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| RESEARCH ARTICLE

College English Teaching Design Based on Bloom's Taxonomy and TPACK Framework: A Case Study

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| ABSTRACT
This paper discusses the combination of TPACK framework and Bloom's taxonomy of educational objectives to construct an innovative teaching model to meet the educational needs of the intelligent age. Taking college English courses as an example, this study verified the effectiveness of the novel model in promoting the development of students' cognitive capabilities through case analysis and empirical research. The results reveal that the model can meet the needs of students with different cognitive levels, especially in the enhancement of higher cognitive ability. The study also points out that teachers need to constantly update TPACK knowledge to accommodate changes in educational technology. Although the research has achieved some results, the universality of the conclusions is limited by the restrictions of sample size and variable control, and the application of this model in different disciplines and education stages needs to be further explored in the future.

| KEYWORDS

TPACK framework; Bloom's taxonomy of educational objectives; The Age of Intelligence; College English; Cognitive development

| ARTICLE INFORMATION

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1. Introduction

Driven by the revolutionary advancement of information technology, education is undergoing unprecedented shift from the industrial age model to the intelligent age model. The traditional mode of education, characterized by taking knowledge imparting as the core, emphasizing standardization and unification, and focusing on training the labor force to meet the needs of industrial production, have no longer been aligned with the education goal in the intelligent age. As the educational landscape evolves, there is a growing need for frameworks that can assist educators in adjusting their teaching practices to conform to the new goals of the intelligent age. Bloom's taxonomy, which has been a cornerstone in educational theory for decades, was, is and will be a valuable approach to achieving this conformity. Since its initial proposal in the 1950s, Bloom's taxonomy has served as a pivotal tool for categorizing educational objectives, which facilitates educators in devising complete teaching flow scheme, providing a structured foundation for teaching practices in clarifying teaching objectives, organizing teaching activities and assessing learners' performance. However, in the undertone of the intelligent era, traditional teaching methods and assessment approaches must strike a chord with modern technology to accommodate new pedagogical requirements and learning styles. Consequently, educators are also confronted with the challenge of effectively incorporating technology to enhance learners' cognitive development. In this regard, this study aims to construct an innovative instructional model that integrates the TPACK (Technological Pedagogical and Content Knowledge) framework with Bloom's taxonomy to offer a more comprehensive perspective and pragmatic approach to digital learning environments.

Whereas digital learning environments provide learners with abundant resources and interactive experiences, they also require teachers to effectively align technological tools with instructional content. Initially proposed as a model describing the domains of knowledge required of teachers, the TPACK framework lays a theoretical foundation for integrating technological pedagogical knowledge with the subject matter. Bloom's taxonomy, on the other hand, presents a distinct hierarchy for setting educational goals and developing students' cognitive skills. This study argues that the TPACK framework and Bloom's taxonomy are two complementary educational theoretical tools. A more comprehensive and in-depth guide to educational practice in the digital age can be expected by merging these theoretical frameworks. Therefore, this paper will explore how Bloom's taxonomy of educational objectives can be employed to design college English courses while leveraging the technological, pedagogical, and content knowledge in the TPACK model to optimize these courses with the aim of improving the relevance and effectiveness of teaching and learning.

This study aims to address the following questions:

1. How can the TPACK framework be integrated with Bloom's taxonomy to construct a new model of teaching strategies?
2. How does this integrated model assist teachers in designing and implementing digital learning activities and hence, foster students' cognitive development?
3. What is the efficiency of implementing this integrated model in real-world teaching scenarios?
4. How does it affect student learning outcomes?

Then, the next section will commence with an exhaustive review of the relevant literature, encompassing the theoretical basis of both the Bloom's taxonomy and TPACK framework as well as their applications in education. This is succeeded by a detailed exposition of the methodology employed, which includes the theoretical model construction, teaching design based on the novel model, teaching implementation, data collection, and analytical methods. Consequently, the paper will demonstrate the detailed implementation process and case studies of the instructional strategies, alongside an examination of their impact on student learning outcomes. Finally, the paper will discuss the implications of the research findings and present conclusions and directions for future research.

2. Literature Review

2.1 Theory basis

2.1.1 Bloom's taxonomy of educational objectives

First proposed in 1956, Bloom's taxonomy is extensively utilized in teaching objectives classification, curriculum design and educational assessment . According to Bloom's taxonomy, learning objectives can be divided into three domains: cognitive , affective and psychomotor, where the cognitive domain consists of six levels, namely, Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. These levels ranged from simple to complex, reflecting a gradual increase in cognitive ability, and were revised by Anderson and Krathwohl in 2001 to introduce the Create level and reorder it (Bloom, 1956; Anderson & Krathwohl, 2001), expressed as Remember, Understand, Apply, Analyze, Evaluate, and Create. The revised Bloom taxonomy emphasizes the initiative and creativity of learners in the process of cognitive development. Bloom's taxonomy of educational objectives has had a profound impact on the global education field and is widely regarded as the authoritative framework for the classification of educational objectives.

