International Education and Culture Studies
ISSN 2766-6778
Vol. 5, No. 3, 2025
Published by STSL Press

Original Paper

The Effectiveness of an Educational Program Based on the TPACK Model in Enhancing Holistic Thinking among Physics Department Students in the College of Education for Pure Sciences

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Abstract

The research aims to identify (the effectiveness of an educational program according to the TIBAK model in comprehensive thinking among students of the Physics Department/ College of Education for Pure Science. The research is limited to 4th -year students in the Physics Department at the College of Education for Pure Science/ University of Baghdad for the academic year (2024-2025) who are taught according to the vocabulary of the educational laboratory experiments subject scheduled to be taught for the fourth grade at the College of Education. The researchers used the experimental design with partial control (the design of the experimental and control groups with a pre-test "for equivalence purposes" and a post-test), and the number of the research sample was (80) male and female students, with (40) male and female students for the experimental group and (40) male and female students for the control group. Before starting the experiment, the two groups were rewarded (intelligence, comprehensive thinking). To achieve the research objectives, the researchers adopted two approaches represented by the descriptive approach, to build the educational-learning program for teaching the educational laboratory experiments subject, while the second is the experimental approach, to know the effectiveness of the educational program in comprehensive thinking among students of the research sample; the duration of the experiment lasted a full semester of the academic year (2024-2025).They prepared the research tool to measure comprehensive thinking, consisting of (40) multiple-choice items. Also they verified the validity of the tool by presenting it to a group of experts and arbitrators in teaching and education methods, their stability, difficulty and distinctiveness of their items. After applying the tool and processing the data statistically using the t-test for two independent samples, the results showed that the experimental group that studied according to the educational program according to the TAPCK model outperformed the students of the control group who studied the same subject in the comprehensive thinking scale. In light of the research results, the researcher reached a number of conclusions, recommendations and proposals.

Keywords: Effectiveness, Educational Program, TPACK Model, Holistic Thinking, Physics, Students, College of Education

1. Introduction

In today's rapidly evolving educational landscape, integrating technology effectively into teaching and learning has become essential to equip students with the skills necessary to navigate complex scientific concepts (Koehler & Mishra, 2009). The TPACK (Technological Pedagogical Content Knowledge) model provides a framework for achieving this integration by merging content knowledge, pedagogical knowledge, and technological knowledge. While, this approach is particularly relevant in physics education, where abstract concepts and problem-solving skills are crucial (Jang & Chen, 2010). Using TPACK can enhance students' engagement, understanding, and ability to apply knowledge holistically

(Doabler, Nelson, & Kosty, 2014). Holistic thinking, a cognitive approach that allows students to see the interconnections between ideas, is a key skill in science education. It helps students synthesise information, approach problems comprehensively, and apply their understanding in varied contexts. For physics students, holistic thinking is essential, not only to grasp complex theoretical concepts but also to relate them to real-world applications. Furthermore, an educational program that uses TPACK may provide students with opportunities to reflect, apply, and explore physics topics in a way that strengthens holistic thinking. In addition, purpose of this study is to investigate the effectiveness of a TPACK-based educational program in fostering holistic thinking among students in the Physics Department at the College of Education for Pure Sciences. By analysing the outcomes of students exposed to this program, our research aims to contribute to our understanding of how integrated technological pedagogical approaches can enhance cognitive skills in physics education. The findings of this study could provide valuable insights for educators and curriculum designers aiming to create technology-rich, comprehensive learning experiences within science disciplines (Abu Athera, 2012). (Abdulradh, 2025).

