

Unpacking Pedagogical Content Knowledge: The Predictive Power of Pedagogical Content Knowledge Components on Student Achievement in Chinese Pop Singing Courses

Han Ruiling, Shafizan Sabri

Faculty of Music and Performing Arts, Universiti Pendidikan Sultan Idris, Malaysia.

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Abstract

This study delves into the critical role of Pedagogical Content Knowledge (PCK), as theorized by Lee Shulman (1986), in shaping instructor effectiveness and student outcomes. While PCK's significance in enhancing teaching practice and fostering student achievement is well-documented across various disciplines, its application and empirical investigation within music education remain notably limited. This gap is particularly salient in performance-based fields, where unique pedagogical demands often necessitate specialized instructional approaches. Addressing this, the research focuses on the impact of instructors' PCK components on student achievement in one-to-one pop singing courses, a cornerstone of musical performance training at conservatories in China. A quantitative research design was employed, engaging 55 pop singing instructors from conservatories across China. Data were analyzed using multiple linear regression, enabling discernment of the individual influence of four key PCK components: conceptions of teaching purpose, knowledge of student understanding, curricular knowledge, and instructional strategies. The findings indicate that Curricular Knowledge ($\beta=0.509$, $p<0.001$) and Instructional Strategies ($\beta=0.447$, $p<0.001$) emerged as the strongest and most significant predictors of student achievement, underscoring their pivotal role in effective pop singing pedagogy. Knowledge of Student Understanding ($\beta=0.192$, $p<0.05$) demonstrated a moderate, yet statistically significant, influence, suggesting that while understanding students' individual needs is important, its effectiveness is often enhanced when integrated with robust curriculum design and versatile teaching methods. In contrast, Conceptions of Purpose for Teaching Subject Matter ($\beta=0.144$, $p>0.05$) showed no significant effect on student achievement within this context, potentially indicating that in performance-driven disciplines like pop singing, the practical "how-to" aspects of teaching may carry more immediate weight than the broader philosophical "why." This study highlights PCK as a crucial determinant of student success, particularly within the specialized domain of pop singing education.

Keywords: Higher Music Education, Pedagogical Content Knowledge (PCK), Pop Singing Education, Student Achievement, Music Conservatories

Introduction

Effective teaching stands as a cornerstone of quality higher education, serving as the primary conduit through which knowledge is disseminated, skills are honed, and critical thinking is cultivated. This imperative is particularly pronounced within specialized academic and vocational disciplines, where the mastery of complex subject matter and the development of high-level practical competencies are paramount. In the dynamic landscape of the contemporary music industry, there is an ever-increasing demand for highly skilled and versatile performers, necessitating not only rigorous training in technical proficiency but also sophisticated pedagogical approaches that can effectively transform raw talent into professional artistry.

Instructors are essential in any effort to improve educational quality and efficiency. The quality of education is largely contingent on their performance, which reflects their ability to optimally prepare and utilize their competencies (Luqman et al., 2019). Indeed, the better an instructor's performance, the greater the possibility of student achievement (Luqman et al., 2019). The increased availability of data linking students to instructors has made it possible to estimate the significant contribution instructors make to student achievement (Bitler et al., 2021, p. 1). Enhancing professional competence is thus a crucial endeavor for instructors seeking to improve student learning outcomes (Kasim et al., 2023), with professional development consistently leading to higher-quality teaching and increased student learning achievement (Gess-Newsome et al., 2019). This relationship underscores how instructors' professional knowledge profoundly impacts student achievement by elevating teaching quality and fostering student engagement, highlighting the importance of ongoing instructor education and development.

In response to the multifaceted nature of instructor professional knowledge, Lee S. Shulman proposed in 1986 that educational researchers broaden their investigative scope. Among the various aspects of instructor knowledge he identified, Pedagogical Content Knowledge (PCK) garnered significant interest due to its unique focus on situating instructor knowledge and practice within the teaching of a specific discipline (Gess-Newsome et al., 2019). Shulman (1987) posited PCK as the category most likely to distinguish an expert's comprehension from that of a novice, as it refers to a form of professional understanding unique to instructors. Critically, PCK has been identified as a primary factor influencing student progress (Neumann et al., 2019) and one of the most influential factors affecting student achievement (Gess-Newsome, 2013). This theoretical development has subsequently spurred extensive research into PCK across diverse subject areas and professional fields.

In China, the pop music singing major has emerged as a prominent professional program offered by numerous higher art colleges, specifically designed to prepare students for the professional pop music industry. The core of this curriculum is the "one-to-one" pop singing course. Initially recognized in the 1990s as a professional direction within music performance in universities (Shao, 2019; Zhao, 2019), the field has gained increasing attention and importance with the establishment of more dedicated pop singing majors and the formal independence of pop music as a subject in 2018 (Chen & Wang, 2022). Consequently, the

professional knowledge of pop singing instructors is now recognized as playing a crucial role in students' performance and the overall quality of teaching within this evolving discipline.

Problem Statement

Despite the recognized importance of PCK across various educational domains, a significant gap persists in its empirical investigation within music education. Shulman (1986) famously proposed that educational researchers broaden their scope to encompass multiple aspects of instructors' professional knowledge. Subsequent research has constructed careful, large-scale measures of PCK, using this information to examine the construct alongside teacher knowledge, practice, and student achievement (Gess-Newsome et al., 2019). PCK has been consistently found to be a separate and distinct knowledge dimension (Gess-Newsome, 2013), recognized as a key element in teaching practice and instrumental in improving student achievement (Jacob et al., 2020). This necessitates its study in combination with specific subject matter.

In China, the pop music singing major, despite its growing importance, is an emerging subject with a relatively shallow professional foundation. Numerous studies underscore the importance of instructors' professional knowledge for subject-specific teaching; indeed, the primary reason for researching instructor knowledge is to improve student achievement (Guerriero, 2014). However, new subjects often expose inadequacies in instructors' professional competence when completing teaching tasks (Hill et al., 2005).

