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Exploration of Reconstructing the TPACK Framework Based on Generative Artificial Intelligence

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Abstract

In the era of artificial intelligence, the promotion and application of generative artificial intelligence in the field of education is breaking the traditional educational scene, and it is urgent to build a teacher professional knowledge system that adapts to the background of the times. On the basis of analyzing the fundamental role of the Technological Pedagogical and Content Knowledge (TPACK) framework and the reconstruction role of Generative Artificial Intelligence (GenAI), the TPACK framework integrated with GenAI (Gen+TPACK) was proposed. The connotation of Gen+TPACK framework was analyzed from the dimensions of integration of GenAI and Technological Knowledge (TK), Pedagogical Knowledge (PK) and Content Knowledge (CK), as well as composite Technological Content Knowledge (TCK), Pedagogical Content knowledge (PCK), Technological Pedagogical knowledge (TPK), and Technological Pedagogical and Content Knowledge (TPACK). Four implementation paths of Gen+TPACK application were discussed which were the pedagogical innovation enabled by GenAI technology, the dynamic reconstruction of teaching process assisted by GenAI, the optimization of teaching decision supported by GenAI, and the intelligent expansion of teaching boundary. And finally the challenges faced by the application of Gen+TPACK were analyzed.

Keywords: generative artificial intelligence, technological pedagogical and content knowledge, reconstructing, implementation paths, challenges

1. Introduction

In the context of the deep reconstruction of the education ecosystem by artificial intelligence technology, the integration of Technological Pedagogical and Content Knowledge (TPACK) [1] and Generative Artificial Intelligence (GenAI) [2] is becoming the core driving force for promoting educational innovation. Through literature research and theoretical analysis, this paper systematically explains the comprehensive integration method of the Teacher TPACK framework with GenAI from seven dimensions: Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Content Knowledge (TCK), Pedagogical Content knowledge (PCK), Technological Pedagogical knowledge (TPK), and Technological Pedagogical and Content Knowledge (TPACK). And four implementation paths for Gen+TPACK applications will be explored, which include the pedagogical innovation enabled by GenAI technology, the dynamic reconstruction of teaching process assisted by GenAI, the optimization of teaching decision supported by GenAI, and the intelligent expansion of teaching boundary. Four major challenges faced by the practical application of TPACK framework integrating GenAI will be pointed out. Provide a paradigm framework that integrates cutting-edge theoretical characteristics and practical applicability for the professional development of teachers in the era of AI+.

2. TPACK and Generative Artificial Intelligence

2.1 TPACK Framework: The Foundation of Teacher Competence

TPACK is a teacher knowledge framework proposed by American scholars Koehler and Mishra in 2006 [3], designed to guide teachers in effectively integrating technological, pedagogical and content knowledge in the digital age to achieve high-quality teaching. This theory breaks through the unidirectional characteristics of traditional teacher knowledge structures, emphasizing the dynamic balance of technology tools, teaching methods, and disciplinary logic in real classroom contexts. Under the Artificial Intelligence (AI) paradigm, the TPACK framework exhibits three key features:

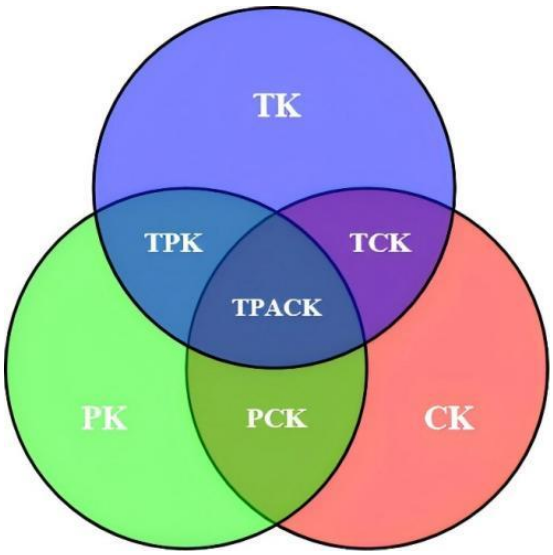

Figure 1. Schematic diagram of TPACK framework

(1) Integration: Teachers are required to have the ability to deeply integrate AI tools (such as intelligent teaching assistants and adaptive learning systems) with discipline teaching. Teachers need to master Technological Knowledge, Pedagogical Knowledge, Content Knowledge, as well as composite Technological Content Knowledge, Pedagogical Content Knowledge, Technological Pedagogical Knowledge, and Technological Pedagogical and Content Knowledge, as shown in Figure 1.

