SvedbergOpen
DISSEMINATION OF KNOWLEDGE

International Journal of Artificial Intelligence and Machine Learning

Publisher's Home Page: https://www.svedbergopen.com/

Research Paper Open Access

Defining Authentic Technology-based Teaching and Learning for Vocational Education: A Conceptual Examination

Zhou Jiayue*[1], Nornazira Suhairom[2], Sharifah Maryam Syed Azman[3]

[1] Faculty of Educational Sciences and Technology, Universiti Teknologi Malaysia, Johor Bahru, 81310, Malaysia.
E-mail: zhoujiayue@graduate.utm.my
[2]Faculty of Educational Sciences and Technology, Universiti Teknologi Malaysia, Johor Bahru, 81310, Malaysia.
E-mail: p-nazira@utm.my
[3]Faculty of Educational Sciences and Technology, Universiti Teknologi Malaysia, Johor Bahru, 81310, Malaysia.
E-mail: sharifahmaryam@utm.my
*Corresponding Author: Zhou Jiayue, E-mail: zhoujiayue@graduate.utm.my

Abstract
Objectives: This conceptual paper aims to define Authentic Technology-based Teaching and Learning (ATbTL) and outline the limits of applying the Technological Pedagogical Content Knowledge (TPACK) framework for VET music education.
Method: This study adopts Conceptual analysis supported by literature synthesis to examine how existing digital competence frameworks, particularly Technological Pedagogical Content Knowledge (TPACK), address technology integration in Vocational Education and Training (VET). Bearings on authentic teaching, VET pedagogy, and digital competence were reviewed to set the background for introducing Authentic Technology-based Teaching and Learning (ATbTL).
Findings: The conceptual analysis shows that the most widely applied digital competence frameworks the particularly Technological Pedagogical Content Knowledge (TPACK) are insufficient for representing the industry oriented and practice based characteristic nature of Vocational Education and Training (VET), especially in technology-intensive subjects such as Music Editing and Production (MEP). The teaching previous research mainly emphasized teachers' technological knowledge but could not reach concepts of the various possibilities of digital technologies to facilitate authentic professional practice in vocational learning. The paper addressed this gap by conceptualizing Authentic Technology-based Teaching and Learning (ATbTL) as teaching and learning with technological fidelity, contextual authenticity, and professional process embedding. That reflects how industry standard technologies, authentic production tasks, and workflow embedded learning activities can essentially facilitate teacher competence development and further align music education within VET with the industry.
Novelty: This was the first attempt to propose an ATbTL conceptual framework that extends TPACK to encompass authentic professional practice with Technology-based Teaching and Learning in VET music education.

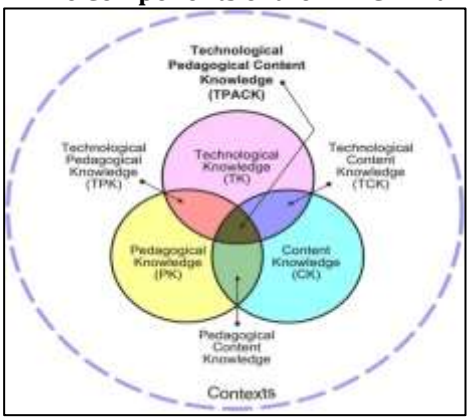
Keywords: ATbTL; VET Colleges; Vocational music education; Teacher competence; Employability