While PCK is most widely applied in science subjects within school education, research on PCK in music education remains notably limited (Manila, 2020; Sarkar et al., 2024). Furthermore, discussions on the professional knowledge of music education instructors in Chinese colleges and universities are scarce, with even the definition and content of music instructors' course teaching competence remaining vague (Dai, 2018). This lack of clarity is detrimental to the research and development of subject teaching. With the recent independence of the pop music major in Chinese universities and colleges, the importance and urgency of teaching and research in pop music singing are self-evident. The professional knowledge of pop music instructors, which directly influences teaching quality and student achievement in pop singing, has thus become an urgent and unavoidable issue that demands study in higher education. A lack of PCK in pop singing instruction could significantly impact student achievement and overall teaching quality. Therefore, it is imperative to examine the influence of instructors' PCK on student achievement in one-to-one pop singing courses.

Theoretical Framework

This study is firmly anchored in a multi-faceted theoretical framework that illuminates the complex interplay between instructor knowledge, pedagogical choices, and student achievement in specialized music education. The Pedagogical Content Knowledge (PCK) Theory, first introduced by Lee Shulman in his seminal 1986 article, "Those Who Understand: Knowledge Growth in Teaching," serves as the central lens for examining the specialized knowledge required by pop singing instructors in one-to-one teaching contexts. Shulman's work revolutionized the conceptualization of teacher expertise by proposing that effective teaching extends beyond mere mastery of subject matter (content knowledge) and general teaching methods (pedagogical knowledge). PCK represents the transformation of subject matter knowledge for teaching, embodying an instructor's ability to blend content with

pedagogy to make the subject comprehensible and accessible to learners. This includes understanding the most powerful analogies, illustrations, examples, explanations, and demonstrations: the ways of representing and formulating the subject that make it comprehensible to others.

PCK is particularly suitable for this study due to its emphasis on the discipline-specific nature of teaching and its direct link to instructional effectiveness and student learning. In specialized, performance-based disciplines like pop singing, instructors must possess not only profound knowledge of vocal technique, music theory, and performance practices but also the unique ability to convey this complex content in a way that resonates with individual students' learning needs and facilitates their practical skill development. PCK provides a robust framework for dissecting how instructors bridge this gap between "knowing" and "teaching" within such a nuanced context.

Complementing PCK, Constructivist Learning Theory underpins our understanding of how students actively construct knowledge from their experiences. This theory emphasizes the learner-centered nature of knowledge construction, highlighting that learning is not a passive reception of information but an active process where individuals build new understandings based on prior knowledge and interactions with their environment. In one-to-one pop singing instruction, this means instructors' pedagogical choices must align with students' existing vocal experiences, musical understanding, and cognitive development to foster meaningful and lasting learning. Effective instructors, guided by constructivist principles, facilitate discovery, encourage experimentation, and provide tailored feedback that helps students integrate new techniques and concepts into their developing vocal schema.

Furthermore, Cognitive Load Theory, developed by John Sweller, is integrated to address the cognitive challenges inherent in learning and teaching music, particularly in individualized pop singing instruction. This theory posits that learners have a limited capacity for processing new information (working memory). Instruction that imposes excessive cognitive load can hinder learning. In pop singing, instructors must manage various types of cognitive load: intrinsic (inherent complexity of vocal tasks), extraneous (poorly designed instruction), and germane (effortful processing leading to schema construction) to optimize learning. Understanding how instructors' PCK informs their strategies for reducing extraneous load and promoting germane load is crucial for enhancing student achievement in a cognitively demanding skill like singing.

Drawing from Shulman's original conceptualization and subsequent refinements, this study specifically investigates four key components of instructors' PCK as they relate to student achievement in pop singing courses:

Conceptions of Teaching Purpose for Subject Matter: This component refers to an instructor's understanding of the specific goals and objectives for teaching pop singing, encompassing technical proficiency, artistic expression, and industry relevance.

Knowledge of Student Understanding: This involves an instructor's awareness of students' common misconceptions, prior knowledge, learning difficulties, and developmental stages in pop singing, crucial for constructivist approaches.

Curricular Knowledge: This refers to an instructor's familiarity with relevant curriculum materials, vocal exercises, repertoire, and assessment tools, and their sequencing within the broader program, impacting how cognitive load is managed across learning progression.

Instructional Strategies: This component pertains to the variety of teaching methods, techniques, and approaches an instructor employs to facilitate learning in pop singing, including feedback mechanisms, demonstration, and strategies designed to manage cognitive load effectively in individualized settings.

Significance of the Study

This research holds substantial significance by addressing a critical gap in the understanding of Pedagogical Content Knowledge (PCK) within contemporary music education, particularly in pop singing instruction at Chinese conservatories.

Theoretical Significance

Theoretically, this study makes several key contributions. It directly addresses a critical research gap by providing a much-needed empirical examination of PCK in pop singing instruction, an area largely underexplored compared to general education or traditional music disciplines. By focusing on this niche, the research refines and contextualizes existing PCK frameworks, shedding light on how instructors integrate their profound understanding of pop music content (genres, vocal techniques, industry trends) with effective pedagogical strategies within a modern, performance-oriented discipline. Furthermore, its focus on conservatories in Chengdu, China, offers valuable cross-cultural insights, illuminating how specific cultural contexts, educational philosophies, and the demands of the vibrant Chinese pop music industry shape the development and application of PCK among instructors, fostering comparative understandings for the global music education community.

Practical Significance

Practically, this research offers substantial benefits to various stakeholders. The findings will provide crucial empirical data to inform curriculum and pedagogy development for conservatories, guiding the design of more effective teaching methods, learning materials, and assessment strategies aligned with pop vocal performance demands. It will also play a vital role in enhancing instructor training and professional development by pinpointing specific PCK components that correlate with student achievement, allowing for the creation of targeted workshops and a clear roadmap for aspiring instructors. Beyond academia, the study contributes to the pop music industry by fostering improved pedagogical practices, thereby developing a more skilled and well-trained talent pipeline. Most importantly, the research has a profound student-centered impact, highlighting the critical importance of instructional quality in shaping students' technical proficiency and musical expression, ultimately leading to significantly improved learning experiences and higher standards of vocal training for aspiring pop singers.

Policy and Institutional Significance

This research also carries significant policy and institutional implications. It provides an empirical foundation for enhancing the strategic direction and quality assurance within conservatories and broader music education bodies in China. The findings offer crucial

evidence-based support for decision-making regarding instructor hiring, promotion, and professional development policies, ensuring that staffing and career progression genuinely reflect effective teaching capabilities. By identifying specific PCK elements that drive student achievement, the study will help establish clearer benchmarking standards for instructor quality within specialized programs, assisting conservatories in their internal quality assurance reviews and external accreditation processes. Ultimately, by promoting excellence in music education through an emphasis on pedagogical quality, this research supports the ongoing pursuit of outstanding student outcomes and reinforces the leadership role of music conservatories in training future musical talent.