Bloom's taxonomy equipped educators with a structured framework for identifying and categorizing different learning goals and cognitive skills, ensuring that teaching activities scaffold students at different levels of cognitive development. This hierarchical classification helps educators clearly outline the ladder of students' cognitive ability development and makes the setting of teaching objectives more targeted and operable. For example, at the level of Remember, the teaching goal focuses on students' memorization of factual knowledge, term definitions, etc. The level of Understand requires students to explain concepts and principles in their own language. The Apply level focuses on students' ability to transfer knowledge to new situations and solve problems. The Analyze level requires students to be able to analyze complex information and identify the relationship between various elements. The evaluation level involves students' critical judgment of ideas, works, etc. The Create level is the highest level, where students are encouraged to integrate their knowledge to create new ideas, works or solutions.

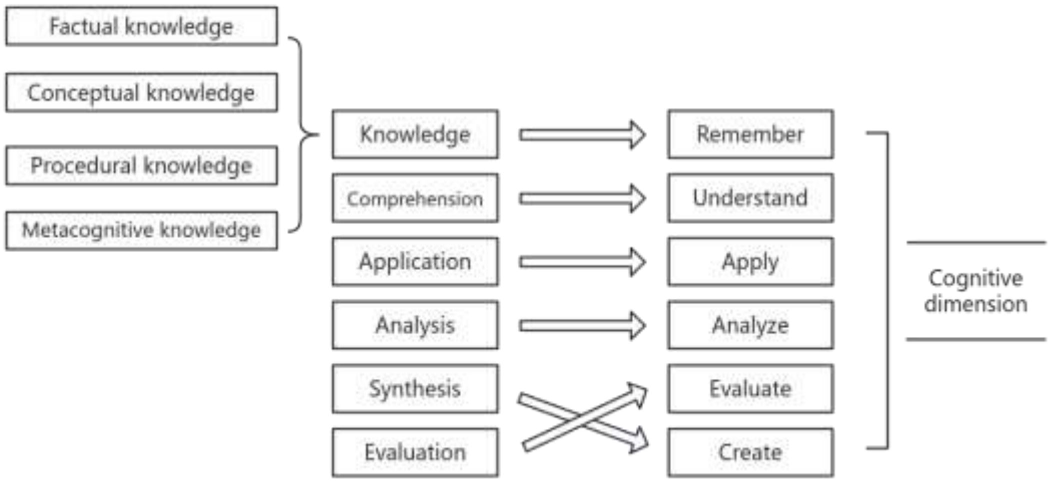

Figure 1: Bloom's Taxonomy Revision. A structure diagram illustrating the revised version of Bloom's Taxonomy, detailing the dimensions of knowledge and cognitive processes.

In the digital age, with the deep infiltration of information technology into the field of education, a new branch of "digital Bloom" has derived from Bloom's taxonomy of educational objectives. Wang Youmei et al. (2013) pointed out that digital Bloom provides a practical framework for information-based education for learners' digital ability development. By establishing a mapping relationship between digital Bloom and digital literacy development, it can be analyzed from three dimensions: learning goal design, key behavior explicit and technology tool application. Wang expounds on the information teaching ideas and implementation suggestions of 3 levels and 11 key points of digital ability. This innovation not only expands the application scope of Bloom's taxonomy of educational objectives, but also provides strong support for digital teaching.

2.1.2 TPACK（Technological Pedagogical and Content Knowledge）framework

A significant shortcoming was identified by The Innovation and Technology Committee of AACTE (American Association of Colleges for Teacher Education) in its inspection of the long-term advancement of information technology in U.S. education: education reform primarily focuses on technology and students' autonomous manipulation of technology, and insufficient attention is paid to the knowledge teachers need to master and the key role of teachers in the process of integrating technology. In the 1980s, Shulman, L. S., proposed the concept of Teacher Knowledge, which encompasses an understanding of the complex interplay between subject Content Knowledge (CK) and Pedagogical Knowledge (PK). Shulman emphasized that the relationship between these two types of Knowledge is crucial for teachers, and that their effective integration forms what is known as Pedagogical Content Knowledge (PCK). Building on Shulman's theory, Matthew J. Koehler, Ph.D., and Punya Mishra, Ph.D., of Michigan State University, developed a new conceptual framework for integrating educational technology. The framework incorporates Technological Knowledge into Pedagogical Content Knowledge (PCK) to create Technological Pedagogical Content Knowledge (TPACK). With the emergence of new technologies such as generative Artificial intelligence (AIGC), augmented reality (AR) and virtual reality (VR), the TPACK framework has expanded to encompass the impact of these emerging technologies on teaching and learning. As the educational landscape continues to evolve, the TPACK framework will also continue to adjust to new educational goals and technological development, supporting teacher professional growth and student learning outcomes.

