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Assessment of Intelligent Teaching Preparation of EFL Teachers: Based on Two-Year Data Comparison

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Abstract: In order to guide the effective application of artificial intelligence (AI) in education (AIEd), China has set up a number of national AI education demonstration areas (AIEDA). Teachers in this AIEDA have carried out action research about AIEd for over two years. For the purpose of assessing teachers' intelligent teaching preparation during the process, we conducted consecutive two years of evaluation through questionnaires and AI-based teaching platform data. This study developed a questionnaire of teachers' intelligent teaching preparation, including teachers' perception of and behavioral intention to AIEd, AI technological pedagogical and content knowledge (TPACK), and AI ethics knowledge. Besides, the data obtained from an AI-based teaching platform were analyzed, which indicated teachers' acceptance and trust towards AIEd. A total of 101 valid samples of English as a foreign language (EFL) teachers participated in data collection for two years. The results showed that teachers' trust in AIEd increased, but their effort expectancy and perception of facilitating conditions of AIEd decreased; Teachers' AI ethics knowledge increased, while their self-report TPACK decreased.

Keywords: Artificial intelligence, EFL teacher, intelligent teaching preparation, AI education demonstration area

1. Introduction

Artificial intelligence (AI) is shaping the education sector and has become an important area of research across the world (Khan et al., 2021). Various countries such as the United States (National Science and Technology Council, 2016), the United Kingdom (Department for Science, Innovation and Technology et al., 2017), France (Government Francais, 2017), and Japan (Headquarters for Japanese Economic Revitalization, 2016), are deploying AI technologies in education. China has designated AI education demonstration areas (AIEDA) to explore the use of AI for subject learning (An et al., 2022), and promote the development of teachers' preparation of AI in education (AIEd) (The Teachers' Office of China, 2018). Teachers in K-12 schools in the AIEDA have leveraged AI affordances through multiple AI tools to facilitate personalized learning and immediate feedback since 2020 (An et al., 2022). The integration of AI into education has presented new challenges to teachers, it is crucial to assess the preparedness of teachers in AI environment.

However, existing research on the AIEd environment has primarily focused on students, while research on teachers remains significantly lacking (Liang et al., 2021). Teachers need to be prepared to embrace the changes brought about by AI and work towards developing their own skills and knowledge to meet the demands of the modern-day classroom. Assessing the preparedness of teachers in AI environment can provide them with targeted suggestions for improvement. Therefore, teachers' intelligent teaching preparations was studied in this research to fill the research gap. Intelligent teaching refers to the application of AI technology and algorithms by teachers to optimize the teaching and learning process and improve students' learning outcomes (Celik, 2023; Liu, 2020).

This study aimed to evaluate teachers' preparation to incorporate AIEd by examining both external and internal factors (An et al., 2022). The Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) accounts for the perceptions of technology from users' viewpoint and was therefore used to explore teachers' perceptions and acceptance of AIEd as external factors. The

intelligent Technological Pedagogical and Content Knowledge (iTPACK) framework (An et al., 2022; Celik, 2023) was used to assess teachers' knowledge of AIEd as internal factors. The study conducted a two-year longitudinal survey of the same group of teachers and collected data from both questionnaires and an AI teaching platform to provide a more comprehensive assessment.

2. Conceptual framework

2.1 UTAUT

UTAUT is a widely used model for understanding users' acceptance and usage of new technologies. It was proposed by integrating the Technology Acceptance Model (TAM) and seven other models. It has been shown to explain up to 70% of the variance in predicting users' behavioral intention to use new technology (Venkatesh et al., 2003). UTAUT surveys various factors, including performance expectation, effort expectation, social influence, facilitating condition, users' behavioral intention, and behavior. The definitions of these factors are shown in Table 2. Due to its effectiveness, UTAUT has been widely used in education field (Hsu, 2022). As AI technology is increasingly used in education, UTAUT could be applied to assess students' acceptance of AIEd. For instance, An et al. (2022) developed a questionnaire based on UTAUT, and explored teachers' behavioral intention to use AIEd systems and its related factors. However, there is still a lack of annual follow-up surveys on teachers, making it difficult to demonstrate the changes in teachers' perceptions and acceptance under the rapid development of AI technology. In this study, UTAUT was adopted to explore teachers' perceptions and acceptance of AIEd in two years.

2.2 iTPACK

Technological Pedagogical Content Knowledge (TPACK) is a framework that describes the knowledge that teachers need to effectively integrate technology into their teaching practices. Developed by Mishra and Koehler (2006), TPACK comprises three core areas of knowledge: technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). These three types of knowledge are interrelated and combine to form Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and TPACK. TPACK provides a framework for professional development, helping teachers to identify areas where they may need to strengthen their knowledge and skills. By leveraging this framework, teachers can effectively integrate technology into their teaching practices.