The aforementioned theoretical and practical imperatives underscore the necessity of this investigation. Accordingly, this study is designed to explore the following research questions and associated hypotheses:

- i. What is the level of instructors' pedagogical content knowledge (PCK), including conceptions of purpose for teaching subject matter, knowledge of students' understanding, curricular knowledge, and knowledge of instructional strategies, in one-to-one pop singing courses at the conservatories in Chengdu?
- ii. Is there a statistically significant relationship between instructors' pedagogical content knowledge (PCK) and student achievement in one-to-one pop singing courses at the conservatories in Chengdu?
- iii. To what extent do the four components of instructors' pedagogical content knowledge (PCK) namely, conceptions of purpose, knowledge of students' understanding, curricular knowledge, and instructional strategies influence student achievement in one-to-one pop singing courses at the conservatories in Chengdu?

Literature Review

The burgeoning pop singing major within Chinese higher education represents a vibrant yet under-researched domain. A significant knowledge gap persists, particularly concerning the professional knowledge requirements of pop singing instructors in China. This scarcity is even more pronounced within the international academic sphere, where empirical studies on the pedagogical content knowledge (PCK) of pop singing instructors remain extremely rare. This literature review critically examines existing scholarship relevant to pop singing pedagogy, PCK theory, and PCK frameworks. By exploring these areas, this review aims to establish a comprehensive teaching paradigm and set clear guidelines for pop singing courses, providing an essential basis for subsequent research into the unique PCK of pop singing instructors.

Pop Music Singing Education: Context and Pedagogy

Higher pop music education has a notable history, with institutions in the United States, such as Berklee College of Music, establishing programs as early as the 1950s (Smith, G. D., 2016). Over the last three decades, many Higher Music Education Institutions globally have increasingly embraced popular music education, acknowledging its growing relevance (Parkinson, 2017).

The teaching of pop singing courses typically focuses on guiding students to acquire foundational knowledge in vocal techniques, music theory, and performance practices. Lessons commonly begin with fundamental aspects, including posture, breath control, and vocal warm-ups (Lă & Fiuza, 2022). Successful singers skillfully balance a multitude of often

competing physiological and artistic forces, encompassing neurological, audiological, musculoskeletal, and aerodynamic systems, alongside crucial musical, emotional, linguistic, and psychological factors (Nair, Howard, & Welch, 2018). Despite a growing understanding of the functional basis of singing, the intricate and sometimes intuitive nature of vocal teaching makes it challenging to precisely define the instructional process. This complexity, coupled with the observation that many renowned singers may not have undergone extensive formal vocal training, underscores the need for more in-depth and detailed study into the specific pedagogical content knowledge required in pop singing education.

Foundational Pedagogical Content Knowledge (PCK) Theory

The theoretical foundation of this study is rooted in Lee Shulman's seminal work on Pedagogical Content Knowledge (PCK), first introduced in his 1986 article, "Those Who Understand: Knowledge Growth in Teaching." Shulman's theory emerged from a perceived lack of scholarly focus on the specific professional knowledge instructors require for effective teaching. He argued that while content knowledge (mastery of subject matter) and general pedagogical strategies (teaching methods) are necessary, they are insufficient on their own to fully explain quality instruction. Instead, Shulman (1986, 1987) introduced PCK as a distinct domain: "the special amalgam of content and pedagogy that is uniquely the province of teachers, their own form of professional understanding" (Shulman, 1987, p. 8).

PCK captures the intersection of teaching and content expertise, representing the transformative process by which instructors adapt and formulate subject matter to make it teachable and accessible for learners. This transformation incorporates insights into student misconceptions, cognitive challenges, and appropriate scaffolding methods (Shulman, 1987). Shulman (2004) retrospectively asserted that PCK was meant to serve as a bridge between subject matter knowledge and pedagogical knowledge, creating a synthesis essential for making learning both rigorous and accessible. Consequently, PCK has been widely recognized as a pivotal component of instructor expertise and a crucial factor influencing student progress (Gess-Newsome et al., 2019; Kind & Chan, 2019; Neumann et al., 2019).

Pedagogical Content Knowledge Frameworks and Components

Building upon Shulman's foundational work, various researchers have developed frameworks to delineate the components of PCK. This study specifically adopts Grossman's (1990) PCK framework, which provides a structured and comprehensive lens well-suited for analyzing the complex and dynamic demands of vocal performance education. Grossman (1990) further broadened the original PCK concept, viewing it as a product of instructors transforming subject matter knowledge for teaching (Neumann et al., 2019). Her framework implies specific professional knowledge requirements beyond mere content mastery for effective teaching.

Grossman's (1990, pp. 8-9) framework delineates four central components of pedagogical content knowledge:

- i. Conceptions of purpose for teaching subject matter: This component encompasses an instructor's knowledge and beliefs about the overarching goals and objectives for teaching a specific subject at different educational levels. These conceptions guide an instructor's pedagogical decisions and are reflected in their instructional aims for particular subject matter. In pop singing, this includes an instructor's understanding of goals such as

- fostering technical proficiency, artistic expression, and industry relevance.
- ii. **Knowledge of Students' Understanding:** This refers to an instructor's awareness of students' existing knowledge, common conceptions, and potential misconceptions regarding specific topics within the subject matter. To design effective explanations and representations, instructors must understand what students already know and what aspects of the subject they are likely to find challenging or puzzling. In pop singing, this means instructors can adjust teaching based on students' individual needs, prior knowledge levels, and specific vocal or musical misunderstandings.
 - iii. **Curricular Knowledge:** This component involves an instructor's familiarity with the available curriculum materials for teaching a particular subject, as well as an understanding of both the horizontal (what is taught concurrently) and vertical (what has been taught previously and will be taught subsequently) curriculum. It requires instructors to have a deep understanding of pop singing subject matter knowledge and to possess comprehensive course knowledge across various dimensions of the curriculum.
 - iv. **Knowledge of Instructional Strategies:** This final component encompasses an instructor's repertoire of teaching methods, techniques, and representations specifically designed for teaching particular topics. Experienced instructors often possess a rich array of metaphors, activities, or explanations that are particularly effective for conveying complex concepts, while novice instructors are in the process of developing such a repertoire (Grossman, 1990, p. 9). This implies that instructors should possess mature teaching methods and strategic abilities to present and transform thematic knowledge into forms that students can easily accept and comprehend.

