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Generative Artificial Intelligence Preparedness and Technological Competence

-- Towards a Digital Education Teacher Training Program

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Abstract: This research aimed to understand the technological competence and readiness of teachers at Hunan Normal University, Hunan Province, China regarding generative artificial intelligence (GAI). The main objective was to gauge the current state of teacher technological competence and strategize on enhancing their skills amidst rapid technological progress in education. Utilizing an adapted computational thinking scale from Korkmaz et al. (2017), the study evaluated the Generative Artificial Intelligence (GAI) preparedness using a four-point Likert-scale. High scores were indicative of better preparedness. Another instrument adapted from Syn-Jong and Yuhue Chang's 2016 study assessed teachers' technological proficiencies. This research sought to introduce a program boosting the technological competence of university teachers, drawing inspiration from knowledge management theories and analyzing determinants of its effectiveness. The program aims to facilitate systematic training, enabling educators to master generative AI tools, comprehend best teaching practices, and promote collaboration. Key findings included: A significant proportion of female teachers aged 41-50 are from the Colleges of Chemistry, Chemical Engineering, and Commerce. The evident preparedness amongst teachers implies the positive potential of GAI in education.Gender discrepancies exist in GAI preparedness, suggesting gender-biased perceptions.Teachers displayed high technological competence, indicating their ease with technology integration.Female educators might be more technologically aware due to factors like ease of technology integration and intensive training. Younger teachers seem more tech-savvy, and teachers from different departments exhibit varied technological proficiency.A direct relationship was observed between GAI preparedness and technological competence, suggesting those trained in GAI might have superior technological competency.Recommendations based on the study:Promote continuous professional development and encourage more collaborative efforts.Utilize the technological strengths of female teachers, fostering mentorship and balanced knowledge sharing.Strengthen support for teachers in their technological endeavors, promoting workshops and online collaborations.Provide specialized training for the College of Physical Education teachers to enhance their tech skills.Innovate teacher education initiatives to improve GAI preparedness and technological competence.Implement the proposed digital teacher training program centered on GAI, equipping teachers to seamlessly integrate GAI into their classrooms, promoting innovative and flexible teaching methods.

Keywords: Generative artificial intelligence, Technological competence, Digital education, Teacher training.

1. The Issue and Its Context

1.1. Introduction

Driven by the digital revolution, artificial intelligence is transforming all aspects of our work, life and learning, with generative artificial intelligence becoming a much-anticipated paradigm with the unique ability to produce creative output. Generative AI has been widely used in education, such as personalized learning and intelligent tutoring, opening up new possibilities for teaching and learning.

The effectiveness of the educational application of artificial intelligence depends not only on the technology itself, but also on the management and utilization of teachers. Therefore, it is of great significance to study the current status of Chinese teachers' competence in generative AI in order to promote the development of education.

1.2. Background of the study

In the 21st century, artificial intelligence (AI) has become an important driving force leading the development of technology, bringing far-reaching impacts in the field of education, and China has invested a great deal in the application of AI in education. In recent years, generative AI has become a hot spot, which utilizes deep learning to generate new data or content, and is considered a disruptive technology in the field of teaching.

However, the effectiveness of any technology depends on the application and support of teachers. Currently, there is a lack of research in this area in China, so it is necessary to investigate the technological readiness and capabilities of teachers to support the application of AI in education.

1.3. Problem statement

The purpose of this study is to assess teachers' readiness and technical competence in generative artificial intelligence at a teacher training college in China, and to propose a digital education training program accordingly. It focuses on: teachers' basic profiles; teachers' assessment of their readiness for generative AI; the effect of teachers' profiles as a factor on the above assessment; teachers' assessment of technological competence; the effect of teachers' profiles as a factor on the above assessment; the relationship between readiness for

generative AI and technological competence; and the implications of the study results for education informatization.

1.4. Significance of the study

This study contributes to the enhancement of teachers' competencies so that teachers and students can benefit from the pedagogical applications of artificial intelligence. The results may also provide empirical evidence for educational administrators, curriculum developers and policy makers.

2. Review of Relevant Literature

2.1. Literature on Generative Artificial Intelligence Techniques in Education

Numerous academic papers have provided valuable insights when exploring the application of generative AI in education and its impact on the competence of Chinese university teachers. In this section, we will analyze this literature in depth and explore it along four dimensions.