1.2 Problem statement

Regardless of the leading role and practical importance of science in general, and physics in particular, there continue to be obstacles and challenges in teaching physics. Numerous students view physics as a set of abstract and unclear laws and concepts, failing to recognize its practical value. Moreover, this perception has led to several negative outcomes, such as low academic achievement (Doabler, Nelson, Walker & Kosty, 2014), the development of negative attitudes, and a reluctance among some students to continue studying applied sciences, like physics, at higher educational levels. Based on one of the desired goals of education is to foster holistic thinking in physics teaching. Failure to develop holistic thinking may result in students experiencing fear and anxiety due to conflicting concepts that do not align with their level of understanding thus, this conflict can manifest through complex stimuli triggered by environmental factors inside or outside the classroom. Furthermore, some educational systems have severely neglected the signification of holistic thinking, focusing instead on cramming students' minds with dry information without enlightening them on the process of learning itself. Moreover, traditional teaching methods have become insufficient for effectively conveying knowledge and developing holistic thinking among students.

The research problem can be summarized in number of pointers explained as follows:

1-One of the reasons for choosing this study was the researcher's observation, supported by surveying the opinions of a group of physics teachers, that students often exhibit dissatisfaction when scientific content is presented in a traditional way that relies on rote memorization and does not engage the learners' cognitive abilities.

2-Futhermore, there was a pressing need to keep up with contemporary trends in modern teaching methods and strategies. Several students lack practical skills in performing various physics experiments, primarily because these concepts are often delivered theoretically by instructors, or due to inadequate resources necessary for conducting these experiments.

3-Additionally, many physics concepts require imagination and contemplation, which traditional methods fail to foster.

Previous research and studies have indicated a weakness in students' holistic thinking abilities and highlighted the inability of existing teaching methods and strategies to stimulate holistic thinking. Such thinking is essential for driving students towards inquiry, discovery, and critical analysis.

Based on this, the research problem can be identified by answering the following question

The Effectiveness of an Educational Program Based on the TPACK Model in Developing Holistic Thinking among Physics Department Students in the College of Education for Pure Sciences."

1.3 The Significance

The educational process is grounded in several key pillars, among which educational programs stand out as crucial. These programs serve as a primary source of knowledge, providing learners with comprehensive aspects of grasping. Furthermore, without dedicated attention to these programs, the

educational process cannot succeed or evolve to meet global advancements. Therefore, educational programs must be developed, innovative, and tailored to meet the capabilities and needs of students, teachers, and educational institutions likewise.

Notwithstanding, educational programs organize objectives and content in a systematic, sequential manner, carefully avoiding excessive content or redundant activities. This structure facilitates both continuous and final evaluation and documentation, enabling the identification and remediation of various learning weaknesses. Consequently, an educational program is a critical tool for addressing disorganized or ad hoc learning processes. This researcher posits that integrating technology into education enriches curricula and represents a foundational step in higher education by leveraging communication and information technologies to foster effective learning. This integration enhances students' capacity for self-directed learning and repositions instructors from being mere repositories of information to becoming facilitators who guide students toward the correct learning trajectory. Therefore, the importance of developing educational programs lies in demonstrating the connection between theoretical principles and their practical applications within educational settings. This development also relies on educational theories to improve learning applications, emphasizing experiential learning and fostering students' self-initiated efforts in the learning process. Based on this educational technologies are employed optimally, promoting high levels of interaction with learning materials and enabling the evaluation of students' work. Furthermore educational programs thus serve as a bridge between scientific and technological advancements and their societal applications (Abu Athra, 2012, p. 39). The TPACK model is one of the frameworks that supports this approach that, its philosophy emphasizes the integration of teachers' knowledge of technology with content expertise and pedagogical strategies. Thus, this triad is fundamental to effective teaching, with the model comprising seven main domains (Rosenberg & Koehler, 2015, p. 190; Durdu & Dag, 2017, p. 151.)