Despite its widely acknowledged significance, PCK remains a challenging concept for researchers to define precisely and quantify due to its often-intangible nature (Loughran et al., 2007). It manifests in the nuanced, day-to-day interactions between the instructor, the subject matter, and the students, from explaining a complex vocal technique to guiding a student's creative interpretation. Furthermore, the practice of teaching is an intricate and continuously evolving process, demanding that instructors possess flexible, in-depth knowledge that extends beyond traditional curricula, including staying abreast of industry trends and applying this knowledge to diverse student needs. Consequently, a plethora of additional PCK frameworks and models have been developed since Shulman's (1987) original contribution, offering varied perspectives on applying PCK across educational settings.

PCK in Specific Disciplines and its Relationship with Student Achievement

PCK has been widely recognized across diverse disciplines, with extensive studies, particularly in science education, linking high levels of teacher PCK with improved student outcomes (Depaepe et al., 2013; Gess-Newsome et al., 2019; Kind & Chan, 2019; Neumann et al., 2019). The relationship between PCK and student achievement is acknowledged as complex and multifaceted. While numerous studies affirm PCK's impact on academic performance, its influence is not universally uniform across all disciplines (Jacob, John, & Gwany, 2020). Each field presents distinct characteristics, learning processes, and instructor-student interactions that shape how PCK is applied and its subsequent effect on learning. In the performance-based and highly creative domain of pop singing, an instructor's ability to teach vocal techniques while simultaneously inspiring creativity, stage presence, and interpretive skills is paramount. This highlights the critical need for targeted research to understand how pop singing instructors' PCK specifically influences student achievement within this specialized

major, analyzing the efficacy of diverse teaching strategies in developing students' vocal range, tone quality, and audience connection during live performances.

PCK in Music Education and the Research Gap

Despite the extensive research on PCK in other fields, its empirical investigation within music education remains notably limited (Manila, 2020; Sarkar et al., 2024). This scarcity is even more pronounced within the unique context of Chinese higher education. There are few discussions on the professional knowledge of music education instructors in Chinese colleges and universities, and even the definition and content of music instructors' course teaching competence are very vague (Dai, 2018). This lack of rigorous examination of PCK in one-to-one vocal music instruction, especially within contemporary genres like pop singing at conservatories, represents a significant research gap. Existing literature often focuses on traditional Western classical music pedagogy or general music education, leaving a void in understanding how PCK operates within the dynamic and rapidly evolving context of contemporary vocal music instruction in China.

Unique Pedagogical Considerations in One-to-One Pop Singing Instruction

One-to-one performance instruction, which is standard in pop singing education at conservatories, presents unique pedagogical challenges and considerations distinct from traditional group classroom settings. This individualized format necessitates highly personalized feedback, tailored curriculum adjustments, and dynamic, real-time interaction between the instructor and student. Such a setting demands exceptional diagnostic skills from the instructor, who must accurately identify individual student strengths, weaknesses, and misconceptions on the fly. Instructors must possess a flexible repertoire of instructional strategies to adapt to diverse learning styles and progress rates, balancing the development of technical proficiency with artistic expression and student motivation. The intimate nature of this setting also requires strong interpersonal skills to build rapport and foster a supportive and trusting learning environment. In this context, PCK is paramount: instructors must not only know what to teach but also how to teach it effectively to a single, unique learner, often adapting their methods in response to immediate performance needs. This necessitates a highly responsive and adaptive application of curricular knowledge, instructional strategies, and deep knowledge of student understanding.

Student Achievement in Music Education

Student achievement in music education is a multifaceted construct that extends beyond mere technical proficiency or examination grades. It encompasses a range of outcomes reflecting a student's holistic development as a musician and performer. Common measures and indicators of student achievement in music education contexts include: performance assessments (e.g., juries, recitals, public concerts), technical mastery (e.g., vocal range, breath control, intonation, rhythmic accuracy), musicality and artistic expression (e.g., interpretation, phrasing, stylistic authenticity), theoretical understanding, sight-reading ability, and even aspects like stage presence and audience engagement. Furthermore, student achievement can be understood through their progress in self-regulated learning, motivation, and the development of a personal artistic identity.

The assessment of student achievement in pop singing in China has evolved beyond an exclusive focus on mere "singing technology." With the dynamic expansion of contemporary popular music, encompassing over 2,000 diverse styles and genres, each capable of

generating novel aesthetics, the criteria for evaluating pop singing proficiency have similarly broadened. In this context, pop singing instructors are challenged not only to tailor their pedagogy to individual student characteristics and preferences but also to demonstrate a deep understanding and respect for the inherent developmental laws of popular music and its rapidly changing industry landscape. Thus, the comprehensive evaluation of student achievement in pop singing reflects a higher embodiment of instructors' specialized professional knowledge and pedagogical quality.

For the purpose of this study, student achievement specifically pertains to the academic outcomes of pop singing majors at conservatories in Chengdu. The assessment structure for pop singing majors typically involves five distinct types of examinations: (1) the "professional review" examination for undergraduate admission in the arts field; (2) end-of-semester pop singing course examinations; (3) annual pop singing course examinations (often a more comprehensive end-of-year assessment); (4) graduation examinations for graduating students; and (5) competitive examinations for top student selection, overseen by the Academic Affairs Office (Shi, 2020). Aligned with the research questions of this study, the measure of student achievement will specifically be derived from the Type 3 annual pop singing course final examinations, which encompass a comprehensive evaluation of students' progress and mastery. All student achievement data utilized in this study were graded according to the "Grading Standards for Students' Achievement of Pop Singing Course Examination" (Shi, 2020).

Synthesis and Urgency of Research

Ultimately, PCK plays an indispensable role in classroom teaching, occupying a unique space at the intersection of subject content knowledge and pedagogical skills. Deficiencies in either content knowledge (leading to inaccurate information) or pedagogical knowledge (resulting in ineffective teaching) inevitably undermine an instructor's PCK, negatively impacting teaching quality. In pop singing, such deficiencies could hinder students' full potential in vocal development, performance skills, and creative expression. This chapter underscores the urgent need for further investigation into the pedagogical content knowledge of pop singing instructors. Such focused research is crucial for developing more effective teaching methods, improving curriculum design, and ultimately enhancing the quality of pop singing education in a rapidly evolving musical landscape.