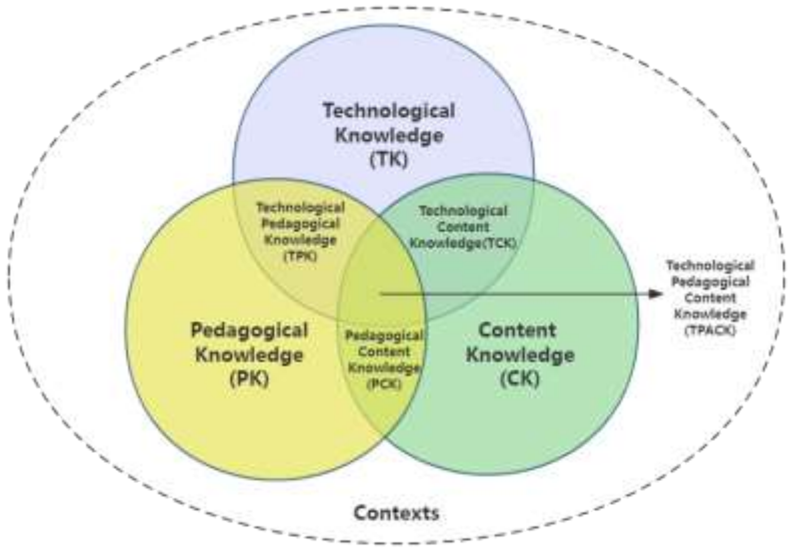

Figure 2: TPACK framework. This Venn diagram illustrates the overlapping domains of Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK), highlighting the distinct areas of Technological Pedagogical Content Knowledge (TPACK), Technological Pedagogical Knowledge (TPK), and Pedagogical Content Knowledge (PCK). [Source: Adapted from a theoretical framework proposed by Shulman L. S., Matthew J. K. and Punya M.]

2.2 Challenges and Critiques

As a classic model of instructional design and evaluation, Bloom's taxonomy of educational objectives also confronts challenges in the intelligent age: Critics have highlighted its limitations in guiding teaching, describing learners' intrinsic qualities, and portraying the learning process, etc., and proposed a comprehensive critique from the perspectives of taxonomy, pedagogy, psychology, and epistemology. They pointed out that Bloom's taxonomy lacks the generation mechanism of "class" from the perspective of taxonomy, and divides people into multiple independent parts from the perspective of pedagogy, and only describes behavior states on the surface from the perspective of psychology. There is a lack of philosophical thinking on the nature of knowledge from the perspective of epistemology (Feng, Li, 2019). With the development of educational technology, particularly the widespread use of digital tools and online resources, learners gain easier access to information and knowledge, which reduces the reliance on lower-level cognitive skills such as memory, while escalating the demand for higher-order cognitive skills such as critical thinking and innovation. Some educators argue that Bloom's taxonomy needs to be further expanded to more fully address the cultivation of higher-order thinking (Chen & Zhu, 2023). In addition, the digital age attaches great importance to active learning, collaborative learning and project-based learning. These learning styles require students not only to memorize knowledge, but also to be able to generate new knowledge, solve problems, and collaborate with others-tasks that extend beyond the traditional levels of Bloom's taxonomy. Furthermore, education in the digital age, to a great extend, is centered on data analysis and evaluation to optimize teaching outcomes. Bloom's taxonomy of education may need to incorporate more data-driven approaches to enhance teaching quality. The inherent nature of the digital age determines that the learning environment is becoming increasingly open and interactive, where students can acquire knowledge through multiple channels and may no longer follow the linear cumulative process from Remember to Understand to Create, and Bloom's "one-size-fits-all" classification may not fully adapt to the trend of individualized learning needs of students. In light of the characteristics of information-based teaching, scholars both domestically and internationally have proposed adaptations such as Digital Bloom (Churches, 2008) and Flipping Bloom (Wright, 2012). Chinese scholars have also proposed the development of a Chinese version of Digital Bloom (Chen, 2011), thereby infusing new vitality into Bloom's theoretical system.