Technology Knowledge (TK)

Pedagogical Knowledge (PK)

Content Knowledge (CK)

Technological Content Knowledge (TCK)

Technological Pedagogical Knowledge (TPK)

Pedagogical Content Knowledge (PCK)

Technological Pedagogical Content Knowledge (TPCK)

On the other hand, Researchers and psychologists have underscored the importance of systematically cultivating students' critical thinking abilities, enabling them to apply these skills to both their academic pursuits and real-world behaviour. Moreover, analysing a problem critically and evaluating it to devise a solution is a creative process that reflects each individual’s unique method of problem assessment, leading to the development of practical and achievable solutions. In defiance of, developing diverse thinking skills provides students with essential tools to navigate future information and changes with efficiency and effectiveness. Consequently, cultivating these skills has become increasingly recognized as a vital element for student success and societal advancement. In particular, enhancing thinking abilities—especially holistic thinking—is a key goal in science education, as holistic thinking stands as one of the most crucial forms of cognitive processing. This type of thinking is invaluable, as it enables the identification of weaknesses and gaps in proposed ideas. Furthermore, it promotes an open exploration of a broad range of alternatives and options, empowering individuals to select the most suitable and effective solutions to problems.

This ongoing study could be supported by

1-The TPACK framework focuses on the interrelationships between content, pedagogy, and technological knowledge domains. TPACK can be provided a useful organizational structure to identify what teachers need to know to integrate technology effectively. As well as,this framework also considers how these three domains interact to enhance learners' motivation, leading to more effective teaching and training.

2-The TPACK model acts for a modern framework that underscores the significance of integrating technological, content, and pedagogical knowledge as foundational components for effective teaching through the utilize of educational technologies.

3- Grasping the nature of holistic thinking exhibited by some students will help in addressing individual differences between them, specifically, and within their community, more broadly—an area of significant interest to specialists.

4-This current research focuses on the significance of raise group, university students, highlighting the need to enhance their academic level by examining and understanding their cognitive abilities, including holistic thinking.

5-This study may advantage curriculum developers within the Ministry of Higher Education in planning and designing courses by providing suitable teaching techniques for each subject, thereby advancing the teaching process.

1.4 Research Objectives

The present study seeks to achieve the following objectives:

To examine the effectiveness of an educational program grounded in the TPACK model for enhancing holistic thinking skills among students in the Physics Department at the College of Education for Pure Sciences.

To analyses the differences in post-test mean scores of holistic thinking between the experimental and control groups among students in the Physics Department at the College of Education for Pure Sciences.

1.5 Research Hypothesis

To achieve the objective of the research, the following null hypothesis has been formulated:

There is no statistically significant difference at the 0.05 level between the mean scores of the experimental group students who study physics topics using an educational program based on the TPACK model in scientific inquiry among physics students in the College of Education for Pure Sciences and the mean scores of the control group students who study the same material using the traditional method on the comprehensive thinking scale.

1.6 Limitation of study

The current research is limited to:

1- The College of Education for Pure Sciences (Ibn Al-Haytham) at the University of Baghdad.

2- Fourth-year students in the Department of Physics in the morning study program.

3- The second semester of the academic year (2024/2025).

4- Laboratory experiments on educational devices and tools.

1.7 Definition of the Key Term

First: Instructional Program: Al-Douri (2003: 15) defined a program as "an activity that includes a set of experiences and procedures provided based on sound scientific principles in light of a well-studied scientific plan aimed at adding knowledge and skills to individuals who were previously unable to perform them and helps them grow and gain insight."

Al-Dakhil (2007: 12) defined a program as "a set of organized and planned activities aimed at developing the knowledge and attitudes of trainees and helping them refine their skills, enhance their competencies, guide their thinking, and improve their performance in their work."

In this research, the program is operationally defined as: an educational framework that includes, in addition to the usual prescribed experiences, a set of additional experiences based on the TPACK model that suits the rational level of students, aiming to cultivate curiosity and comprehensive thinking among physics students in the College of Education for Pure Sciences.

Second: TPACK Model: Rosenberg and Koehler (2015: 186) defined the TPACK model as "the knowledge that arises from the interaction of content knowledge, pedagogical knowledge, and technological knowledge during teaching to create a new knowledge framework suitable for various teaching contexts and situations."