1. Introduction

Vocational Education and Training (VET) is intended to prepare learners for employment to equip professional competences as per the industry's changing demand [1]. Hence, the leading mission for VET Colleges is to train an appropriately skilled workforce that meets the demands of the changing labor market demands [2]. In recent years, the rapid development of Information and Communication Technologies (ICT) and the emergence of Industry 4.0 have significantly transformed the competencies required in modern workplaces [1,3]. These technological changes have also reshaped educational practices, particularly in vocational education where learning outcomes are closely connected to industry expectations. As a result, Technology-based Teaching and Learning has become increasingly important for ensuring that graduates possess relevant professional competencies. This transformation is particularly evident in technology-intensive programs such as Music Editing and Production (MEP), where teaching involves using professional digital tools such as Digital Audio Workstations (DAW), multimedia, and virtual instruments in the creative production process [2,4].
To support technology integration in education, several conceptual frameworks have been developed to guide teachers' use of digital technologies. Among them, the technological pedagogical content knowledge (TPACK) framework (Figure 1) [5] is one of the most widely applied models for explaining

how teachers combine technological knowledge, pedagogical knowledge, and disciplinary content knowledge in instructional practice [6,7]. In music education, DAW are embedded in composing, recording, and producing, so their use is central both pedagogically and professionally [8]. Other studies hint that generic digital competence frameworks may not always apply in vocational teaching environments, where digitally mediated technologies represent both an instructional medium and a central element of professional practice [2]. Concepts of technology integration usually prove taxing for vocational teachers when building suitable learning environments for Authentic teaching and Professional learning.

Figure 1: The Components of the TPACK Framework



Despite increasing attention to teacher digital competence, existing studies frequently examine technology integration from a general educational perspective rather than the industry-aligned context of VET music education [9]. Current frameworks rarely explain how teachers can design learning environments that reproduce professional production workflows in technology-intensive disciplines such as MEP. This limitation highlights the absence of a conceptual perspective that connects digital competence with authentic vocational practice and industry requirements.

To address this gap, this study adopts Conceptual analysis supported by literature synthesis to examine the limitations of the TPACK framework in VET music education and to define Authentic Technology-based Teaching and Learning (ATbTL). The study further develops an ATbTL conceptual framework that integrates technological fidelity, contextual authenticity, and professional process integration to better align Technology-based Teaching and Learning with authentic professional practice in VET.

2. Review Methodology

This study adopts Conceptual analysis supported by literature synthesis to examine the limitations of the TPACK framework in VET music education and to define ATbTL.

This study synthesizes existing literature on Technology-based Teaching and Learning, Authentic teaching and Professional learning, and teacher digital competence in VET. This paper tries to conceptualize the deficiencies in existing models of technology integration and attempts to develop a model more consistent with the industry nature of vocational music education. The article builds the ATbTL conceptual framework of technological fidelity, contextual authenticity, and professional process integration to support Authentic teaching and Professional learning in technology VET courses.

To develop the conceptual framework of ATbTL, related literature was reviewed using advanced search functions in major databases: Web of Science, Scopus, and Google. This review mainly covers literature from 2020-2026. The literature selection followed three main criteria. The first was for technology integration in VET education. The second was related to music technology education research, including DAW and other digital production software as learning tools within music and music technology education. The third was literature on teacher competence, digital competence frameworks such as TPACK, and authentic vocational learning pertinent to concept analysis development. Hence, the identified literature provides a critical conceptual grounding to identify research flaws and further develop the concept ATbTL

2.1. Conceptualizing ATbTL in the Context of VET music education

2.1.1. Defining ATbTL: Core Conceptual Elements

ATbTL is defined as a specialized pedagogical approach in which music teachers in Chinese VET colleges design learning environments using industry standard digital technologies that reflect the

expectations, practices, and production conventions of the contemporary music profession. This differs from a general technology integration approach, where digital tools mainly facilitate content delivery. In this regard, ATbTL views technology as the professional milieu from which both artistic and technical competencies emerge, particularly in MEP courses in MEP courses [1].

ATbTL comprises three core elements. First, technological fidelity refers to the extent to which the digital tools used in Music Education correspond to those employed in professional music production. This requires integrating Music Computer Technologies (MCT) such as DAW and audio processing software, enabling students to develop genuine technical competence and creativity [3]. Second, contextual authenticity means that learning activities are designed to be professional tasks in the music industry, such as composing for digital media or creating sound design for specific functions, managing an entire chain of production, etc. These tasks require the application of acquired technical skills and artistic discretion creative thought [8,9,10]. Third, professional process indicates that teaching needs process elements iteration, collaboration, and a quality imperative element that need to be present in making digital music. Teachers guide students through stages from conceptual development to editing, mixing, and refinement, and assessment focuses on the quality of digital artefacts and students' ability to work effectively in technology mediated environments [11].