(2) Situational Adaptability: There are significant differences in the application of TPACK under different disciplines, stages, and learning resource conditions. For example, teaching in humanities and social science focuses on the integration of multimedia resources, while teaching in science, engineering, and natural science relies more on professional software operations, requiring teachers to have situational technical decision-making abilities.

(3) Dynamic Development: With the emergence of new technologies such as generative artificial intelligence and VR/AR, teachers need to continuously learn and update their technological knowledge in related fields to adapt to the impact and changes of new technologies and concepts on the education sector.

2.2 Generative Artificial Intelligence: A Reconstructor of Educational Scenarios

On October 18, 2025, China Internet Network Information Center released the Report on the Development of Generative AI Applications (2025) (hereinafter referred to as the Report) at the 2025 (6th) China Internet Basic Resources Conference. The Report clearly shows that as of June 2025, the number of users of generative AI in China has reached 515 million, with a penetration rate of 36.5%, an increase of 266 million in half a year. The user group is mainly young and middle-aged people under 40 years old (accounting for 74.6%), and the proportion of highly educated users is 37.5% [4]. Generative artificial intelligence technology, represented by the big language model, has been innovatively applied in multiple fields such as intelligent manufacturing, biomedicine, technology finance, design creativity, and autonomous driving. It has demonstrated excellent core capabilities in multi style and multi task long text generation, multi-level cross lingual language understanding, open domain knowledge question answering, situational thinking chain logical reasoning, multi question type analyzable mathematics, multifunctional and multilingual code, and multi modal input and expression [5]. In the field of education, generative artificial intelligence is actively applied in personalized education, intelligent assisted teaching, educational management, and decision support [6]. Generative artificial intelligence empowers teaching, promoting the transformation, formation, and innovation of teaching modes, assessment modes, human-machine collaborative learning modes, and discipline integration education modes [7]. Generative artificial intelligence plays a positive role in cultivating teachers' interdisciplinary educational abilities [8], promoting teachers' professional development [9], and reconstructing teachers' key abilities [10]. It requires teachers to update their discipline cognition, teaching methods, and technological application concepts to adapt to the new educational environment and challenges of the era of generative artificial intelligence [11]. Therefore, the significance of reconstructing the teachers' TPACK framework based on GenAI for teacher integration technology is highlighted.

3. Reconstruction of TPACK Framework with Integrating Generative Artificial Intelligence

As shown in Figure 2, the TPACK framework is fully integrated with GenAI, and the integration mainly includes the integration of generative artificial intelligence with three core dimensions and three composite dimensions of TPACK.

3.1 GenAI+TK: Integrating GenAI with Technological Knowledge

The core of the integration of GenAI and TK is technology as the basic point, and a closed-loop system of technology understanding, technology application and technology innovation is built through the complementary human-computer technology capabilities, technology scenario application and dynamic iteration. This integration needs to break through the shallow cognition of AI as a tool, turn to the deep collaboration of AI as a technical partner, and promote the upgrading of TK from operational skills to technical intelligence. In the context of the widespread application of generative artificial intelligence technology, TK should include not only the existing operational skills and technical foundations of teachers using technical tools, but also the operational skills and techniques of generative artificial intelligence tools, such as the methods of using generative artificial intelligence tools, the selection of raw material data for generative artificial intelligence, and the skills of writing instructions for generative artificial intelligence.