When AI entered education, a series of ethical issues have appeared. It is believed that teachers should master AI ethics knowledge as well as TPACK. Celik (2023) proposed iTPACK framework, including teachers' TPACK and ethics knowledge. Teachers should have a rational understanding of the ethical issues in AIEd, such as privacy, fairness, and responsibility (Feng et al., 2020). In the process of integrating AI into teaching, teachers need to ensure that they consciously abide by social moral norms in information activities, pay attention to privacy and data security, and deal with issues related to information cocoon, data privacy, AI bias and ethical decision-making in a targeted way (Burton, 2017). However, previous studies typically only conducted one-time surveys, making it difficult to present the knowledge development of teachers in AI environments. In this study, we would conduct a follow-up survey on teachers' knowledge based on iTPACK framework to fill the research gap.

3. Methods

3.1 Participants

The participants of this study are teachers of English as foreign language (EFL) in middle school in Dongcheng District, one of the AIEDA in China. In Dongcheng District, the Information Office of the Education Commission, the Education Science Research Institute, universities, and enterprises are cooperating to promote the integration of AI and teaching among middle school EFL teachers. Teachers

conducted action research to explore the integration of AI and EFL subjects in this district. Each teacher is guided by three interdisciplinary experts, which includes an EFL expert, an educational technology expert, and a scientific research expert, contributing to the development of intelligent teaching preparation among teachers.

To assess the development of teachers' preparation for AIEd, questionnaires and AI teaching platform (E-listening and speaking, https://www.ets100.com/home/perintro.html) data analysis were used in this study. Teachers can assign a variety of exercises, which are automatically fed back by the AI to students, and the teacher can also give feedback on the platform. A total of 354 EFL teachers' AI teaching platform data was collected on April 30, 2022, including the users' data in the period of January 1, 2021 to April 30, 2022.The first questionnaire was conducted from November 3, 2021 to November 9, 2021, and the second questionnaire was conducted from December 5, 2022 to December 14, 2022. A total of 101 EFL teachers who effectively participated in both surveys were selected, while samples with duplicate options for all scale questions were deleted. The basic information of the respondents is shown in Table 1.

Table 1. *Demographic Information of Participants*

Demographic Profile	Classification	Number	Percent (%)
Sex	Male	2	1.98%
	Female	99	98.02%
Year of Birth	1960-1969	6	5.94%
	1970-1979	36	35.64%
	1980-1989	39	38.61%
	1990-1999	24	23.76%
Year of Starting Teaching	1981-1989	4	3.96%
	1990-1999	20	19.80%
	2000-2009	37	36.63%
	2010-2019	30	29.70%
	2020-2021	10	9.90%

3.2 Instrument

The questionnaire was developed mainly referred to An et al (2022) and Celik (2023), including teachers' perception of and behavioral intention to AIEd based on UATUT, and teachers' knowledge preparation of AIEd based on iTPACK framework. Table 2 lists the constructs and item examples of the questionnaire. Five-point Likert scale was adopted in the questionnaire, with 1 representing strongly disagree, 2 representing disagree, 3 representing general, 4 representing agree, and 5 representing strongly agree. Based on the relevant literature and theory development, the scale was reviewed and filled out by two educational technology experts, one staff member of the Education Commission of Dongcheng District, two junior high school English teachers, and modified according to the feedback to ensure the content validity.

Table 2. *Structure of Teacher Intelligent Teaching Preparation Assessment Scale*

Dimension	Sub-Dimension	Definitions	Sample item
UTAUT	Performance Expectancy (PE)	Performance Expectancy means the degree to which a teacher believes that using the AI system will help him or her attain gains in job performance (Venkatesh et al., 2003).	AI can help me improve the quality of teaching.
	Effort Expectancy (EE)	Effort Expectancy means the degree of ease associated with the use of an AI system (Venkatesh et al., 2003).	I think AI teaching systems are very simple.