2.1.2. Theoretical Foundations of ATbTL

ATbTL belongs to a family of diverse, yet complementary learning theories that explain why this approach is most suited to Music Education in Chinese VET colleges, particularly in technologically intense disciplines such as MEP. According to constructivism, students should construct musical artifacts rather than passively absorb information. In that regard, technical tools such as the DAW create an environment where, instead of abstract music theory, learners are facilitated in creating actual digital compositions to be more autonomous, creative, and exploratory [8,9,10,11,12]. Professional competences develop along with authentic social and technological contexts, and in this VET music teaching, the use of DAW, audio tools, and online platforms are viewed as authentic contexts whereby students practice mimicking practices in the music business [13]. From a Competency-based Education (CBE) perspective, learning is evaluated through demonstrable performance aligned with labor market expectations. For MEP, this means that digital competence must extend to occupational competence the ability to use industry standard tools to produce musical outputs that meet professional standards, assessed through the quality of digital musical works and decision making in the production process [14]. Together, these theories justify a pedagogy in which learning occurs through technology, in authentic professional contexts, and toward clearly defined industry related competencies [15].

2.1.3. ATbTL for music teachers in Chinese VET Colleges: Applicability and Necessity

The implementation of ATbTL in Chinese VET colleges is driven by both industry developments and national educational reform priorities. For music teachers ATbTL provides a necessary pedagogical direction for bridging the gap between traditional instruction and contemporary professional practice. The necessity of ATbTL emerges from the complete digitalization of music production processes. Dan [16] emphasize that digital music technologies are essential for modern music pedagogy. However, many teachers in Chinese VET colleges continue to rely on traditional teacher centered instruction with limited integration of industry standard digital tools. This mismatch contributes a significant contributory factor toward the lack of readiness to work in technology intensive professional contexts. Wan [8] observed that despite frequent use of digital technologies, the students rated themselves with low competence. The implication was that current teaching does not develop a deep technical capability [17]. Accordingly, instead of learning about technology in acquiring competencies through technological processes that are industry relevant, ATbTL shifts the emphasis toward learning to use technologies aligned with industry practices to teach the competencies in Music Education vital for Industry 4.0 [18].

Further, within the Chinese VET policy context, ATbTL is very instrumental in high-quality development and the training of digital talents. As Qian [19] notes that strengthening teachers' ICT enabled instructional competence is integral to achieving national modernization goals. ATbTL operationalizes this policy direction by showing how teachers can incorporate advanced tools such as DAW into instruction, project design, and assessment. Furthermore, in MEP courses, digital technologies constitute the professional practice itself. In this respect, Hu [4] outlined the requirement of ontological fidelity, whereby a learning task needs to reflect technologies and processes commonly used in professional practice. Thus, through ATbTL, a teacher designs and creates Music Education learning environments that can satisfy industry demands as identified by the core VET mandate: employability enhancement of students [20].

Finally, ATbTL directly addresses the challenges faced by Chinese VET teachers particularly the lack of external support conditions identified by Yang [3]. By articulating the specific competencies needed for

authentic technology-based instruction (like mastery of professional music software, competence in designing project-based assessments), ATbTL offers a roadmap for targeted professional development. This empowers teachers to move from passive adopters of technology policies to active designers of authentic learning environments, fostering a more human centered and industry responsive approach to technology integration in Music Education [13].