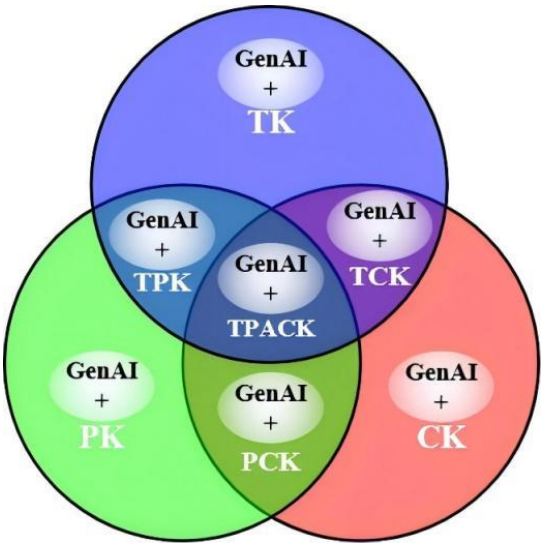

Figure 2. Schematic diagram of TPACK framework integrating GenAI

3.2 GenAI+PK: Integrating GenAI with Pedagogical Knowledge

The integration of PK with GenAI is reflected in the principles and theories of teaching with GenAI, the design and planning of teaching with GenAI, and the evaluation of teaching with GenAI. The integration of GenAI's pedagogical principles and theories is the fusion of the big data learning principles of generative artificial intelligence, the user demand instruction disassembly method based on rule sets, and the content creative output principle based on probability analysis at the basic theoretical level. The integration of GenAI in teaching design and planning involves embracing generative artificial intelligence throughout the entire process of teaching resource preparation, teaching content design, and teaching implementation. In terms of preparing teaching resources, using generative artificial intelligence to solve the dilemma of difficult access to abstract images, videos, and other teaching resources; In terms of teaching content design, using generative artificial intelligence to assist teachers in generating, modifying, and improving teaching content; In terms of teaching implementation, based on student learning feedback, generative artificial intelligence is utilized to dynamically plan teachers' teaching tasks and students' learning paths, establishing a closed-loop feedback-controlled teaching process. The integration of GenAI in teaching evaluation has achieved a shift from an experience based paradigm to a data-driven paradigm. Based on generative artificial intelligence tools, it quickly extracts, summarizes, and provides timely feedback on teaching evaluation data.

3.3 GenAI+CK: Integrating GenAI with Content Knowledge

With the rapid development of artificial intelligence technology, especially the application of GenAI technology in the field of education, CK which includes basic concepts and principles of disciplines, disciplinary systems and

structures, disciplinary frontiers and development trends, the connection between disciplinary knowledge and real life, disciplinary thinking methods and skills is gradually integrating with GenAI. By integrating GenAI concepts and principles into the fundamental concepts and principles of disciplines, incorporating GenAI's disciplinary applications in the forefront and development trends of disciplines, and integrating GenAI's intelligent thinking methods and skills in disciplinary thinking methods and skills, effective integration of GenAI and Content Knowledge can be achieved.

3.4 GenAI+TCK: Integrating GenAI with Technological Content Knowledge

The integration of generative artificial intelligence and TCK focuses on the deep integration of GenAI enhanced TCK, emphasizing that GenAI enhanced technology reshapes the presentation of CK, expands learning boundaries, and provides students with new understanding paths. Generative artificial intelligence mainly integrates three dimensions: technical tools, discipline content, and learning experience, which realizes the transformation of technical tools from teaching auxiliary tools to teaching cognitive partner, discipline content from fixed bounded knowledge system to dynamic exploration knowledge system, and learning experience from manual one-way theoretical knowledge teaching to intelligent multi directional interaction based on multi modal teaching content push and immersive learning environment experience.

3.5 GenAI+PCK: Integrating GenAI with Pedagogical Content Knowledge

PCK is the core knowledge system for teachers to transform discipline content into effective teaching forms. The essence of the integration of generative artificial intelligence and PCK is to empower discipline teaching with generative artificial intelligence, mainly including: assisted optimization of teaching design with generative artificial intelligence, generation of innovative teaching resources with generative artificial intelligence, deepening learning exploration with generative artificial intelligence, and strengthening evaluation feedback with generative artificial intelligence. The integration of GenAI and PCK needs to take technology adapting to the nature of teaching as the core, and realizes the transformation of teaching paradigm from experience driven to intelligence driven through the three paths of intelligent tool reconstructing teaching process, data-driven optimization of teaching decision-making, and man-machine cooperation expanding teaching boundary.

3.6 GenAI+TPK: Integrating GenAI with Technological Pedagogical Knowledge

The integration of GenAI and TPK is the fusion of PK and TK enhanced by generative artificial intelligence. Teachers need to understand how to use generative artificial intelligence tools to support the updating and optimization of TK and the organization and implementation of teaching activities. It mainly integrates generative artificial intelligence and TPK around three dimensions: teaching strategies, classroom management, and learning evaluation. The teaching strategy has shifted from open-loop presetting to closed-loop dynamic feedback generation, and transform the preset fixed teaching process into GenAI assisted analysis and decision-making of teaching task path generation. Classroom management has achieved a transformation from teacher manual management to intelligent assisted control, and provides timely classroom control suggestions to teachers based on classroom control data. The transformation of learning evaluation from relying on teacher experience for manual evaluation to data-driven intelligent assisted evaluation generation for teaching and learning has improved the timeliness and comprehensiveness of learning evaluation generation.