Based on the theoretical underpinnings of PCK and the existing literature, this study proposes the following null hypotheses for investigation:

H₀₁: There is no significant relationship between instructors' pedagogical content knowledge (PCK) and student achievement in one-to-one pop singing courses at the conservatories in Chengdu.

H₀₂: The components of instructors' pedagogical content knowledge: conceptions of purpose for teaching subject matter, knowledge of students' understanding, curricular knowledge, and instructional strategies do not significantly influence student achievement in one-to-one pop singing courses at the conservatories in Chengdu.

Methodology

This study utilized a quantitative research design, specifically a correlational approach. This design was chosen to investigate the relationships between instructors' pedagogical content knowledge (PCK) components and student achievement in one-to-one pop singing courses, without manipulating variables. The correlational design is appropriate for examining the extent to which variations in PCK components are associated with variations in student achievement.

Participants

The population for this study includes all pop singing instructors currently teaching at accredited conservatories in China. The research sample for this study comprises 55 pop singing instructors selected from three conservatories in Chengdu, China. These three conservatories represent the complete set of institutions in China offering structured one-to-one pop singing programs, making them a comprehensive and highly suitable setting for this research. A purposive sampling technique was employed to identify instructors who met predefined criteria. This non-probability sampling method was chosen because it facilitates the targeted selection of participants with the specific expertise and experience necessary to effectively address the research questions (Fraenkel, Wallen, & Hyun, 2023).

Although the primary unit of analysis in this study is the pop singing instructor (N = 55), student data was also incorporated to assess learning outcomes. Specifically, each instructor provided achievement data for all of their students enrolled in one-to-one pop singing courses. Because the number of students varied across instructors, individual student scores were not used in the analysis. Instead, a mean student achievement score was calculated for each instructor, representing the average performance of their students. The sample size of 55 instructors meets the minimum recommendation for correlational studies, as suggested by Fraenkel, Wallen, and Hyun (2023), supporting the adequacy of the sample size for robust statistical analysis. Instructors were selected based on the following criteria:

- Current Employment: Must be currently employed as a pop singing instructor at an accredited conservatory in Chengdu.
- Voluntary Participation: Must express a willingness to participate in the study and provide access to relevant student achievement records.
- Educational Qualification: Must possess a minimum educational qualification of a master's degree or higher in music or vocal pedagogy. This criterion ensures instructors have a foundational understanding of music education, which is pertinent to their pedagogical content knowledge.

The demographic characteristics of the 55 participating instructors are summarized below:

- Gender: 24 (43.6%) were male, and 31 (56.4%) were female.
- Age: The largest group was between 30-40 years old (n=28, 50.9%), followed by 20-30 years old (n=10, 18.2%), 40-50 years old (n=15, 27.3%), and 50-60 years old (n=2, 3.6%).
- Educational Background: 43.6% (n=24) specialized in Pop Music Singing/Pop Music, 30.9% (n=17) in Music Education, 7.3% (n=4) in Musicology, 7.3% (n=4) in Traditional Bel Canto or National Vocal, and 10.9% (n=6) in other fields.
- Years of Experience: The most experienced group was 5-15 years (n=23, 41.8%). Instructors with 1-5 years and 15-25 years of experience each constituted 25.5% (n=14) of the sample, while 7.3% (n=4) had 25-30 years of experience.

Instrumentation

Instructors' pedagogical content knowledge (PCK) was assessed using a specifically designed and validated self-report questionnaire. This instrument, which measures PCK across its four dimensions (Conceptions of purpose, Knowledge of student understanding, Curricular knowledge, and Knowledge of instructional strategies), was developed and validated for measuring instructors' PCK level in one-to-one pop singing courses at conservatories in China (Ruiling & Sabri, 2025). The questionnaire comprises 21 items, each rated on a five-point Likert scale ranging from "Strongly Disagree" (1) to "Strongly Agree" (5).

Prior to data collection, the questionnaire underwent rigorous refinement through expert review. Seven experienced pop singing pedagogues and music education researchers evaluated the instrument for clarity, relevance, and content validity, ensuring its appropriateness for the study's context.

The reliability of the questionnaire and its subscales was assessed through internal consistency using Cronbach's alpha (α). The total questionnaire demonstrated good reliability with $\alpha=0.792$. Individual subscales also showed strong internal consistency: "Conceptions of purpose for teaching subject matter" (items 1-4) yielded $\alpha=0.917$; "Knowledge of student understanding" (items 5-9) yielded $\alpha=0.970$; "Curricular knowledge" (items 10-15) yielded $\alpha=0.944$; and "Knowledge of instructional strategies" (items 16-21) yielded $\alpha=0.890$.

To further assess the suitability of the data for factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were conducted. The KMO value was 0.706, which is above the recommended threshold of 0.60, indicating adequate sampling for factor analysis. Bartlett's test of sphericity was statistically significant (Approx. Chi-Square = 1204.801, df = 210, Sig. < .001), suggesting that the correlations between items were sufficient for factor analysis.

A principal component analysis was performed on the PCK questionnaire items to confirm its factor structure. The analysis revealed four components with eigenvalues greater than 1, collectively accounting for 78.981% of the total variance. This finding supports the four-component structure of Grossman's PCK framework as operationalized in the adapted questionnaire.

Data Collection Procedures

Data collection was executed through a multi-phase process, adhering strictly to ethical guidelines and institutional protocols.

Ethical Considerations and Instrument Validation

Formal ethical approval for this study was obtained from the Human Research Ethics Committee of Sultan Idris Education University (Reference Number: 2024-0461-01). Concurrently, institutional authorization was secured from the conservatories' Academic Affairs Offices and faculty deans to facilitate instructor recruitment and online questionnaire distribution.

Prior to the main data collection, the initial 22-item PCK questionnaire, based on Grossman's (1990) framework, underwent rigorous content validation. Seven subject matter experts, purposively selected for their advanced qualifications (Master's/PhD in Music Education/Vocal Pedagogy) and extensive experience (10+ years as pop singing instructors at accredited institutions), reviewed the draft. Their feedback, provided via an online content validation form, led to the removal of one redundant item, finalizing the questionnaire at 21 items.