2.1.4. Distinguishing ATbTL from TPACK Framework

While the TPACK framework is widely used to explain how teachers integrate technology into teaching, ATbTL introduces additional dimensions that are particularly relevant to the vocational context and to Music Education in Chinese VET colleges. TPACK primarily describes the types of knowledge a teacher should possess Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK) and the intersections among them. In contrast, ATbTL is a more practice oriented and prescriptive concept that focuses on how this knowledge is enacted to create technology mediated learning environments with high ontological fidelity to professional practice [21].

The distinction between TPACK and ATbTL can be clarified in at least three aspects:

1) From generic "Technological Knowledge" to profession specific "Occupational Competence"

In the TPACK model, TK is defined broadly and may include basic computer literacy and the use of general educational tools. However, Music Education in VET requires teachers to develop occupational competence, that is, the ability to use industry standard digital music technologies as part of their core professional practice. Hassan [1] point out that in VET, technology is not merely an instructional aid but a central component of the work environment. Accordingly, ATbTL emphasizes mastery of professional grade digital audio technologies such as DAW and audio processing tools in ways that align with Industry 4.0 expectations [2]. This depth and specificity of technical competence are not explicitly required by the generic TK category in TPACK.

2) From pedagogical integration to professional process alignment

The TPACK framework assumes that technology will be used to enhance pedagogical methods, for example more interactive software may help present the content better or help conduct activities within class settings. ATbTL goes a step further by requiring that pedagogical strategies be aligned with professional production processes. Dan [16] argue that digital music teaching must move beyond theoretical explanation and involve students in practical creation and production. According to ATbTL, teachers are asked to organize learning around sequences that resemble contemporary digital music creation processes, including idea development, digital composition, editing, and refining, rather than the isolated, tool focused tasks [22]. In this sense, technology is not only integrated into pedagogy but defines the structure of learning activities themselves.

3) From classroom bounded context to industry aligned context

The extended version of TPACK recognizes the dimension "Context", which is more at the school or system level than at the contextual level. Therefore, the Music Education curriculum at Chinese VET colleges must also pay regard to industry and creative practice communities. Ma [6] observes that in China, music education always comes out of the classroom to get glued to most forms of digital creation and production embedded in music practice today. ATbTL explicitly aims to bridge this gap by positioning the music industry its tools, standards, and creative processes as a key reference point for designing learning experiences. This helps ensure that learning activities will be relevant to the employability criteria in the music and creative industries [8].

And while TPACK is a highly significant cognitive frame for teacher knowledge, ATbTL considers industry alignment and authentic learning a further step. It, therefore, shifts the descriptive, almost static understanding of technological knowledge toward a dynamic, career oriented pedagogic practice that positions students for professional digital music production.

3. Overview

3.1. Key Findings from Literature analysis

The review of recent literature will demonstrate the niche for research and analysis of the increased role of digital technologies in Music Education in pursuit of industry related learning outcomes. Discourses on music technology pedagogy suggest that digital technologies, such as DAW, virtual instruments, and multimedia production environments, constitute significant platforms for contemporary music making and music learning [12]. These technologies enable learners to engage in creative production processes, collaborative learning activities, and project-based tasks that reflect current practices in the music industry [23].

Several persistent tensions identified in the integration of digital technologies into the VET context are considered. For instance, while the evidence shows that most teachers have access to basic levels of digital competence, digital technologies are not easily integrated to foster more authentic learning environments in vocational education [3]. In technology-intensive courses such as MEP, digital tools are

not merely instructional aids but represent the professional production environment itself [18]. This distinction creates additional demands on teachers, who must demonstrate competence not only in using digital tools but also in modelling authentic music production workflows [24].

3.2. Research Gap in VET Music Education

While more and more focus is turning toward teacher professional digital competence, studies generally analyze integration in the general education context, not the industry related music VET education context [2]. Various representations, such as the TPACK framework, support distinctly interrelating teachers' technological, pedagogical, and subject matter knowledge [6]. However, such an approach focuses on teachers' knowledge areas, neglecting the process and practice-based nature of vocational production of music.