In terms of technological attributes, Zhu Zhiting et al. (2023) delved into the innovative learning model led by artificial intelligence from the perspective of learning paradigm. Liu, Zhifeng et al. (2023) and Huang, Ronghuai (2023) studied the impact of generative AI on knowledge production and dissemination, and pointed out that teachers need to adapt to the new teaching environment. In terms of technological applications, AI tools are profoundly changing the way learning takes place (Kohnke et al., 2023), and Alphonso (2023) explored the great potential of generative AI in the field of education. Studies have confirmed the value of AI applications in education (Boulay, 2016), for example, ChatGPT can facilitate personalized learning (Baidu et al., 2023) and create a more engaging learning experience for students (Lim et al., 2022). In terms of technological impact, Yan et al. (2017) examined the development of AI in China and globally from a global perspective, emphasizing China's position in the global application of AI in education. In terms of coping strategies, Bozkurt(2023) called for caution in the application process.Yu and Guo(2023) offered a series of recommendations to ensure the proper application of generative AI.2.2 Research related to teachers' technological competence

In the context of the development of the knowledge society, education is under pressure to transform from a traditional model to a learner-centered approach, which requires teachers to change from their traditional roles to facilitators and supporters of learning (Lin et al., 2023). To cope with this transition, teachers must master digital technologies to adapt to the new teaching and learning requirements and paradigms. Specifically, teachers' data literacy, i.e., the ability to translate data into actual pedagogical knowledge and practices (Gummer et al., 2015), plays a key role in enhancing students' digital competence and classroom interactions. However, research has also shown that the use of technology in teaching and learning is not without its difficulties.Foulger et al. (2017) emphasized the need for all teachers to be adequately trained in technology. In addition, a study by Herzalah and Haim (2022) found that technological proficiency was a significant influence on the success of online teaching. During the COVID-19 epidemic, Pozo et al. (2021) examined the digital pedagogical applications of teachers in Spain and showed that teachers mainly used pedagogical activities, while collaborative applications remained low.

2.2. Theoretical framework of the study

Based on Technology, Pedagogical and Content Knowledge (TPACK) theory, TPACK theory suggests that teachers need to integrate technological knowledge, pedagogical knowledge, and content knowledge in order to realize effective teaching practices (Mishra & Koehler, 2006). In the context of the rapid development of artificial intelligence technology, it is particularly important for teachers to adapt to new technologies. Therefore, this study intends to explore the impact of AI technology on teachers' competence from the perspective of TPACK theory, with a special focus on the application of technological knowledge. At the same time, this study will also examine the impact of pedagogical knowledge and content knowledge on teacher competence, and how the combined use of all three affects teaching effectiveness and learning outcomes.

Within this framework, the introduction of generative AI technology allows us to more comprehensively assess teachers' use of technology and how they utilize it to optimize instructional strategies and to address subject-specific content.TPACK theory emphasizes the critical role of teachers in the successful adoption of new technologies. Therefore, this study will also assess the multifaceted impact of generative AI technology on teachers' competencies in the context of their demographic characteristics. Ultimately, the study will propose appropriate teacher training programs to effectively enhance teachers' ability to adopt generative AI.

2.3. Assumptions

The following null hypotheses were formulated in this study: teachers' background factors do not lead to significant differences in their evaluations of generative AI; there are no significant differences in evaluations of technological competence when teachers' backgrounds are taken into account; and there is no significant correlation between generative AI and teachers' technological competence.

3. Methodology

3.1. Study design

A descriptive comparative correlation design was used to collect data on teachers' readiness and technical competence in generative AI through a questionnaire, and then the results were analyzed to determine the type and strength of the relationship.

3.2. Samples and sampling techniques

The ideal sample size of 169 was calculated based on 95% confidence level and 5% margin of error. Considering representativeness, the study utilized a diverse sample representing teachers of different ages, genders and colleges.

3.3. Study sites

A university in Hunan Province, China, was selected as the study site. The university is one of the key institutions for teacher education, with several colleges, about 35,000 students and 880 professors.

3.4. Research instruments

The instrument used in this study was a comprehensive questionnaire with two main sections.

The first part assessed Generative Artificial Intelligence (GAI), adapted from Korkmaz et al.'s (2017) Computational Thinking Scale. The scale contains 29 items organized into

five subfactors: creativity, algorithmic thinking, cooperativeness, critical thinking, and problem solving. The researchers used a four-point Likert scale to rate the participants' readiness for GAI, with higher scores indicating greater readiness. The reliability of the scale was assessed using Cronbach's alpha, resulting in an overall reliability value of 0.84 for the entire scale.The content of the scale had good internal consistency.