Pilot and Main Data Collection

A pilot study was conducted in May 2024 with 50 pop singing instructors from conservatories outside the main study's scope. These instructors were purposively selected to assess the questionnaire's clarity and reliability. Informed consent, including a detailed Participant Information Sheet (PIS) and a physically signed consent form, was obtained from each participant before they accessed the online questionnaire, ensuring voluntary participation and anonymity of responses.

Following the successful pilot, the main data collection commenced from July to October 2024. A purposive sample of 55 pop singing instructors from the three target conservatories in Chengdu was recruited through official institutional channels (email/WeChat). Similar to the pilot, all main study participants received a comprehensive PIS and were required to provide a physically signed consent form electronically before gaining access to the online PCK questionnaire. This rigorous consent process ensured explicit understanding and voluntary, formal agreement to participate in accordance with ethical guidelines, while guaranteeing anonymity and confidentiality of all data.

All questionnaires for both the pilot and main studies were administered via the secure online survey platform Questionnaire Star (integrated with WeChat for accessibility). This platform is widely used in Chinese academia and adheres to stringent data security protocols, including robust encryption, strict access controls, multi-factor authentication, and data desensitization techniques. Questionnaire Star holds ISO/IEC 27001:2013 certification, ensuring the integrity and confidentiality of all collected data. Student achievement data (annual examination scores) were subsequently obtained from the conservatories' Academic Affairs Offices with appropriate institutional permissions and adherence to data privacy regulations.

Data Analysis

Statistical analyses were performed using IBM SPSS Statistics Version 27.

- i. **Descriptive Statistics:** We calculated descriptive statistics, including means, standard deviations, and frequencies, for all PCK components and student achievement scores. These statistics summarized the characteristics of our sample and the variables under investigation.
- ii. **Inferential Statistics:** To address the research questions regarding the relationship and influence of PCK components on student achievement, we employed Multiple Linear Regression Analysis.
- iii. **Justification:** Multiple linear regression was appropriate for this study because it allowed us to examine the linear relationship between a dependent variable (student achievement) and multiple independent variables (the four PCK components) simultaneously. This method enabled us to determine the predictive power of each PCK

component while controlling for the effects of the other components.

- iv. Variables: The independent variables in our regression model were the four components of instructors' pedagogical content knowledge: conceptions of purpose for teaching subject matter, knowledge of students' understanding, curricular knowledge, and knowledge of instructional strategies. The dependent variable was student achievement in one-to-one pop singing courses, as measured by the annual examination scores.
- v. Assumptions: Before conducting the multiple linear regression, we checked the underlying assumptions of the analysis. These included linearity, independence of residuals (assessed via Durbin-Watson statistic), homoscedasticity (examined through scatterplots of residuals), normality of residuals (assessed via P-P plots and histograms), and multicollinearity (assessed via Variance Inflation Factor (VIF) and tolerance values). All assumptions were found to be adequately met, ensuring the validity of the regression results.

Results

Herein are the empirical findings of the study, encompassing descriptive statistics for all variables, the results of one-sample t-tests for both overall PCK and student achievement, the correlation matrix illustrating relationships among the variables, and the results of the multiple linear regression analysis examining the influence of instructors' pedagogical content knowledge (PCK) components on student achievement in pop singing courses.

Descriptive Statistics

The questionnaire consisted of 21 items, each rated on a five-point Likert scale. Therefore, the maximum attainable PCK score for an instructor was 105 points (21 items x 5 points). Table 1 provides the descriptive statistics for the overall PCK level of the pop singing instructors, while Table 2 presents the descriptive statistics for each of the four PCK dimensions. Table 3 summarizes the descriptive statistics for student achievement in pop singing courses.

Table 1

Descriptive Statistics of Overall PCK Level of Pop Singing Instructors (N=55)

N	Mean (M)	Median	Standard Deviation (SD)	Variance	Minimum	Maximum
55	89.95	90.00	6.096	37.164	75.00	101.00

Table 2

Descriptive Statistics for the Four Dimensions of Pedagogical Content Knowledge (PCK) (N=55)

PCK Dimension	Items	Max Score	Mean (M)	Median	Standard Deviation (SD)	Variance	Minimum	Maximum
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1. Conceptions of purpose for teaching subject matter	1-4	20	17.60	18.00	2.290	5.244	12.00	20.00
2. Knowledge of students understanding	5-9	25	20.51	20.00	2.159	4.662	15.00	25.00
3. Curricular knowledge	10-15	30	25.51	25.00	3.731	13.921	18.00	30.00
4. Knowledge of instructional strategies	16-21	30	26.33	27.00	3.067	9.409	18.00	30.00

Table 3

Descriptive Statistics of Student Achievement in Pop Singing Courses (N=55)

N	Mean (M)	Median	Standard Deviation (SD)	Variance	Minimum
55	86.32	87.00	2.597	6.743	80.00

One-Sample T-tests*Overall PCK Score*

A one-sample t-test was conducted to determine if the observed mean PCK score of the 55 instructors differed significantly from a benchmark value of 90. The results of this analysis are presented in Table 4.

Table 4

One-Sample T-test for PCK Score of Instructors (Test Value = 90)

t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference Lower
-.066	54	.947	-.05455	-1.7026

The analysis yielded a t-statistic of -0.066 (df = 54), with a corresponding p-value of 0.947. As this p-value (0.947) is considerably greater than the significance threshold of 0.05, it indicates no statistically significant difference between the observed mean PCK score of the instructors (M = 89.95) and the benchmark value of 90. This minor difference could be attributed to individual variation, but it does not detract from the overall high level of PCK demonstrated across the sample. These findings provide evidence of a strong foundational knowledge base among pop singing instructors.

Student Achievement

A one-sample t-test was also conducted to compare the mean student achievement score against a benchmark of 85. Table 5 presents these results.

Table 5

One-Sample T-test Results of Student Achievement of 55 Instructors (Test Value = 85)

t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference Lower
3.791	54	.000	1.327	0.625

The analysis showed a statistically significant difference, $t(54) = 3.791$, $p < 0.001$. The observed mean student achievement score ($M = 86.32$) was significantly higher than the benchmark value of 85 (Mean Difference = 1.327). This indicates that, on average, students in one-to-one pop singing courses achieved scores significantly above the established performance benchmark.

Correlation Matrix

Table 6 presents the Pearson correlation coefficients between instructors' overall PCK level and student achievement.