In this respect, digital technologies in professional music environments have ground level significance as a means through which creative work is produced, edited, and distributed. In this regard, authentic professional production practices in teaching the MEP courses form part of the learning environment and cannot be informed by an instrumental perspective on distance supports for theoretical teaching. Hence, this dimension remains in conceptual in linking digital competence and authentic teaching of professional learning within music VET.

3.3. Development of the ATbTL Concept

To address these limitations, this study introduces the concept of ATbTL as a pedagogical perspective designed to bridge the gap between digital competence and authentic vocational practice. The ATbTL concept extends existing technology integration frameworks by emphasizing the alignment between educational activities and professional music production processes.

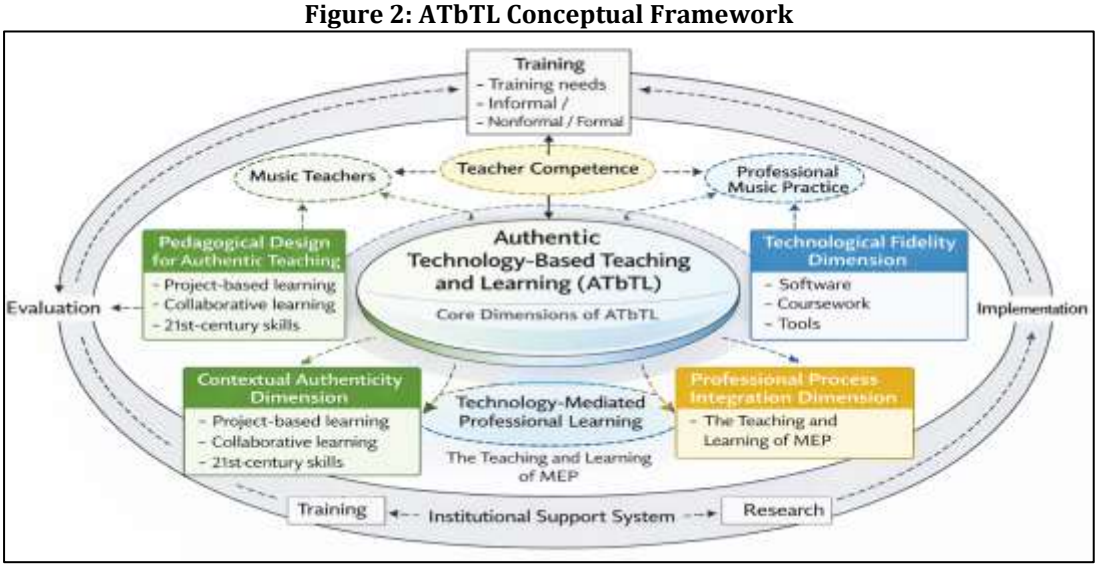
Under the ATbTL perspective, digital technologies are treated not merely as instructional tools but as the professional medium through which both artistic and technical competencies are developed. In Chinese VET Colleges, this implies that music teachers must demonstrate teacher competence not only in operating digital tools but also in modelling authentic production workflows such as digital composition, sound design, mixing, and post-production processes [18].

3.4. ATbTL Conceptual Framework

Based on the conceptual synthesis of literature on Authentic teaching and Professional learning, digital technology integration in VET, and music production pedagogy, this study develops an ATbTL conceptual framework to illustrate how technology, pedagogy, and professional practice can be systematically integrated in VET music education. Figure 2 presents the conceptual framework of ATbTL proposed in this study. The framework integrates three key dimensions: technological fidelity, contextual authenticity, and professional process integration.

The conceptual framework developed in this study is presented in Figure 2

Figure 2: ATbTL Conceptual Framework



Technological fidelity refers to the use of industry-standard digital tools such as DAW, audio processing software, and multimedia production technologies. Thus, pedagogical tools must ensure that the learning environment reflects technological tools and infrastructure appropriate for contemporary music production. Contextual authenticity entails designing learning tasks like real life

situations that professionals would face, such as scoring for digital media, production tasks-based collaboration, and sound design tasks requiring the learner to integrate artistic and technical aspects. Professional process integration emphasizes the alignment of instructional processes with professional processes. MEP courses would fit this by guiding the students through conceptual development, digital composition, editing, mixing, and mastering stages iteratively, thus allowing them to do an authentic production cycle like that in the music industry.