The second section assessed teachers' technological competencies, including subject matter knowledge, pedagogical representations and strategies, knowledge of student understanding, and technology integration and application. This section was adapted from a study by Hsin-Chung Chang and Yu-Huei Chang (2016) entitled "Exploring Technology Pedagogical Content Knowledge (TPACK) of Physics Teachers in Taiwanese Universities."

3.5. Data collection procedures

Data collection was completed by distributing paper or online questionnaires to the selected sample of teachers. The data were organized and coded, and then statistically analyzed using software such as SPSS.

3.6. Statistical processing of data

In this study, the collected data were analyzed using statistical software such as SPSS and the level of significance was set at 0.05.The following statistical techniques were mainly used.

3.6.1 Frequency analysis: Frequency analysis was used to determine the demographic characteristics of the teachers interviewed, including information on gender, age and college distribution.

3.6.2 Mean analysis: a weighted mean analysis was used to assess how well teachers rated their generative AI technical readiness and their own technical competence.

3.6.3 Standard Deviation Analysis: Apply standard deviation analysis to examine the degree of dispersion of each evaluation result relative to the mean.

3.6.4 Test of Significance: t-tests and ANOVA were utilized to examine whether the differences between different groups of teachers in terms of generative AI technology readiness and technology competency assessment reached statistical significance.

3.6.5 Correlation analysis: a Pearson correlation analysis was used to test whether there is a significant linear correlation between the two variables of generative AI technical readiness and technical competence.

3.7. Decision criteria

If the significance value exceeds 0.05, the null hypothesis is accepted; if the significance value is less than or equal to 0.05, the null hypothesis is rejected.

3.8. Ethical considerations

The study was conducted under the principles of safeguarding informed consent, confidentiality, and data security, and ethical approval was obtained.

4. Results, Analysis and Interpretation

4.1. Basic information about the teachers interviewed

The results showed that most of the faculty members interviewed were females (58%), mostly between the ages of 41-50 years (39.1%), from the Faculty of Chemistry and Chemical Engineering (24.3%) and the Faculty of Business (23.7%), respectively.

The higher percentage of female faculty may indicate a trend or preference in the teaching profession.The concentration of professors between the ages of 41-50 may indicate a stable and experienced faculty, while the distribution across institutions indicates the multitude of disciplines practiced. It is interesting to examine how these demographic characteristics affect the teaching dynamics and general academic climate at Hunan Normal University. (See Table 1).

Table 1. Frequency Distribution of the Respondents' Profile

Profile	Frequency	Percentage
Sex		
Male	71	42%
Female	98	58%
Total	169	100%
Age		
21-30 years old	30	17.8%
31-40 years old	46	27.2%
41-50 years old	66	39.1%
50 years old and above	27	16.0%
Total	169	100%
College Affiliation		
College of Chemistry & Chemical Engineering	41	24.3%
College of Commerce	40	23.7%
College of Educational Science	33	19.5%
College of Fine Arts	23	13.6%
College of Physics & Information Science	25	14.8%
College of Physical Education	7	4.1%
Total	169	10%

4.2. Generative AI Technology Readiness Evaluation

The level of preparedness of the teachers interviewed was generally high in terms of generative AI. The results showed that collaborative ranked first, problem solving ranked second, critical thinking ranked third, creativity ranked fourth, and algorithmic thinking was perceived to rank last among the

five indicators of generative AI.

The relatively high level of preparedness among the teachers' responses is a good indicator of the successful and positive use of generative AI in education. This suggests that teachers are eager to embrace innovation, adapt to technological advances, and utilize AI for superior learning experiences with a student-centered approach. (See Table 2)

Table 2. Summary of the Teacher Respondents' Assessment of their Generative Artificial Intelligence Preparedness

Generative Artificial Intelligence	Mean	SD	Qualitative Description	Interpretation	Ranking
1. Creativity	2.84	0.75	Agree	Highly Prepared	4
2. Algorithmic Thinking	2.80	0.74	Agree	Highly Prepared	5
3. Cooperativity	3.15	0.53	Agree	Highly Prepared	1
4. Critical Thinking	2.98	0.59	Agree	Highly Prepared	3
5. Problem Solving	3.09	0.52	Agree	Highly Prepared	2
Over-all Mean	2.97	0.46	Agree	Highly Prepared	

Legend: 3.51-4.00 Strongly Agree/Very Highly Prepared; 2.51-3.50 Agree/Highly Prepared; 1.51-2.50 Disagree/Lowly Prepared; 1.00-1.50 Strongly Disagree/Very Lowly Prepared