Durdu and Dag (2017: 151) defined the TPACK model as "the intersection of the primary forms of knowledge: content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK), which produce new knowledge, including pedagogical content knowledge (PCK), technological content knowledge (TCK), pedagogical technological knowledge (TPK), and the intersection of all three types, known as TPACK." Based on the above definitions, this research operationally defines the TPACK model as: a set of methods and strategies based on the integration of content knowledge, pedagogical knowledge, and technological knowledge to improve scientific inquiry and comprehensive thinking among physics students in.

Third: Holistic Thinking; (Tony, 2002:12) defined holistic thinking as the ability of individuals to think about problems in a comprehensive manner, setting aside details to find solutions. This type of thinking relies on evidence to reach final, practical, empirical results that can be tested, verified, and analyzed.

(Harman, 2003:16) described holistic thinking as an individual's ability, through their unique perspective, to shift from the traditional view of learning to a comprehensive, holistic approach. (Deamon, 2004:19) concepted holistic thinking as the individual’s capacity to approach problems in a thorough and inclusive manner, bypassing details to find solutions. It is motivational in nature, aiming to create alternatives, move away from routine thinking, and expand abilities through imagination and intuition. For the purposes of this research, the researcher operationally pointed out holistic thinking as a kind of thinking directed toward specific objectives that students strive to achieve. Moreover, it relies on induction and deduction as means to solve problems they feel a need to address, and is measured by the score a university student achieves on the holistic thinking test prepared in the current research. The College of Education for Pure Sciences.

2. Theoretical Framework

2.1 The TPACK Model

Rahimi and Pour Shahbaz (2019, p. 84) characterise the TPACK (Technological Pedagogical Content Knowledge) model as "a framework comprising the interplay among three principal components of educators' knowledge: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK)." The TPACK approach emphasises the significance of synthesising various domains to improve instructional efficacy. Ahmad (2019) asserts that the TPACK model is a modern methodology in teacher training and professional development, designed to enhance instructional efficacy through optimal practices. The concept underscores the necessity of integrating and balancing technological expertise, subject knowledge, and pedagogical knowledge for effective instruction utilising educational technologies. It seeks to provide educators with fundamental skills that facilitate the integration of technology into their instructional methodologies. Rosenberg and Koehler (2015, p. 190) and Durdu and Dag (2017, p. 151) elucidate that the TPACK model facilitates this integrative approach by promoting a thorough comprehension among educators of technology, content knowledge, and the most effective instructional strategies for the subject matter.

The model consists of seven principal domains:

1- TK Technology Knowledge

2- PK Pedagogical Knowledge

3- CK Content Knowledge.

4- TCK Technological content Knowledge

5- TPK Technological pedagogical Knowledge:

6- PCK Pedagogical content Knowledge

7- TPCK Technological Pedagogical Content Knowledge

Advantages of the TPACK model: The TPACK model is Identify by the following features; It links knowledge of content, pedagogy, and technology, enabling holistic communication processes. Gives teachers helpful visual aids, descriptions, and instances to simplify and clarify lesson concepts or subjects (Petra, et al., 2015: net).

2.1.1 The significance of the TPACK model

1- Enabling learners to evaluate their grasp of TPACK, self-assessment surveys serve as a tool for self-reflection on the model's seven components.

Improving educator s' expertise in TPACK domains to enhance educational results and attain specified objectives (Hasan, 2018).

2-Staying abreast of advancements in technology, pedagogy, and material to enhance educational environments.

3-Facilitating educators in resolving technical difficulties, overseeing classroom management, and rectifying misunderstandings.

4-Assisting educators in identifying optimal strategies to enhance student comprehension of academic content.

4-Advocating for sustainable professional development for educators and the necessity of remaining informed about advancements to enhance professional efficacy.

2.1.2 The educator’s function within the TPACK framework

1-Combining technology, pedagogy, and topic expertise to develop effective and compelling educational experiences.

2-Consistently refining and modifying pedagogical approaches to integrate emerging technologies and improve students' comprehension.