Through the integration of these three dimensions, the ATbTL framework provides a structured conceptual model that connects teacher competence, digital technologies, and industry practices in VET music education.

3.5. Implications for VET Music Education

The conceptualization of ATbTL offers several implications for VET music education, particularly in relation to teacher competence development, curriculum design, and student employability.

First, ATbTL places teacher digital competence within the perspective of occupational competence relative to the technologies and practices within the music industry. Music teachers would have to be competent in the digital tools and professional production in accordance with today's music industry [23]. Second, authentic production projects would replace sporadic technical exercises in the MEP curriculum and the curricula of related music courses. Sound design, digital arrangement, and other mixing activities must closely resemble a professional practice environment. This would ensure students learn relevant technical skills and the parameter for acceptable and appropriate solutions in a given professional context [4]. Finally, adopting an ATbTL perspective contributes directly to the central mission of VET, which is to enhance student employability. Teaching approaches and learning settings better reflect today's music sector's technological and creative ecology to produce graduates ready for work in digital music production and associated creative industries [2].

4. Conclusion

This study develops the concept of ATbTL as a pedagogical perspective for Music Education in Chinese VET colleges. The analysis suggests that existing technology integration frameworks, particularly the TPACK framework, provide a useful foundation for understanding teacher knowledge but do not fully capture the occupational competence required in technology-intensive programs such as MEP courses. This paper places the framework within a three fitting dimension: technological fidelity, contextual authenticity, and professional process integration through literature coalescence regarding authentic teaching and professional learning, digital competence, and vocational pedagogy. The framework highlights how Technology-based Teaching and Learning in VET music education can better align instructional practices with professional music production processes and industry expectations.

However, this study is conceptual in nature and is based on Conceptual analysis supported by literature synthesis. Thus, the ATbTL conceptual framework needs practical application within real educational contexts. Further operationalization of the ATbTL into a countable multiplicity of teacher abilities and then some empirical classroom research on its relevance for an MEP course will provide valuable guidance for teacher professional development, curriculum design, and assessment strategies concerning technology intensive music education in VET colleges.

Acknowledgement

This research is supported by Universiti Teknologi Malaysia, which provided an essential academic environment and resources for this study.

5. References

1. Hassan RH, Hassan MT, Naseer S, Khan Z, Jeon M. ICT Enabled TVET Education: A Systematic Literature Review. IEEE Access. 2021;9:81624-81650. doi:10.1109/ACCESS.2021.3085910
2. Jafar DSA, Saud MS, Hamid MZA, Suhairom N, Hisham MHM, Zaid YH. TVET Teacher Professional Competency Framework in Industry 4.0 Era. ujer. 2020;8(5):1969-1979. doi:10.13189/ujer.2020.080534
3. Yang C, Guo R, Cui Y. What Affects Vocational Teachers' Acceptance and Use of ICT in Teaching? A Large-Scale Survey of Higher Vocational College Teachers in China. Behavioral Sciences. 2023;13(1):1. doi:10.3390/bs13010077
4. Hu A, Liu Q, Daniel B. Digital Technologies in Authentic Assessment in Higher Education: A Systematic Literature Review and Narrative Synthesis. SAGE Open. 2025;27(1):1-27. doi:10.1177/21582440251357198
5. Istiningsih I. Impact of ICT integration on the development of vocational high school teacher TPACK in the digital age 4.0. WJET. 2022;14(1):103-116. doi:10.18844/wjet.v14i1.6642