Domestic and foreign scholars have explored various aspects related to the development of the theoretical connotation of TPACK (Xu, et al., 2013), the structure and current status of TPACK knowledge of college teachers (Ren & Ren, 2015; Xu et al., 2018), and the current status of TPACK knowledge competence among teachers in specific disciplines and its influencing factors (Li & Zhang, 2021). Research has shown that TPACK is a key component of teacher education programs (Koehler & Mishra, 2009). Despite its wide acceptance, TPACK has been faced with criticism. Some scholars have argued that the TPACK theoretical model suffers from unclear conceptual meanings and inter-conceptual relationships, particularly the definition of TPACK composite elements such as Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK), which are controversial (Niess, 2019). For instance, there is a lack of descriptions of the relationships between various types of teacher knowledge, while the Technological Content Pedagogical Network (TCPNet) is the key to teacher knowledge (Zhang, 2023). The greatest value of TPACK theory lies in guiding teacher education practice, which remains relatively weak, with few mature and large-scale cases (Niess, 2013).

2.3 Research gaps

While the existing literature provides a solid foundation for understanding Bloom's taxonomy of educational objectives, TPACK as well as their applications, there remains certain gaps in current research. In the first place, in spite of the criticism and improvements proposed by some Chinese scholars, there is still a lack of localized research that takes into account the actual educational context in China. Future research could further explore how to integrate Chinese educational concepts and cultural background to construct an educational objective classification system with Chinese characteristics. Moreover, current research on teachers' TPACK capabilities and the application of digital intelligence technologies in education mostly focuses on short-term effects and specific application cases. There is relatively less research on the long-term impact of teachers' TPACK capabilities on education and the sustainable development of the educational ecosystem. Future research could strengthen the tracking and analysis of the long-term impact of digital intelligence technologies in education, providing a more comprehensive basis for the formulation of educational policies and the improvement of educational practices. Besides, domestic and foreign researches primarily focus on the cultivation and improvement of teachers' TPACK capabilities. However, there are few empirical studies to evaluate the impact of TPACK on students' performance at different cognitive levels. Limited research has addressed the question: What is the predominant role of teachers' TPACK competence at various levels in facilitating students' cognitive development? Lastly, at present, most of the literature has explored those fields from a multi-disciplinary perspective. However, the depth and breadth of cross-disciplinary research as a whole still need to be improved. Future research can further strengthen the integration of multiple disciplines such as education, psychology, technology, and sociology, and study the taxonomy of educational objectives and teachers' TPACK capabilities from a more macroscopic and comprehensive perspective. As previously noted, the value of TPACK theory lies in guiding teachers' educational practice. Consequently, constructing an effective educational practice paradigm under TPACK theory holds significant research value.

2.4 Conclusion of Literature Review

This literature review synthesizes current research on Bloom's taxonomy and its relationship to the TPACK framework, illuminating the potential relationships of integrating these frameworks for teaching strategies and students' cognitive development. In the digital era, the traditional model of educational objectives must evolve from a single categorical framework to an integrated tool for teaching, technology and educational informatization assessment; it should shift from focusing solely on assessing student performance to paying more attention to the learning and teaching process, and the procedures and strategies of informatization teaching. At the philosophical level, educational practice should shift from maintaining value neutrality to emphasizing value-based interventions. The cultivation of values should be integrated throughout the development of students' cognitive abilities, enhancing their deep learning capabilities while fostering innovative, critical, and analytical thinking skills; at the cognitive level, the linear cumulative process of Remember-Understand-Apply-Create should be reconstructed and more flexible and interconnected learning pathways should be allowed. Theoretically, an ideal "Bloom's taxonomy of educational objectives + TPACK" framework should serve as a more sustainable and adaptive educational model, which, alongside retaining the core theories of Bloom's taxonomy, emphasizes digital age competencies such as information literacy, media literacy, technology skills, collaboration abilities, and personalized learning capabilities. It can be predicted that this coalesce would generate enhanced engagement, improved technology integration, and professional development for educators.

3. Methodology

3.1 Theoretical model construction

This study seeks to build a model that synergizes TPACK framework with Bloom's taxonomy of education. By aligning the level of learners' cognitive development with the TPACK framework for educators, a comprehensive system of teaching and learning activities can be designed. Take College English an example, this integrated model enables teachers to design a systematic teaching plan that not only caters for the low-order cognitive goals such as the imparting of language knowledge but also includes the high-order cognitive development such as critical thinking, creative thinking, and problem-solving abilities. This approach helps students develop across different cognitive levels and provides teachers with a set of teaching strategies that integrate content knowledge, pedagogy, and technological knowledge. The following steps illustrate how to construct a novel theoretical model that merges Bloom's taxonomy of educational objectives with the TPACK framework and how to implement it in practical teaching scenarios.

3.2 Teaching design based on the novel model

Using the *Water Problem* from Unit 5, Volume 1 of the widely adopted *New Comprehensive College Advanced English Course*, an English textbook commonly utilized in Chinese colleges and universities, as a prime case study. The subsequent design is implemented under the guidance of the "Bloom's taxonomy of educational objectives + TPACK framework".