3-Resolving technical issues that occur in the classroom to facilitate an uninterrupted learning experience.

4-Choosing and implementing suitable technology instruments to enhance content dissemination and promote learning.

5-Offering direction to students regarding the efficient utilization of technology in their educational pursuits.

6-Contemplating and enhancing their pedagogical methods in accordance with TPACK principles to guarantee enduring professional development. subject area.

2.1.3 The learner's role in the TPACK model

1- Innovator and purveyor of knowledge.

2- Engaged participant in conversations and dialogues throughout the presentation of educational content.

3- Efficiently manages time and learning activities.

4- Capable of exchanging experiences with colleagues.

5- Proficient in locating requisite academic material

6- Determines the necessary information for the course material. Possesses the capability to engage with others electronically. Al-Abadi (2016, p. 13)

2.2 Holistic Thinking

Barker (1992: p.3) defines holistic thinking as the capacity of an individual to grasp the truth in a wide and complete manner, eschewing details or specifics. Bruner (1992: pp. 5-6) posits that holistic thinking is a capability that enables humans to address and resolve problems by perceiving them in their entirety.

Some assert that it is a capability that allows individuals to transition from a conventional paradigm to a flexible, comprehensive strategy for addressing the challenges they face (Hassan, 2022).

2.2.1 Characters of Holistic Thinking

1-It is a deliberate cognitive capacity that does not exist in isolation or without an aim.

2-Holistic thinking can be cultivated in an individual through the parenting methods employed in social development.

3-The individual demonstrates exceptional proficiency in collaborative environments.

4-It is marked by a focus on generalities while eschewing.

5-Enhances the capacity to conceive and produce ideas that facilitate problem-solving.

6-Empowers the individual to thrive and surmount various challenges they face.

7-Equips the individual with the capacity to communicate effectively with others.

8-Facilitates the enhancement of creative production in individuals. Holt (2004, p. 25)

2.3 Previous Studies: The researchers divided the studies into two portions.

Section One: Research on the TPACK Framework

1- Research conducted by Chen and Jang (2010): Chen and Jang's study pointed out to investigate the correlation between teachers' interest in technology integration and their level of TPACK knowledge among high school educators in Taiwan. The research utilized the Schmidt et al. (2009) questionnaire, administered to a cohort of 650 high school educators in Taiwanese institutions. Therefore, the study analyzed instructors' interests throughout three stages, and following factor validity assessment, only four domains were identified (TK, PK, CK, TPC). This study demonstrated a correlation between instructors' interest in integrating technology into instruction and their TPACK knowledge level.

2- Research conducted by Koehler, Mishra, and Kocoglu (2013): This study sought to investigate the evolution of TPACK knowledge among English student teachers engaged in a TPACK project employing a design-based methodology in Turkey over a duration of 12 weeks. The researchers utilized the Schmidt et al. (2009) questionnaire on a cohort of 22 educators. The findings indicated a notable enhancement in the subsequent domains of knowledge:

-Technological Knowledge (TK)

-Technological Content Knowledge (TCK).

-Technological Pedagogical Knowledge (TPK)

-Technological Pedagogical Content Knowledge (TPCK)

Section Two: Studies on Holistic Thinking.

1- Research conducted by Ferial et al. (2014: p. 572): The study sought to identify notable distinctions in cognitive styles (analytical versus holistic) among students of the Faculty of Educational Sciences and Arts at UNRWA, contingent upon various variables. Moreover, to do this, the researchers employed a Thinking Styles Scale (analytical vs. holistic), comprising 43 questions that encompass two sub-domains (analytical thinking style and holistic thinking style). Furthermore, The scale's psychometric features were validated and subsequently administered to a sample of 225 students, comprising 28 males and 197 females.