6. Ma R. Research on the development and measures of Music Education students in the information Age based on TPACK framework. AEHSSR. 2023;6(1):133. doi:10.56028/aehssr.6.1.133.2023
7. Wibowo DY, Masunah J, Karyono T, Milyartini R. Study of Technological Pedagogical Content Knowledge (TPACK) Concept in Music Learning: In: 2022. doi:10.2991/assehr.k.220601.018
8. Wan W. Digital Technologies in Music Education: The Case of Chinese Students. Hodie. 2022;22. doi:10.5216/mh.v22.70752
9. Váradi J, Józsa G, Fodor ASz, Molnár-Tamus V, Szűcs T. Investigating music teachers' ICT skills and technical possibilities in the field of online music education during the COVID-19 pandemic. Heliyon. 2023;9(6):e16463. doi:10.1016/j.heliyon.2023.e16463
10. Hernández-Serrano MJ, Cullen J, Jones B, Romo NM. A Flexible Framework Integrating Digital and Social Competences in Vocational Education Across Diverse Contexts. MaC. 2025;13:8974. doi:10.17645/mac.8974
11. Brocca N. Adoption of new technologies in pre-service teachers. The case of interaction-enhancing videos. Teaching and Teacher Education. 2024;138:104427. doi:10.1016/j.tate.2023.104427
12. Zhong Z, Juwaheer S. Digital competence development in TVET with a competency-based whole-institution approach. Vocat Tech Edu. 2024;1(2). doi:10.54844/vte.2024.0591
13. Xue H. A TPACK-Based Case Study of Music Technology Integration in Liberal Music Education at a Vocational College: Exploring Student Learning Outcomes and Engagement. IJEH. 2023;8(3):5-8. doi:10.54097/ijeh.v8i3.8073
14. Jopp R. A case study of a technology enhanced learning initiative that supports authentic assessment. Teaching in Higher Education. 2019;25:1-17. doi:10.1080/13562517.2019.1613637
15. Shi Y, Gu M, Li M. AI literacy in vocational education: A framework for teacher professional development. J educ theory pract. 2025;2(4). doi:10.62177/jetp.v2i4.863
16. Dai DD. Artificial Intelligence Technology Assisted Music Teaching Design. Ding B, ed. Scientific Programming. 2021;2021:1-10. doi:10.1155/2021/9141339
17. Wang L, Julsuwan S. Enhancing digital literacy and pedagogical innovation among vocational educators in zhengzhou: A competency-based development framework. JEL. 2025;14(6):286. doi:10.5539/jel.v14n6p286
18. Civit M, Civit-Masot J, Cuadrado F, Escalona MJ. A systematic review of artificial intelligence-based music generation: Scope, applications, and future trends. Expert Systems with Applications. 2022;209:118190. doi:10.1016/j.eswa.2022.118190
19. Qian F. Strategies for Enhancing the Information Technology Teaching Competence of Vocational Education Teachers. IJETR. 2024;1(2). doi:10.70767/ijetr.v1i2.306
20. Petkova DV. DIGITAL TECHNOLOGIES FUNCTIONALITY IN MUSICAL EDUCATION. Published online June 26, 2023. doi:10.5281/ZENODO.8091847
21. Rodríguez Moreno J, Agreda Montoro M, Ortiz Colón AM. Changes in Teacher Training within the TPACK Model Framework: A Systematic Review. Sustainability. 2019;11(7):1870. doi:10.3390/su11071870
22. Zhong J. Music Information Technology as a Practical Direction for Developing the Innovative Abilities of Future Music Educators. JEER. 2023;4(3):202-206. doi:10.54097/jeer.v4i3.11416
23. Ghosh L, Ravichandran R. Emerging technologies in vocational education and training. J Dig Learn Edu. 2024;4(1):41-49. doi:10.52562/jdle.v4i1.975
24. Aadil Hussain Mir. Vocational and skill-based education in India: A critical review of nep 2020's implementation and challenges. MORFAI. 2025;5(1):406-410. doi:10.54443/morfai.v5i1.2626