3.2.1 A thorough examination of the TPACK content of this unit

TPACK	Specific content
Content knowledge (CK)	Text content: Understand the importance of water and its potential to become the most important resource of the 21st century. Vocabulary: Learn about technical terms related to water resources, such as "conservation", "faucet", "aqueducts", "desalination", etc. Grammatical structure: Identify and understand complex grammatical structures in the text, such as conditional sentences, passive voice, etc.
Pedagogical knowledge (PK)	Teaching strategies: Case studies, discussions and role plays are used to promote students' in-depth understanding of water resources issues. Classroom management: Through group activities and interactive discussions, ensure that all students participate and contribute their own perspectives. Assessment: Design an assessment that includes vocabulary tests, reading comprehension, and oral expression.
Technological knowledge (TK)	Multimedia resources: Use videos and images to enhance students' visual understanding of water resources issues. Online tools: Use online dictionaries and language learning software to help students learn new vocabulary. Interactive platform: Facilitate student participation and feedback through interactive whiteboards and online discussion boards.
Pedagogical content knowledge (PCK)	Discipline-specific pedagogy: Teaching students how to analyze and discuss texts related to water resources. Student understanding: Help students understand how water issues relate to everyday life. Content presentation: Concretize abstract water resources concepts through examples and comparisons.
Technological content knowledge (TCK)	Vocabulary learning: Use online vocabulary learning tools to help students memorize and practice key vocabulary. Grammar exercise: Online grammar exercise software is used to strengthen students' grasp of complex grammar structures. Text understanding: Use technical tools to enhance understanding of water issues, such as data visualization tools to show the global distribution of water resources
Technological pedagogical knowledge (TPK)	Interactive teaching: Use online interactive tools such as real-time polling and online Q&A to increase student engagement. Personalized learning: Provide personalized online learning resources based on students' progress and interests.

Technological pedagogical content knowledge（TPACK）	Curriculum design: Combining technical, pedagogical and content knowledge to design curricula and teaching activities, such as water conservation projects. Project-based learning: Students are led to participate in water-related research projects, using technical tools for data collection, analysis, and report writing. Interdisciplinary learning: Students are encouraged to combine English language learning with knowledge of other disciplines, such as environmental science and international relations.

3.2.2 The determination of the TRACK content for each cognitive level

Bloom's cognitive levels	TPACK content						
	CK	PK	TK	PCK	TCK	TPK	TPCK
Remember	The key vocabulary and grammatical structures in the text need to be learned and memorized	T use story telling, image association and other teaching methods to help S memorize new vocabulary	T take advantage of online vocabulary learning platforms and apps for interactive vocabulary exercises	T use storytelling, image association and other teaching methods to help students memorize vocabulary related to the theme of the text	T incorporate technical tools, such as vocabulary games or online quizzes, to help students memorize and review vocabulary	S are encouraged to memorize vocabulary and grammatical structures through online interactive activities such as virtual flash cards	T use technology to integrate teaching content and teaching methods, design memory games and challenges to enhance memory effects
Understand	Key concepts in the text, such as the importance and complexity of water resource issues	T use Q&A, mind mapping and other methods to help S understand the content of the text	T use multimedia presentations and visual tools to enhance S' comprehension of reading materials	T show how to incorporate new vocabulary and grammatical structures into simple sentences to help S understand their usage	T use multimedia tools, such as videos or diagrams, to help S better understand complex concepts	S work on group projects using online collaboration tools to complete shared readings	T integrate teaching content and technology to design interactive teaching activities, such as simulated conversations, to promote S understanding
Apply	S apply newly learned vocabulary and grammatical structures in	Through role play or case studies, S apply their knowledge to specific situations	T create simulated situations using online platforms, VR/AR technology, etc	T instruct S to use new words and expressions appropriately in different contexts	S apply newly learned vocabulary and grammar in simulated situations, such as role	S use online platforms for interactive exercises to apply language knowledge to	T integrate technological and pedagogical content to design interdisciplinary