The findings revealed that the analytical thinking style was more dominant among college students than the holistic thinking type. Furthermore, statistically significant differences in holistic thinking style favoured males, whereas no statistically significant variations in analytical thinking style were linked to gender. The study revealed no statistically significant variations in analytical and holistic thinking styles among college students, regardless of their high school academic branch or academic level. A slight link was identified between students' scores on the analytical and holistic thinking scales and their cumulative GPA. In conclusion, this study has yielded various recommendations, the most significant of which is the

use of tactics and instructional methods that foster holistic thinking skills in students.

2- Raheef's Study (2023:1711): The study sought to assess the degree of hyperarousal in middle school students and to determine statistically significant gender-based differences in hyperarousal (male versus female), as well as to evaluate holistic thinking among middle school students and any statistically significant gender-based differences in holistic thinking (male versus female). Furthermore, it examined the correlation between hyperarousal and holistic thinking in middle school children. Moreover,this research sample comprised third-year students from morning middle schools in the 2022-2023 academic year. Based on this,.the researcher utilised the hyperarousal scale created by Mohammed (2015) and built a holistic thinking scale, confirming the validity and reliability of both instruments. The scales were delivered to a cohort of 200 male and female middle school pupils, and SPSS was utilized for data analysis. The research findings determined that:

-Middle school pupils demonstrate a significant degree of hyperarousal relative to the theoretical mean of the scale.

-Middle school students utilise holistic thinking in their educational pursuits.

-A substantial favourable link exists between hyperarousal and holistic thinking in middle school children.

3. Methodology

The experimental method was adopted to verify the research objective, and the experimental design for the experimental and control groups with partial control was the independent variable; and the dependent variable (Abdulsalam, 2025), (Yousif, 2024).

4. Results

In this chapter, the researcher presents the results obtained after statistical analyses, followed by the interpretation of these results, the conclusions drawn, and the recommendations and suggestions provided for the concerned authorities.

4.1 Results of the Holistic Thinking Test

To verify the null hypothesis, which states that: **"There is no statistically significant difference between the mean scores of the experimental group (students studying the subject of educational laboratory experiments using the educational program based on the TPACK model) and the mean scores of the control group (students studying the same subject without using the program) in the variable of holistic thinking,"** the researcher applied the holistic thinking scale to both the experimental and control groups as in table 1.

Table 1. Results of the Post-Test on Holistic Thinking in Educational Laboratory Experiments

Group	Sample Size	Mean Score	Standard Deviation	Variance	Degrees of Freedom	t-value (Calculated)	t-value (Table)	Significance Level (0.05)
Experimental	40	71.17	10.93	119.59	78	3.81	1.99	Statistically Significant
Control	40	63.07	9.52	60.66				

The data presented in Table 1 clearly demonstrates that students in the experimental group, who were taught using the TPACK-based educational program, achieved a significantly higher mean score (71.17) compared to their counterparts in the control group (63.07). The statistical analysis, utilizing the independent samples t-test, reveals that the calculated t-value (3.81) exceeds the critical t-value (1.99) at the 0.05 significance level, confirming that the observed difference is not due to random chance. Moreover, this outcome suggests that the TPACK-based educational program had a positive effect on enhancing holistic thinking among the experimental group students, thereby supporting the hypothesis that the educational intervention led to a measurable improvement in this cognitive domain.

4.2 Analysis of Findings

The research findings on holistic thinking indicated that students in the experimental group, who engaged with the Laboratory Experiments course through the TPACK-based educational program, surpassed their counterparts in the control group, who followed the standard curriculum for holistic thinking. Therefore, we rejected the second null hypothesis. The researcher attributes this superiority to a variety of explanations and circumstances, as demonstrated by the study's results:

The TPACK model enabled students to reflect on instructional scenarios, facilitating the identification of strengths and shortcomings in their topic mastery, pedagogical approaches, or the integration of technological tools in instruction.