3.7 GenAI+TPACKK: Integrating GenAI with Technological Pedagogical and Content Knowledge

GenAI+TPACK is a combination of TK, PK, and CK which integrate generative artificial intelligence. GenAI+TPACK mainly includes: knowledge of discipline content expressed using generative artificial intelligence technology, knowledge of innovative teaching methods using generative artificial intelligence technology, knowledge of assisting students in learning using generative artificial intelligence technology, and knowledge of developing students' cognitive abilities using generative artificial intelligence technology. Therefore, teachers not only need to use generative artificial intelligence technology as a tool for teaching and learning, but also need to consider how to collaborate with AI teachers and incorporate the knowledge of collaboration with GenAI into the scope of GenAI+TPACK, in order to build a fusion of generative artificial intelligence and technology discipline teaching knowledge under human-machine collaboration.

4. Implementation Paths of Gen+TPACK

The Gen+TPACK is mainly implemented through the pedagogical innovation enabled by GenAI technology, the dynamic reconstruction of teaching process assisted by GenAI, the optimization of teaching decision supported by GenAI, and the intelligent expansion of teaching boundary.

4.1 Pedagogical Innovation Enabled by GenAI Technology

The pedagogical innovation enabled by generative artificial intelligence technology refers to the application of the content generation ability of generative artificial intelligence technology, breaking through the limitations of traditional teaching tools in content innovation, deeply integrating TK and PK, and giving birth to a new teaching mode. The development of intelligent teaching tools and the generation of multi modal teaching resources are typical application scenarios. Taking the generation of multi modal teaching resources as an example, in the teaching of Chinese poetry, the use of generative artificial intelligence tools to generate poetry text into image resources or dynamic visual resources can reduce the threshold of poetry understanding.

4.2 Dynamic Reconstruction of Teaching Process Assisted by GenAI

With the help of generative artificial intelligence technology, the teaching process is transformed from the preset fixed standard process to the dynamic reconstruction of personalized process. Personalized learning plan making and intelligent learning situation diagnosis and intervention are typical application scenarios. Taking the formulation of personalized learning plan as an example, in the course teaching, teachers will import learning data such as students' learning situation data and learning portrait data into the GenAI system, and the system will generate targeted student learning plans one by one for teachers' reference, so as to realize the integration of PK and CK in GenAI , so as to teach students in accordance with their aptitude.

4.3 Optimization of Teaching Decision Supported by GenAI

GenAI integrates multi-source and multi-dimensional teaching and learning data, provides scientific decision support for teachers, and promotes the dynamic optimization of PK and CK. Dynamic group collaborative learning and interdisciplinary project-based learning are typical application scenarios. Taking dynamic group collaborative learning as an example, in project-based learning, the intelligent teaching system groups students according to their abilities (data analysis ability, problem finding ability, etc.) and interests (history, science and technology, sports, etc.), and designs differentiated tasks according to groups, which can break the traditional grouping mode, promote the integration of interdisciplinary knowledge, and improve the effect of collaborative learning.

4.4 Intelligent Expansion of Teaching Boundary

Teachers can use the GenAI tool to connect and analyze the knowledge of different disciplines, design interdisciplinary projects, and cultivate students' comprehensive application ability. Teachers can also use the GenAI system to build an immersive teaching scene, guide students' in-depth thinking and learning, and deepen the understanding of discipline content. Students' global vision and cultural understanding training, virtual simulation experiment and exploration are typical application scenarios. Taking the cultivation of students' global vision and cultural understanding as an example, in the teaching of comparison of Chinese and foreign festivals, teachers use GenAI to generate virtual festival culture experience scenes, and students compare the similarities and differences between Chinese and western festival customs in immersion scenes.

5. Challenges Faced by GenAI+TPACK Applications

The application of GenAI+TPACK mainly faces challenges in theoretical and technical dimension, ethical and moral dimension, privacy and security dimension, and educational equity dimension:

(1) In terms of theoretical and technological dimension, the popularity of GenAI is insufficient. Due to the novelty of generative artificial intelligence, professional knowledge and skills in the field of generative artificial intelligence are mainly mastered by domain researchers and developers. Non domain researchers have a high threshold for understanding and mastering relevant professional knowledge and skills, which affects the smoothness of the promotion and application of generative artificial intelligence.