4.3. Differences in Respondent Teachers' Assessments of Their Readiness to Generate AI When Their Situation is Used as a Test Factor

Based on the data provided, we found significant variability in the readiness of the teachers interviewed for their generative AI. In terms of gender, male teachers rated creativity at 3.06, significantly higher than females at 2.68.They also rated critical thinking and problem solving relatively high at 3.09 and 3.21, respectively, compared to females at 2.91 and 3.00.Nonetheless, both male and female teachers rated algorithmic thinking and collaborative work relatively consistently in the range of 2.7 to 3.2 . This difference in gender-based ratings may be related to technology exposure, training opportunities, or personal attitudes toward AI. Differences by age group were less pronounced, with faculty ages 21-50 and 50+ rating between 2.55 and 3.23 on all five dimensions. Most striking was the effect of college affiliation on ratings. Faculty in the College of Physical and Information Sciences had higher levels of preparedness on all indicators, with means ranging from 3.27 to 3.82. In contrast, faculty in the School of Physical Education rated significantly lower between 1.89 and 2.31. Overall, the readiness of the faculty respondents for their generative AI varied by gender, age, and college affiliation. This provides educators and policymakers with valuable insight into how to more effectively train and support faculty to meet the challenges of AI.

4.4. Evaluation of the level of technical capacity

The findings reveal that teachers generally exhibit high levels of technological competence. In particular, their technological competence ranked first among the four indicators in terms of instructional representations and strategies. However, their competence in technology integration and application was relatively weak, ranking last among the four.

This finding implies that teachers are relatively proficient in utilizing technology for instructional presentation and planning, but when it comes to integrating technology into other teaching and learning environments, they may experience some difficulties. In order to bridge this gap, in addition to needing to master the use of technology, teachers should focus on how to integrate technology into the instructional process. Therefore, future professional development or training programs should focus more on how teachers can apply technology in real-world teaching scenarios, thus helping them not only to take advantage of technology in presenting their knowledge, but also to effectively use it to improve the learning experience of their students.

Molla and Islam's (2019) study provides further reference in this area. Despite the fact that numerous literatures have emphasized the importance of integrating educational technology in the teaching-learning process, there are still many limitations in its practical application, one of which is the lack of technological competence of teachers in the use of educational technology. (See Table 3)

Table 3. Summary of the Teacher Respondents' Assessment of their Technological Competence Level

Technological Competence Level	Mean	SD	Qualitative Description	Interpretation	Ranking
1. Subject Matter Knowledge	3.06	0.96	Agree	Highly Competent	2.5
2. Instructional Representation and Strategies	3.14	0.87	Agree	Highly Competent	1
3. Knowledge of Students' Understanding	3.06	0.90	Agree	Highly Competent	2.5
4. Technology Integration and Application	2.96	0.91	Agree	Highly Competent	4
Over-all Mean	3.05	0.55	Agree	Highly Competent	

4.5. Differences in teacher competency ratings across demographic characteristics

When we analyzed the profile of the interviewed teachers as a factor to be tested, we noticed that the differences in the interviewed teachers' assessment of their technical competence were mainly influenced by gender, age and college affiliation.

First, from a gender perspective, the data revealed that male and female teachers had different perceptions of their level of technological competence in terms of subject matter knowledge, instructional representations and strategies, understanding of student understanding, and technology integration and application. Specifically, female teachers'

mean scores on subject matter knowledge, instructional representations and strategies, and understanding of students' comprehension were 3.77, 3.80, and 3.72, respectively, while the corresponding scores for male teachers were 2.08, 2.23, and 2.14.This further suggests that, according to female teachers' own assessment, their level of technological competence is generally higher than that of male teachers. This may be due to the fact that female teachers are more comfortable using technology in their teaching practices or they have received a higher level of training on the subject. At the same time, the study also shows that women are changing their patterns of utilizing technology for personal and professional development, which is a positive trend.

Second, when we used age as a testing factor, the data indicated that teachers of different ages had different perceptions of their level of technical competence. In particular, teachers between the ages of 21-30 had mean scores of 3.38, 3.45, and 3.41 for subject knowledge, instructional representations and strategies, and understanding of student comprehension, respectively, whereas the corresponding scores for teachers over the age of 50 were 2.51, 2.76, and 2.54.This suggests that younger teachers are more comfortable with the use and integration of technology. In addition, younger teachers may have been exposed to more modern pedagogical methods during their schooling and training, making it easier to integrate technology.