4.2.1 Characteristics of the program, according to TPACK

The program's framework, which organized educational information in accordance with the TPACK model and analysed it through issues and exercises pertinent to the students' lives and realities, facilitated the stimulation of their thinking. It endowed them with enhanced imagination, initiative, and creativity, enabling students to formulate plausible assumptions regarding solutions, explore alternatives, and contest ideas. Challenges encountered in individuals' lives may provide substantial opportunities for the development of cognitive skills, facilitating their use in novel educational contexts. Unlike the previous curriculum, which emphasized the cognitive dimension of the scientific content, the educational program offered this;

4.2.2 Understanding the competencies of the TPACK model

The students' understanding of the TPACK model's skills and the interconnectedness of material, pedagogy, and technology enabled them to analyse and organize their classes to achieve integration among these three elements. A

1-The TPACK model facilitates reflection on teaching situations.

The TPACK model enabled students to reflect on teaching situations to identify strengths and weaknesses, whether related to their mastery of the content, the teaching methods used, or the integration of technological applications in teaching.

2-Nature of the Program Based on the TPACK Model.

The program, which structured the educational content according to the TPACK model and analysed it using problems and tasks related to the students' lives and realities, helped stimulate their thinking. The program instilled in them a greater sense of vision, initiative, and creativity in their thinking, motivating them to explore potential solutions, seek alternatives, and confront ideas. The problems encountered in individuals' lives could serve as an important tool for training thinking skills, enabling students to apply them in new educational situations. This is what the educational program offers, in contrast to the traditional program, which primarily concentrates on the cognitive aspect of the scientific content.

3-Understanding the TPACK Model's Competencies and Its Interrelationship with Content, Pedagogy, and Technology:

Students' understanding of the competencies of the TPACK model, along with the interrelationships between content, pedagogy, and technology, allowed them to analyse and plan their lessons to achieve integration among these three components.

5. Conclusions

One over decisive presentation and interpreting the results, the researcher concludes the following: Organizing, Designing, and Constructing Educational Content: The researcher's work, guided by well-defined objectives, significantly enhanced holistic thinking. The inclusion of activities, exercises, diagrams, illustrations, and colours, along with the use of educational and technological tools for content presentation, played a crucial role in fostering comprehensive thinking. The feasibility of teaching using the TPACK model The TPACK model, as a contemporary approach, emphasizes the integration of technology, content, and pedagogy. Moreover, this combination is essential for effective teaching when using educational technologies, confirming that the TPACK model is a viable framework for instruction.

The program promoted student engagement and critical thinking by encouraging students to freely express their opinions, engage in discussions, raise questions, participate actively, and foster a spirit of healthy competition. It also promoted flexibility in thinking and problem-solving, which contributed to enhancing critical thinking skills. The TPACK-Based Program proved effective in enhancing holistic thinking among the students in the research sample.

In light of the results and conclusions reached by the researchers, the following recommendations can be made: Exploring the impact of TPACK-based pedagogies on holistic thinking in physics education; this phrasing highlights the focus on teaching methods (pedagogies) an impact on students' cognitive development. The Role of TPACK in Developing Critical Thinking and Problem-Solving Skills Among Physics Students; if the goal is to explore more specific cognitive outcomes like critical thinking and problem-solving, this could be a targeted approach. Enhancing Cognitive Skills: A TPACK-Driven Approach to Holistic Thinking in Physics Education; this title places emphasis on "cognitive skills," which may provide clarity on what type of thinking or cognitive development is being measured. Integrating technology, pedagogy, and content knowledge to foster holistic thinking in physics students; this version could appeal to those who want to emphasize the integration of the three TPACK components: technology, pedagogy, and content knowledge. The Influence of Technology-Enhanced Teaching on Holistic Thinking in Physics Students: A TPACK-Based Study; this title specifies the use of technology, which is a core aspect of TPACK and suggests its influence on holistic thinking. Assessing the effectiveness of a TPACK-based educational framework for improving holistic thinking among physics students; this one suggests a more structured approach, focusing on the "framework" and the assessment aspect, which may appeal if the research includes an evaluation component. Building holistic thinkers: Investigating the impact of TPACK on physics education at the college level.

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