(2) In terms of ethical and moral dimension, there is controversy over how to use GenAI reasonably. The use of generative artificial intelligence tools by teachers to assist teaching, evaluation, and management carries certain ethical risks. The use of generative artificial intelligence by teachers and students also has increased the risk of academic integrity crisis, and there are still hidden dangers to the accuracy of information generated by generative artificial intelligence tools. These are all urgent issues that need to be addressed by generative artificial intelligence.

(3) In terms of privacy and security dimension, GenAI applications still have hidden dangers. Generative artificial intelligence models require a large amount of data during the training process, and there is a risk of personal privacy information and internal information leakage in data collection, desensitization, training, and model usage.

(4) In terms of educational equity dimension, the fusion application of generative artificial intelligence and TPACK may exacerbate the education gap between regions. On the one hand, economically developed regions

and affluent families may have earlier exposure to and mastery of generative artificial intelligence knowledge and technology, thereby gaining more educational resources and advantages; On the other hand, underdeveloped areas and impoverished families may not be able to fully benefit due to technological barriers and resource limitations. This gap is not only reflected in the popularity of hardware devices, but also in the differences in intelligence literacy and skill levels. If the allocation of intelligent platform resources is not prioritized and the intelligent literacy of relevant teachers is not enhanced, the application of generative artificial intelligence may further exacerbate educational inequality.

6. Conclusion

In summary, this paper analyzes the characteristics of TPACK as the foundation of teacher competence and the significance of reconstructing the TPACK framework based on generative artificial intelligence. This paper proposes a TPACK framework integrated with GenAI, analyzes the connotation of the connotations of reconstructing TK, PK, CK, TCK, PCK, TPK and TPACK based on generative artificial intelligence, and discusses the implementation paths of GenAI+TPACK. At the same time, we should also recognize the shortcomings, controversies, and hidden dangers in theoretical and technical dimension, ethical and moral dimension, privacy and security dimension, and educational equity dimension of GenAI+TPACK applications. In subsequent research, detailed research and practical verification will be conducted on how to promote the effective integration and application of generative artificial intelligence and TPACK.

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References

[1] He, K. (2012). TPACK—The new development of the research on the approaches and methods of information technology and curriculum integration in the United States (Part 2). *e-Education Research*, *33*(06), 47–56.

[2] Lu, Y., Yu, J., Chen, P., & et al. (2023). Educational application and prospect of generative artificial intelligence: Taking ChatGPT system as an example. *Chinese Journal of Distance Education*, *43*(04), 24–31, 51.

[3] Yan, Z., Fu, J., Zhu, Y., & et al. (2020). AI-Technological Pedagogical Content Knowledge (AI-TPACK): Connotation, teaching and learning practice and future issues. *Journal of Distance Education*, *38*(05), 23–34.

[4] China Internet Network Information Center. (2025, October 18). *Report on the development of generative AI applications (2025)*. https://www.cnnic.cn/n4/2025/1021/c88-11391.html

[5] Liu, B., Nie, X., Wang, S., & et al. (2024). Generative artificial intelligence and the reshaping of future education: Technical framework, capability characteristics and application trends. *e-Education Research*, *45*(01), 13–20.

[6] Zheng, Y., Wang, C., & Zhang, W. (2024). Application and regulation of generative artificial intelligence in education. *China Educational Technology*, *(05)*, 114–119.

[7] Yang, Z., Wang, J., Wu, D., & et al. (2023). Exploring the impact of ChatGPT/AIGC on education and strategies for response. *Journal of East China Normal University (Educational Sciences)*, *41*(07), 26–35.

[8] Wang, B., Wang, Q., Kang, B., & et al. (2024). Value and future orientation of physical education teachers' interdisciplinary teaching ability cultivation based on generative artificial intelligence. *Sports Culture Guide*, *(06)*, 95–101, 110.

[9] Xu, D. (2024). The role of generative artificial intelligence in teacher professional development—Taking improving teachers' independent lesson planning ability as an example. *Journal of Guangzhou Open University*, *24*(05), 40–44, 109.

[10] Yang, H. (2024). Reconstruction of key abilities of primary and secondary school English teachers in the era of generative artificial intelligence. *Teaching Monthly (Middle School Edition)*, *(12)*, 18–23.

[11] Liu, G., & Xie, Z. (2025). Re-examination of teachers' professional knowledge in the era of generative artificial intelligence—From the perspective of TPACK. *The Inservice Education and Training of School Teachers*, *(03)*, 36–41.