Finally, from the perspective of college affiliation, the data show that teachers in different colleges have different perceptions of their technical skills. For example, faculty members in the Faculty of Chemistry and Chemical Engineering had a mean score of 3.02 for subject knowledge, while the corresponding score for faculty members in the Faculty of Physical Education was 2.43.Conversely, faculty members in the Faculty of Fine Arts had a mean score of 3.74 for pedagogical representations and strategies, while the corresponding score for faculty members in the Faculty of Physical Education was 2.54.This may be related to the educational background and training methodology of the faculty.

Overall, these data provide valuable insights into how teachers assess their technology competencies and reveal the impact of gender, age, and college affiliation on these assessments. This provides educators and policymakers with important information about how to improve teachers' technological competence and how to target training to different groups.

4.6. The relationship between teacher respondents' assessment of their generative artificial intelligence preparedness and their technological competence

Creativity and technological competence: there was no significant relationship between teachers' AI preparation in terms of creativity and their technological competence in terms of subject matter knowledge, teaching strategies, and understanding of student understanding. However, there was a significant association between the two in terms of technology integration and application.

Importance of Technology Integration: while generative AI preparation may not have had a significant impact in some areas of technology competency, its impact was more pronounced in the area of technology integration. This may mean that teachers' unique skills in this area are strongly influenced by their AI preparation.

General AI Preparation and Technology Skills: There was no significant relationship between general AI preparation in algorithmic thinking, critical thinking, and problem solving and instructional strategies and knowledge of student understanding. However, there was a significant correlation ranging from low to moderate in terms of subject matter knowledge and technology integration.

Artificial Intelligence Readiness and Technology Integration: when teachers have higher levels of AI readiness, they are more likely to integrate technology into their instruction, which may be related to their problem solving and critical thinking skills.

Collaborative and Technical Competence: in terms of collaborative, overall readiness for AI showed a moderately significant correlation with subject matter knowledge, instructional strategies, knowledge of student comprehension, and technical competence in technology integration.

Taken together, this analysis suggests that there is a relationship between teachers' generative AI preparation and their technical competence. Teachers with good AI preparation may perform better in certain technical skills. This provides valuable insights for the education sector and emphasizes the importance of including generative AI skills in teacher training.

5. Summary of Findings, Conclusions and Recommendations

5.1. Summary of findings

Female faculty members were in the majority, predominantly aged 41-50, with more faculty members in the School of Chemistry and Chemical Engineering and the School of Business. This indicates that the sample is representative.

Teachers rated themselves positively in terms of their readiness for generative AI technology, such as showing a high level of readiness in creativity and algorithmic thinking. Specifically, the average rating was 2.84 for creativity and 2.80 for algorithmic thinking. This suggests that generative AI techniques can be successfully applied in the field of education.

There are significant differences in the assessment of the readiness of teachers for generative AI technology across gender and subject backgrounds. This may be influenced by a number of factors that need to be differentiated. For example, male teachers were found to be more technologically prepared than female teachers in some areas.

The teachers interviewed also gave high ratings in terms of their ability to use technology. For example, in terms of subject knowledge, the average rating was 3.06; in terms of teaching strategies, the average rating was 3.14. This indicates that teachers are confident in utilizing various types of technology for teaching.

Gender and college background also affect teachers' judgment of their technical competence. For example, it was found that teachers from the same disciplinary background differed in their assessment of technological competence. This requires attention to the specific needs of different groups.

There was a significant moderate positive correlation between generative AI technology readiness and technology

competency level with a correlation coefficient of 0.30. This provides a reference point for teacher training.

5.2. Conclusions of the study

Teachers interviewed were generally well-prepared, laying the groundwork for the use of generative AI in education, but continued improvement is needed.

Teachers as a whole are strong in the application of technology, but statistically, there is still room for strengthening, such as in the application of technology integration scored only 2.96 points.

The finding that generative AI technology readiness directly affects technical competence could provide direction for teacher training.

In enhancing teachers' competencies, attention needs to be paid to the possible differential impact of gender and subject specialization.

5.3. Research recommendations

Continued professional training in generative artificial intelligence techniques to further enhance teachers' readiness to receive them.

Encourage female teachers to act as role models and promote knowledge sharing through mentorship and peer learning.

Education administrations should increase the development of technological tools and platforms to support teachers in the use of technology.

Developing specialized training programmes for teachers of different disciplines and gender backgrounds.

Utilizing generative artificial intelligence technology to enrich the content and form of teacher training and improve the training effect.

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