	writing and speaking exercises				play or situational conversation	real-world communication	projects that allow students to apply language knowledge to other subject areas
Analyze	T instruct S to analyze the structure and arguments of the text and identify the author's points of view and evidence	T guide S to analyze the themes and arguments of the text through questions and discussions	Online discussion tools and group collaboration tools are used to help S identify and analyze language patterns	T teach S to analyze language structure and stylistic features	T use technical tools, such as online grammar analysis, to help S analyze sentence structure	T use online discussion boards to facilitate interaction and in-depth analysis among S.	T combine technical, pedagogical, and content knowledge to design analytical activities such as textual comparison and critical reading
Evaluate	S evaluate the arguments and evidence in the text and form their own opinions	T improve S' critical thinking skills through peer review and self-assessment	T use online assessment tools, such as questionnaires, to collect S' comments on the content of the text	T instruct S to evaluate and provide constructive feedback on language use	T utilize technological tools, such as online grading systems, to help S practice evaluation and feedback	Through online forums and blogs, S are encouraged to express their opinions and opinions	T integrate technical, pedagogical and content knowledge to design assessment activities such as peer assessment and self-assessment
Create	S creatively use new vocabulary and grammatical structures to write original stories or essays	S are encouraged to undertake creative writing and original projects that demonstrate their mastery of the language	T use multimedia tools, such as video editing software, to help students create multimedia projects	T instruct S to creatively apply language knowledge to new contexts	T utilize technological tools, such as online writing platforms, to support students' creative writing	Through an online collaboration and sharing platform, S are encouraged to share and showcase their creative work	T combine all teaching elements to design a comprehensive project, such as creating a multimedia presentation on water conservation.

The TPACK framework, as depicted in the above figure, offers corresponding support throughout the process of attaining Bloom's educational objectives at each cognitive level. Based on the empirical teaching process, the subsequent diagram presents the predominant domain of educators' TPACK proficiency that facilitates learners in reaching their desired cognitive levels.

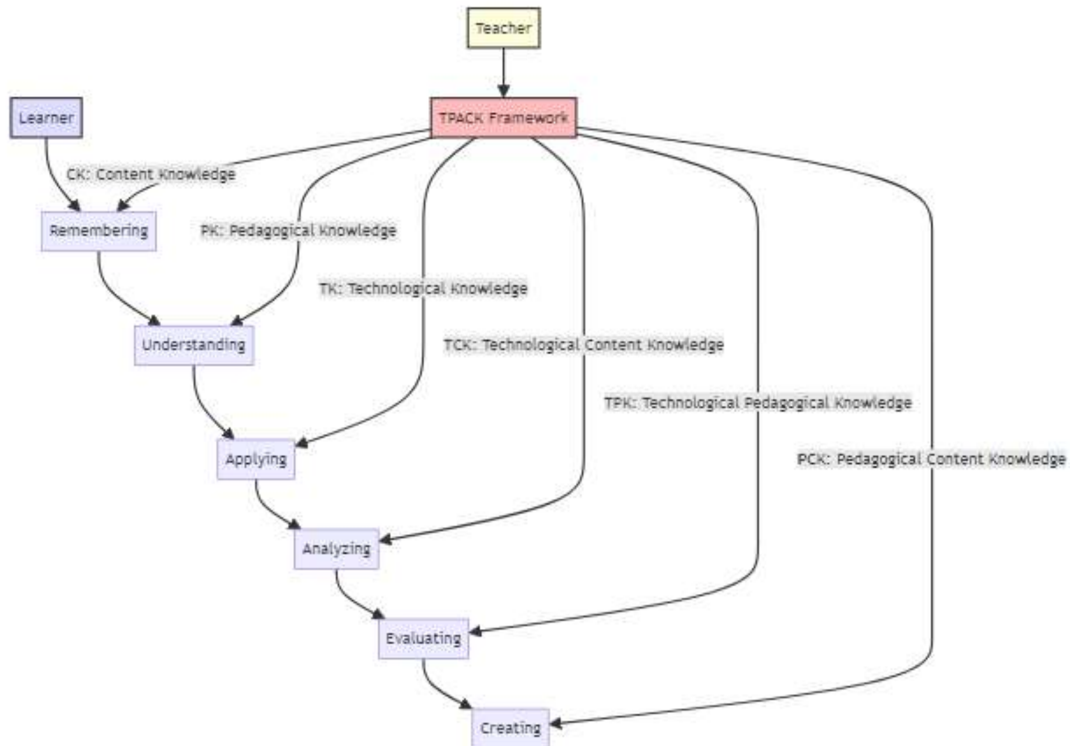

Figure 3: TPACK Framework and Support for Cognitive Levels. This figure delineates the TPACK framework, showcasing the main facilitation for various Bloom's cognitive levels [created by the author]

3.2.3 Teaching steps designed in alignment with the model

In College English teaching, each cognitive level not only imposes unique requirements on both teaching content and pedagogy but also establishes benchmarks for evaluating learning outcomes. Consequently, the setting of teaching goals, orchestration of teaching activities, and implementation of assessing methods guided by the "Bloom's taxonomy + TPACK framework" are as follows:

Bloom's cognitive levels	Teaching goal setting	Teaching activity planning	Student competence assessing
Remember	Students are able to memorize and recall basic English vocabulary and grammar rules	Word matching game Virtual flash card Quick quiz	Students' memory skills are assessed through online quizzes and vocabulary games
Understand	Students will be able to explain the main points of the passage and understand the importance of water resources	English videos watching English podcasts listening Online discussion and collaboration	Students' comprehension levels are assessed through short answer and reading comprehension tests
Apply	Students are able to discuss the impact of water scarcity and apply their language knowledge to writing and speaking	Role play Debate Model United Nations	Students' ability to apply knowledge is assessed through situational simulation performance

Analyze	Students can analyze the structure of the text and identify the author's writing techniques	Online collaboration Text analysis	Students' analytical skills are assessed by mind maps written by study groups
Evaluate	Students are able to evaluate the quality of the text and the arguments of the authors and make recommendations for water conservation	Peer assessment activity Evaluative discussion	Students' evaluation ability are assessed by peer review comments
Create	Students are able to use English creatively in writing or speaking to design a water conservation project	Community water conservation advocacy project Multimedia display	Students' creative writing, innovation, and personal expression are assessed by project presentations.

As depicted in the table, a complete teaching scheme can be constructed adhering to the sequence of "teaching goal setting-teaching activity planning-student competence assessing". Educators can utilize the TPACK framework to integrate technical, pedagogical and content knowledge to facilitate teaching objectives at different cognitive levels. Appropriate technology tools and teaching strategies are instrumental in fostering student engagement and optimizing learning outcomes. Furthermore, the model emphasizes the provision of prompt and targeted feedback to students, which is essential for their progression towards advanced cognitive hierarchy.

3.3 Teaching implementation & after-class feedback and survey

Following the development of teaching steps based on the integrated teaching model, a single instructor conducted practical instruction for both Class A and Class B of freshmen with equivalent language proficiency and skills (approximately equivalent to CSE 3~4). The duration of instruction, homework assignments, and evaluation methods were identical. Subsequently, questionnaires were distributed to the students. This study attempts to assess the impact of this teaching model on cognitive level of students through questionnaires and homework evaluation feedback.

4. Results and Discussion

The teacher implemented the teaching design based on the proposed novel model. Following the actual teaching of freshman class A and Class B with the equivalent language level and skills, the teacher distributed questionnaires to the students to assess the students' understanding of the course content, the effectiveness of the pedagogy and their overall satisfaction with the learning experience. These queries encompass multiple cognitive levels, ranging from knowledge retention to critical thinking and creative application. The questionnaire design is as follows:

No.	Questions	Evaluation dimension
1	How well do you remember the key vocabulary after learning the vocabulary in this unit using online tools?	Memory ability
2	Can you explain the impact of water scarcity in your own words?	Understanding and presentation skills
3	How did you experience applying what you learned in a simulated situational speaking activity or case study?	Knowledge application ability
4	Are you able to analyze the author's viewpoints and arguments in the text, as well as the author's writing style?	Analysis and critical thinking

5	How do you feel about your ability to integrate what you have learned to design a community water conservation campaign?	Comprehensive application and innovation ability
6	How do you rate the effectiveness of your own or your peers' water conservation solutions?	Evaluating and reflective abilities
7	Are using various online tools helpful in your studies?	Effectiveness of teacher's TK proficiency
8	Are you satisfied with the teaching methods used in this course?	Satisfaction with teacher's PK proficiency
9	Are you satisfied with the overall learning experience?	Overall learning experience satisfaction
10	Do you have any suggestions or feedback that can help us improve our teaching?	Improvement suggestions and feedback

42 students from Class A and 48 students from Class B were surveyed with the following results:

No.	Class A	Class B
1	64.29% very clear, 33.33% relatively clear, 2.38% average	8.33% very clear, 56.25% relatively clear, 27.08% average, 8.33% vague
2	42.86% totally OK, 42.86% basically OK, 14.29% difficult	8.33% totally OK, 39.58% basically OK, 45.83% difficult, 6.25% very difficult
3	42.86% totally OK，42.86% basically OK，14.29% difficult	10.42% totally OK，35.42% basically OK，45.83% average，6.25% difficult，2.08% very difficult
4	40.48% very easy, 42.86% somewhat easy, 16.67% somewhat difficult	6.25% is very easy, 52.08% is somewhat easy, 39.58% is somewhat difficult, 2.08% is very difficult
5	33.33% very strong, 38.1% relatively strong, 26.19% average	12.5% very strong, 29.17% relatively strong, 43.75% average, 8.33% weak
6	47.62% very satisfied, 45.24% somewhat satisfied, 7.14% average	12.5% very satisfied, 45.83% somewhat satisfied, 39.58% average, 2.08% not very satisfied
7	52.38% very helpful, 38.1% helpful, 9.52% moderate	22.92% Very helpful, 47.92% helpful, 29.17% moderate
8	59.52% very satisfied, 35.71% satisfied, 4.76% moderate	27.08% very satisfied, 45.83% satisfied, 27.08% moderate
9	61.9% very satisfied, 33.33% satisfied, 4.76% moderate	27.08% very satisfied, 45.83% satisfied, 27.08% moderate