	Facilitating Conditions (FC)	Facilitating Conditions means the degree to which a teacher believes that an organizational and technical infrastructure exists to support the use of the AI system (Venkatesh et al., 2003).	When I need to use AI in teaching, my school will provide help for me.
	Social Influence (SI)	Social Influence means the degree to which an individual perceives that important others believe he or she should use the new system (Venkatesh et al., 2003).	My colleagues think I should use AI to support teaching..
	Behavioral Intention (BI)	Behavioral Intention means the beliefs teachers have about the AI using behavior under consideration (Davis, 1989).	I intend to use AI in teaching in the future.
iTPACK	AI language technological knowledge (AI-TK)	AI-TK means knowledge about AI technologies in language fields (Schmid et al., 2020).	I know that speech recognition technology can score pronunciation accuracy, fluency, and phonological tone type.
	AI technological pedagogical knowledge (AI-TPK)	AI-TPK means knowledge of how teaching may be changed as the result of using AI technologies (An et al., 2022).	I know how to use AI tools to meet students' differentiated learning needs.
	AI technological content knowledge (AI-TCK)	AI-TCK Knowledge about how AI technology and subject content relate to each other (Schmid et al., 2020).	I know how to use AI to help students learn vocabulary.
	AI technological pedagogical content knowledge (AI-TPACK)	AI-TPACK means knowledge for teaching with AI technology which requires an understanding of how AI technologies can support teaching subject matter (An et al., 2022).	I know how to use the strategy of personalized guidance to improve students' English skills with the help of AI.
	AI ethics	AI ethics means that teachers can consciously abide by social moral norms in AI-supported teaching activities, have a rational understanding of ethics and safety issues in the process of integrating AI into education and teaching, pay attention to the threat of AI to education ethics and safety and properly deal with it (An et al., 2022).	I will pay attention to the privacy of students' data when using AI.

3.3 Data analysis

Following data collection, the reliability and structural validity of the survey scale were evaluated. Data analysis includes two parts: Confirmatory Factor Analysis (CFA) and reliability analysis. Reliability analysis of the scale was conducted with SPSS20.0, while CFA was conducted with Mplus 8.3.

The standards recommended by Hair et al., (2014) were adopted in the CFA. Accordingly, indices of χ^2/df (< 5), Root Mean Square Error of Approximation (RMSEA) (< 0.10), Comparative Fit Index (CFI) (> 0.90), and the Tucker-Lewis Index (TLI) (> 0.90) were utilized to assess the model fit. To examine the convergent validity of the scale, factor loadings (λ) were employed to calculate Average Variance

Extracted (AVE) (>0.5) and Construct Reliability (CR) (>0.7). Discriminant validity of the scale was determined by comparing the square root values of AVEs of components with the correlations between components.
In the reliability analysis of the scale, Cronbach's α value was calculated to assess the internal consistency coefficients. The Cronbach's α value of the entire scale and all sub-scales should be above 0.7 (Fornell & Larcker, 1981).

4. Results

4.1 Validity and Reliability

To verify the structural validity of the scale, CFA was carried out. The model fit indices were assessed, with a χ^2/df of 3.001 (< 5.0), RMSEA of 0.091 (< 0.10), CFI of 0.916 (> 0.90), and TLI of 0.901 (> 0.90), indicating an acceptable fit for the scale items. Standardized factor loadings ranged from 0.719 to 0.949, all falling within an appropriate range. Additionally, the AVE values exceeded 0.5, and the CR was higher than 0.7, indicating good convergent validity. Discriminant validity was also confirmed, with the square root values of AVE for each component exceeding the respective inter-component correlations. Furthermore, the reliability coefficient Cronbach's α of subdomains ranged between 0.880 and 0.939, with an overall reliability of 0.952, indicating high internal consistency. In conclusion, the scale has good validity and reliability.

4.2 Acceptance and Trust for AI Teaching Platform

The real teaching behaviors of teachers are analyzed with the help of backend data from AI teaching platform. The two kinds of backend data (number of assign homework and number of check homework) represent two commonly used functions for teachers on the platform. The results are shown in Table 3. In 2022, the average monthly number of teachers using this platform to assign homework has increased significantly compared with 2021, but the proportion of teachers checking homework is declining. This indicates that teachers' acceptance of the AI teaching platform is increasing, and their trust in the automatic feedback function of the platform is also increasing.

Table 3. *The use of an AI teaching platform by EFL teachers in Dongcheng District*

Classification	Average in 2021	Average in 2022	Growth Rate
Number of assign homework (AH) /month	6.29	16.21	157.69%
Number of Check homework (CH)/month	1.96	2.74	39.97%
AH/CH (%)	31.18	16.94	-45.68%

4.3 UTAUT of AIEd

In order to learn more about the situation of teachers, this study conducted a questionnaire survey. Samples of scale questions in the questionnaire are normally distributed (range of kurtosis is [-1.441, 1.254], range of skewness is [-0.463, 0.394]), so it is possible to conduct paired sample t-tests for two years of teacher scale data. The scores of various dimensions and the different test results of UTAUT of middle school EFL teachers in 2021 and 2022 are shown in Table 4. There was no significant difference in the three dimensions of teachers' performance expectancy, social influence and behavioral intention in the two-year survey, while the scores of effort expectancy and facilitating conditions in 2022 were significantly lower than those in 2021.