Table 6

Pearson Correlation between Instructors' Overall PCK Level and Student Achievement (N = 55)

		Student Achievement	Overall PCK Level
Student Achievement	Pearson Correlation	1	.766**
	Sig. (2-tailed)		<.001
	N	55	55
Overall PCK Level	Pearson Correlation	.766**	1
	Sig. (2-tailed)	<.001	
	N	55	55

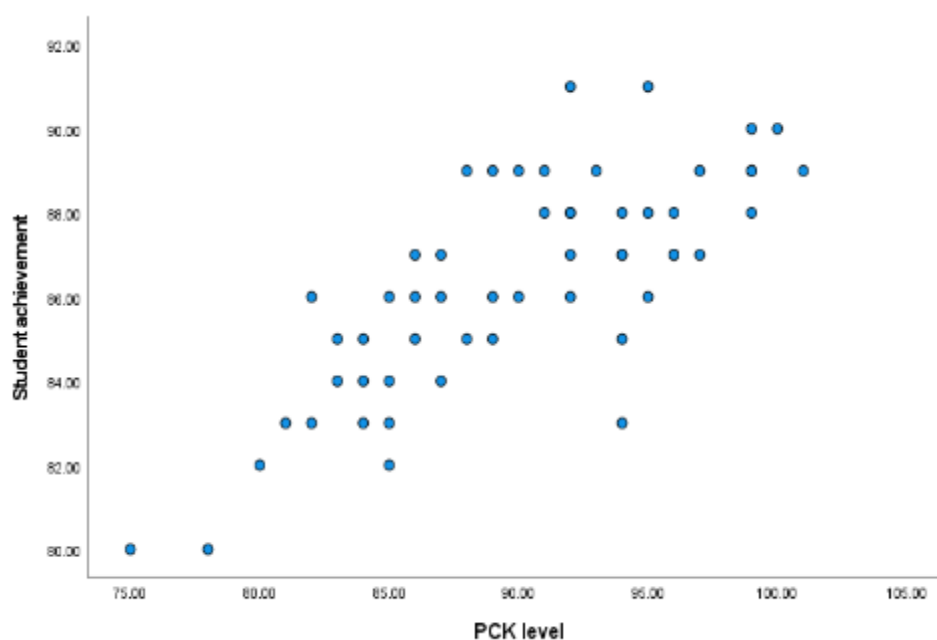


Figure 1 Scatter Plot of Overall Instructor PCK Level versus Student Achievement

A strong, statistically significant positive correlation was observed between the overall PCK level of instructors and student achievement ($r = 0.766$, $p < 0.001$). This indicates that higher levels of overall PCK in instructors are strongly associated with higher student achievement.

Multiple Linear Regression Analysis Results

A multiple linear regression analysis was conducted to examine the extent to which the four components of instructors' pedagogical content knowledge (PCK) influence student achievement in one-to-one pop singing courses. Table 7 presents the model summary for the multiple linear regression.

Table 7

Model Summary for Multiple Linear Regression

R	R Square	Adjusted R Square	Std. Error of the Estimate
.784	.615	.584	1.67540

Independent variables: Component 1 of PCK, Component 2 of PCK, Component 3 of PCK, Component 4 of PCK

Dependent variable: Student Achievement

The R-squared value of 0.615 indicates that the four PCK components collectively explain 61.5% of the total variance in student achievement. This demonstrates a substantially strong fit for the model, signifying that a considerable proportion of student achievement can be accounted for by instructors' PCK. The adjusted R-squared value of 0.584 provides a more conservative estimate of the variance explained (58.4%), accounting for the number of predictors in the model and the sample size. The close alignment between R-squared and adjusted R-squared suggests that the model is well-specified and the inclusion of these four predictors is justified, contributing meaningfully to the model's explanatory power without overfitting the data.

Analysis of Variance (ANOVA)

The ANOVA (Analysis of Variance) test was conducted to evaluate the overall statistical significance of the regression model. This test determines whether the inclusion of the independent variables (the four PCK components) collectively provides a statistically significant explanation for the variation in the dependent variable (student achievement), compared to a model with no predictors. Table 8 presents the ANOVA results for the regression model.

Table 8

Analysis of Variance for the Multiple Linear Regression Model

Source	Sum of Squares	df	Mean Square	F	Sig. (p-value)
Regression	223.761	4	55.940	19.929	< 0.001
Residual	140.348	50	2.807		
Total	364.109	54			

The ANOVA results, displayed in Table 8, indicate that the regression model is highly statistically significant ($F(4,50) = 19.929, p < 0.001$). This significant F-value demonstrates that the four PCK components, when considered together, collectively have a statistically significant influence on student achievement. The Regression Sum of Squares (223.761) being substantially larger than the Residual Sum of Squares (140.348) further underscores the model's ability to explain a significant proportion of the variance in the dependent variable. The rejection of the null hypothesis that instructors' PCK components have no significant influence on student achievement confirms that the combined effect of the four PCK components is a robust predictor of student achievement.

Regression Coefficients Analysis

To assess the individual contributions and relative importance of each PCK component to student achievement, the unstandardized (B) and standardized (Beta) regression coefficients were analyzed. Unstandardized coefficients indicate the expected change in the dependent variable for a one-unit increase in the independent variable, while standardized coefficients allow for direct comparison of the relative strength of each predictor, independent of their original scales. Table 9 presents the detailed results of the regression coefficients.

Table 9

Regression Coefficients Analysis for PCK Components Predicting Student Achievement

Independent Variable	Unstandardized Coefficient (B)	Standardized Coefficient (Beta)	Sig. (p-value)
Conceptions of purpose	0.163	0.144	0.116
Knowledge of student understanding	0.231	0.192	0.038
Curricular knowledge	0.354	0.509	< 0.001
Instructional strategies	0.378	0.447	< 0.001

The analysis of the regression coefficients reveals the following:

Conceptions of Purpose for Teaching Subject Matter (Component 1): With a p-value of 0.116

($p > 0.05$), this component is not a statistically significant predictor of student achievement in this model. The unstandardized coefficient ($B = 0.163$) suggests a minimal, non-significant increase in student achievement for each unit increase in this component, holding others constant.