According to the evaluation method of the course design, the homework feedback of class A and B is as follows: (The score below is the average score of the class, and the grade is the overall grade of the class)

Bloom's cognitive levels	Assessment	Class A	Class B
Remember	Vocabulary online test (automated assessment)	93.44	95.19

Understand	Online reading comprehension test (automated assessment)	82.30	80.18
Apply	Oral presentation in simulated situations	81.15	85.79
Analyze	Online collaborative task	A	A-
Evaluate	Peer review task	B+	B+
Create	Community project presentation	A	A-

Upon analyzing the results of the questionnaire survey, it is evident that class A students generally show a high degree of satisfaction with the effect of online learning tools, teaching methodologies and overall learning experience. Despite some challenges experienced by students in Class B (such as explaining the impact of water shortage and simulating practical application scenarios), the majority expressed satisfaction with both the teaching method and the overall learning experience. Students from both classes agreed that online tools were beneficial to their learning. These findings suggest that the teaching model can promote the cognitive development of students in both classes, although it may have a relatively limited effect on the understanding and application level of students in Class B.

Upon analyzing the students' homework reports, it is observed that Class A exhibited commendable performance across all levels, with particular strengths in the levels of Remember, Apply and Analyze. Class B is superior in Remember and Apply level. Both classes performed well at the cognitive level, however, Class B slightly outperformed class A at the Remember and Apply level, and Class A was more prominent at the analyze and Create level. Notably, both classes have demonstrated good ability at the senior level. Based on the teacher's empirical teaching experience, the comprehension, analytical skills, and critical thinking ability of Class A students were slightly more advanced than those of Class B. This suggests that the model may exert a slightly greater influence on promoting higher-order cognitive development among Class A students compared to their counterparts in Class B.

The conclusions drawn from this study are subject to certain limitations: The sample scale is insufficient to accurately represent the wider student population or to account for variations across different educational backgrounds ; additional variables that could potentially influence student performance, such as students' personal background, study habits, major, etc. are not taken into account; the domains of teachers' TPACK capacity in promoting students' cognitive level development is largely based on teachers' empirical observation and experience, rather than from rigorous quantitative research; evaluation methods used at different levels may not be directly comparable. For instance, online tests that are automatically assessed may differ in scoring criteria and objectivity from peer review tasks and community project presentations; students' abilities to access and utilize technology may vary, which could impact their performance at certain levels. Therefore, the generalizability of these conclusions to other settings or courses requires further validation in diverse educational contexts.

5.The study's constraints and limitations

The conclusions drawn from this study are subject to certain limitations: The sample scale is insufficient to accurately represent the wider student population or to account for variations across different educational backgrounds ; additional variables that could potentially influence student performance, such as students' personal background, study habits, major, etc. are not taken into account; the domains of teachers' TPACK capacity in promoting students' cognitive level development is largely based on teachers' empirical observation and experience, rather than from rigorous quantitative research; evaluation methods used at different levels may not be directly comparable. For instance, online tests that are automatically assessed may differ in scoring criteria and objectivity from peer review tasks and community project presentations; students' abilities to access and utilize technology may vary, which could impact their performance at certain levels. Therefore, the generalizability of these conclusions to other settings or courses requires further validation in diverse educational contexts.

6. Conclusion and suggestions for future research

Through empirical research, this study verifies the positive impact of the teaching model of "Bloom's taxonomy +TPACK framework" on enhancing students' cognitive abilities across Remember, Understand, Apply, Analyze, Evaluate, and Create. The findings suggest that this integrated model can meet the cognitive needs of students at all levels. The performance of students in two classes demonstrated distinct strengths at varying levels , indicating successful outcomes from the teaching experiment in bolstering students' comprehensive abilities. The results of this study advocate for teachers to employ the "Bloom’s taxonomy +TPACK framework" teaching model when designing curriculum and teaching activities to foster students' cognitive development at all levels. Simultaneously, teachers need to constantly update their TPACK knowledge to adapt to changing educational technology and student needs. Although this study provides evidence of the effectiveness of the integrated teaching model, other variables affecting learning outcomes are not fully taken into account. Therefore, further research is needed to explore the application of the model across different disciplines, stages of education, and cultural contexts. In addition, future research could concentrate on tailoring teaching strategies to accommodate the unique characteristics of individual students to achieve effective personalized teaching in the digital age.

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