Table 4. *Analysis on the difference of UTAUT scores of middle school EFL teachers in 2021 and 2022*

Items		M	MD	SD	95% confidence interval		t	Sig.
					lower	upper		
Pair 1	Performance Expectancy 2021	4.15	0.02	0.59	-0.09	0.14	0.41	0.68
	Performance Expectancy 2022	4.12						
Pair 2	Effort Expectancy 2021	3.75	0.15	0.67	0.02	0.28	2.25	0.03
	Effort Expectancy 2022	3.60						
Pair 3	Facilitating Conditions 2021	3.74	0.15	0.69	0.02	0.29	2.24	0.03
	Facilitating Conditions 2022	3.58						
Pair 4	Social Influence 2021	3.63	0.05	0.71	-0.09	0.19	0.67	0.51
	Social Influence 2022	3.58						
Pair 5	Behavioral Intention 2021	4.03	-0.01	0.58	-0.13	0.10	-0.22	0.83
	Behavioral Intention 2022	4.04						

4.4 iTPACK

The specific scores of iTPACK of EFL teachers in 2021 and 2022 are shown in Table 5. There is no significant change in TK and TCK, but TPK and TPACK are significantly lower in 2022 than in 2021. In the meanwhile, teachers' knowledge of AI ethics improved significantly in 2022 compared with 2021.

Table 5. *Analysis on the difference of iTPACK scores of middle school EFL teachers in 2021 and 2022*

Items		M	MD	SD	95% confidence interval		t	Sig.
					lower	upper		
Pair 6	TK2021	3.61	0.11	0.78	-0.04	0.27	1.48	0.14
	TK2022	3.50						
Pair 7	TPK2021	3.62	0.30	0.64	0.17	0.42	4.63	0.00
	TPK2022	3.32						
Pair 8	TCK2021	3.70	-0.07	0.82	-0.23	0.09	-0.82	0.41
	TCK2022	3.76						
Pair 9	TPACK2021	3.84	0.22	0.71	0.08	0.36	3.11	0.00
	TPACK2022	3.62						
Pair 10	AI Ethics2021	3.60	0.58	0.63	0.46	0.70	9.40	0.00
	AI Ethics2022	4.18						

5. Discussion

5.1 Teachers' trust in AI has increased, as has their expectation for the development of technology environment

According to the teachers' behavior data collected from the AI teaching platform, teachers' trust and acceptance of AI are improving. This is the real behaviors of teachers using AI teaching platforms, indicating that teachers have felt the reliable help of AI. However, compared with two years of questionnaire survey results, it can be seen that teachers' perceptions of effort expectancy and facilitating conditions are declining. This indicates that with the deep integration of AI and subject teaching, teachers have diversified and high-level demands in practice, and their expectations and requirements for AI teaching products are increasing, while the support of intelligent teaching software and hardware environment increasingly lags behind teachers' expectations. In the future, we should continue to promote the improvement of AI EFL teaching products, strengthen the support services of technical personnel, and escort the practice of the integration of AI and education for teachers.

5.2 Teachers' self-report AI pedagogical knowledge declined, but AI ethics knowledge improved

From the comparison results of two years, the scores of teachers in AI ethics knowledge increased, while TPK and TPCK of self-evaluation decreased. This indicates that with the development of expert training and teacher action research, teachers have a more prudent attitude towards AI ethics issues, such as the information cocoon, privacy disclosure, decision-making bias, and accountability difficulties. However, the scores of teachers' self-report AI technological pedagogical knowledge declined. It might be because that EFL teachers have realized their shortcomings in AI-assisted pedagogical knowledge as AI integrates with EFL deeper and deeper. In the follow-up practice, more attention should be paid to teachers' ability to improve AI-supported teaching, so that they can use AI to implement more teaching strategies and carry out personalized and precise teaching.

6. Implications

This study showed the current situation and development of teachers' intelligent teaching preparation in AIEDA in China. This study provides evaluation instruments for teachers' intelligent teaching preparation in the process of AI and subject integration, and the research findings provide a practical reference for the integration of AI and education in K-12 further. At the teacher level, this study provides teachers with tools for self-evaluation and self-reflection, points out the direction for their future professional ability development, and provides a guarantee for their independent and professional action research.

Due to space limitations, this study does not present the evaluation content of qualitative data such as interviews and analysis of subject text data. In addition, promoting the development of students is the fundamental purpose of integrating AI technology into education and teaching. This study lacks the evaluation of teachers from the perspective of students, which needs to be improved continuously in the future.

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