shown in table 2, the mean value for professional training for teachers' part is 3.866. The mean value for teaching techniques' part is 2.350. The mean value for teachers' artificial intelligence literacy's part is 2.369. The mean value for incentive mechanism and evaluation system' s part is 2.498. The mean value of teaching hardware and software support is 2.312. It could be found that, college English teachers' satisfaction with the professional training got a high score of 3.866, indicating that teachers are satisfied with the professional training. Many scholars pointed out that with the development and popularization of artificial intelligence, various accessible training opportunities have become increasingly available(Li et al., 2017; Lu, 2019; Maity, 2019). In terms of training format, both online and offline modes are commonly offered to meet teachers' professional development needs (Li, 2024). College English teachers could choose

the most convenient method for receiving training. From the perspective of training organizers, there were unified training programs at the national level, as well as various sessions organized by provinces, cities, universities, industries, and professional associations. In terms of training requirements, some programs were mandatory, requiring college English teachers to participate, while others were optional, allowing teachers to choose based on their individual needs. Regarding the target participants, some training content was relatively general and open to all teachers regardless of discipline, whereas other programs were specifically tailored for English teachers. The quantitative data indicate that college English teachers had easy access to training related to man-machine collaborative teaching and reported high satisfaction with the training provided—both in terms of the relevance of the content and its alignment with current technological developments.

However, the mean values of all the other dimensions were below 3, including teaching techniques, teachers' artificial intelligence literacy, incentive mechanisms and evaluation systems, and teaching hardware and software support. This indicates that these aspects did not meet the satisfaction levels of college English teachers. Among the four dimensions with mean values below 3, teaching hardware and software support had the lowest score. Many scholars have also pointed out that some hardware facilities in universities are outdated. Furthermore, some software systems are also lagging behind, for example, due to limited access permissions for certain applications.

Apart from teaching hardware and software support, which had the lowest mean score, the second lowest was the teaching techniques dimension. The adoption of man-machine collaborative English teaching has posed challenges to traditional college English instruction. New teaching techniques need to be developed and adapted to align with the shift toward AI-powered teaching, which is both inevitable and increasingly prevalent. These new techniques should fully integrate the advantages and convenience of AI-enabled applications to better achieve educational goals, expand the breadth and depth of course content, promote classroom teaching reform, and enhance students' overall English proficiency.

The teachers' artificial intelligence literacy was also relatively low. As previously mentioned, teachers' AI literacy plays a dominant role in implementing man-machine collaborative English teaching. The results indicate that although college English teachers generally possess a basic understanding of foundational AI concepts, their technical skills, practical application abilities, and capacity for innovation remain insufficient. In contrast, college students often demonstrate a strong ability to embrace new technologies and use them independently. If the integration of modern teaching technologies is merely superficial and mechanical—such as being abruptly layered onto traditional classroom teaching—then this approach simply incorporates artificial intelligence for its own sake. It fails to achieve the true purpose of man-machine collaborative teaching, which is to enhance the quality and effectiveness of classroom instruction. In essence, such an approach is indistinguishable from traditional English teaching in terms of substance; the difference lies only in form.

Furthermore, the incentive mechanism and evaluation system also deserve special attention, as this dimension received a relatively low score. Man-machine collaborative teaching needs to be firmly rooted in frontline teaching practice, and both incentive mechanisms and evaluation systems are indispensable in this process. A well-designed and practical incentive mechanism can provide positive guidance and a clear value orientation for college English teachers to explore the application of man-machine collaborative teaching—based on students' real needs and learning backgrounds. In addition, the development of a mature evaluation system can serve as a guiding tool to help teachers reflect on and improve their implementation of man-machine collaborative teaching. It can further standardize and enhance the quality of their instructional practices. To sum up, based on the results of the descriptive statistics, it can be concluded that college English teachers' satisfaction with the professional training dimension was relatively high. Therefore, such training should be continuously improved

and updated to keep pace with the times, ensuring strong support for the practice and application of man-machine collaborative teaching. At the same time, other influencing factors that received lower satisfaction scores should be addressed to ensure balanced development. Greater attention should be paid to the development of effective teaching techniques to facilitate implementation. A targeted incentive mechanism and evaluation system should be formulated and improved. The updating of teaching hardware and software must be accelerated, and teachers' artificial intelligence literacy should be purposefully cultivated..

Conclusions

This research aims to figure out the factors influencing college English teachers' conduction of man-machine collaborative teaching. The research findings indicate that teachers' artificial intelligence literacy, teaching hardware and software support, preparation of the teaching techniques, Incentive mechanism and evaluation system, professional training for teachers, are the five key factors that influence the application of man-machine collaborative teaching by college English teachers. Based on the five factors, a 5-point Likert scale was developed to investigate college English teachers' satisfaction on conducting man-machine collaborative college English teaching. The results reveal that apart from professional training—which received generally positive feedback—college English teachers reported relatively low satisfaction with the other four areas, indicating a need for further improvement.

However, this study has several limitations. First, due to time constraints, there were shortcomings in the research design and process that need further refinement in future work. The primary limitation lies in the limited sample size, as only 250 college English teachers from 12 universities were included. Thus, whether the research conclusions are universal or not needs to be further explored. Secondly, the study relies solely on quantitative methods to assess teacher satisfaction. Future research should incorporate qualitative approaches to gain deeper insights into college English teachers' experiences and perceptions regarding man-machine collaborative teaching.

Declaration of Conflicting Interest
The authors state that there is no conflict of interest concerning the publication of this paper.

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