Knowledge of Student Understanding (Component 2): This component is a statistically significant positive predictor of student achievement ($p = 0.038 < 0.05$). The unstandardized coefficient ($B = 0.231$) indicates that for every one-unit increase in an instructor's knowledge of student understanding, student achievement is expected to increase by 0.231 units, holding other PCK components constant. Its standardized coefficient ($Beta = 0.192$) indicates a modest unique contribution.

Curricular Knowledge (Component 3): This component is a highly statistically significant positive predictor of student achievement ($p < 0.001$). With an unstandardized coefficient of $B = 0.354$, a one-unit increase in an instructor's curricular knowledge is associated with a 0.354-unit increase in student achievement, assuming other components remain constant. Notably, its standardized coefficient ($Beta = 0.509$) is the largest among all predictors, indicating that Curricular Knowledge is the strongest unique contributor to explaining variance in student achievement.

Knowledge of Instructional Strategies (Component 4): This component is also a highly statistically significant positive predictor of student achievement ($p < 0.001$). An unstandardized coefficient of $B = 0.378$ suggests that for every one-unit increase in knowledge of instructional strategies, student achievement is expected to increase by 0.378 units, all else being equal. Its standardized coefficient ($Beta = 0.447$) highlights its substantial unique contribution, making it the second most influential PCK component in the model.

Based on the unstandardized regression coefficients derived from the multiple linear regression analysis, the predictive model for student achievement can be formally stated as:

$$\text{Student Achievement} = 59.711 + 0.163 * (\text{Component 1 of PCK}) + 0.231 * (\text{Component 2 of PCK}) + 0.354 * (\text{Component 3 of PCK}) + 0.378 * (\text{Component 4 of PCK})$$

This equation mathematically summarizes the estimated linear relationship, quantifying the predicted mean student achievement score based on the specific levels of the four instructors' PCK components. The visual representation of these relationships is further illustrated in Figure 1, depicting the scatter plots and individual regression lines for each PCK component's relationship with student achievement.

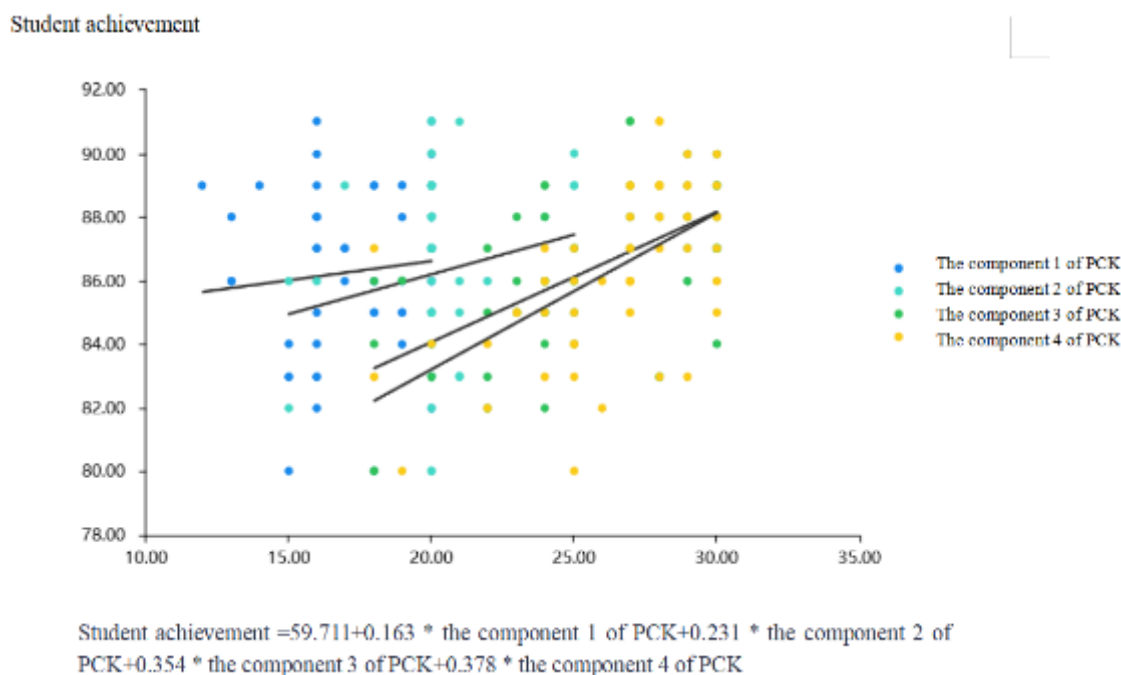


Figure 2 Scatter Plots and Bivariate Regression Lines for each Pedagogical Content Knowledge (PCK) Component's Relationship with Student Achievement.

In summary, the results strongly indicate that an instructor's expertise in curriculum design and their repertoire of instructional strategies are paramount in driving student success in pop singing courses, followed by their understanding of student learning needs.

Discussion

This study investigated the level of pedagogical content knowledge (PCK) among pop singing instructors in Chinese conservatories and its relationship with student achievement in one-to-one pop singing courses. This section summarizes the key findings, interprets them in relation to PCK theory, compares them with previous research, and discusses the implications for practice and theory, along with the study's limitations and directions for future research. The findings offer nuanced insights into the manifestation and impact of PCK within the specialized domain of pop singing instruction, extending Shulman's (1986, 1987) original theory.

Curricular Knowledge and Instructional Strategies as Strong Predictors: The prominence of Curricular Knowledge and Knowledge of Instructional Strategies as the strongest predictors of student achievement is highly significant. In a performance-based discipline like pop singing, where tangible skill development is paramount, a well-structured and relevant curriculum (Curricular Knowledge) provides the roadmap for progressive learning. This includes the selection of appropriate vocal exercises, repertoire, and assessment methods that directly align with performance goals. Similarly, effective and diverse instructional strategies are crucial for conveying complex vocal techniques, fostering artistic expression, and providing real-time, actionable feedback in one-to-one settings. These components of PCK directly address the "how to teach" and "what to teach" aspects, which are immediately observable and impactful on student performance. This aligns with the notion that PCK transforms content into teachable forms, and in performance, the teachability relies heavily

on the design of learning experiences and the methods used to deliver them.

Moderate Influence of Knowledge of Student Understanding: While statistically significant, Knowledge of Student Understanding exhibited a more moderate influence compared to curricular and instructional components. This suggests that while understanding students' prior knowledge, learning styles, and common misconceptions is important for tailoring instruction, its impact might be more indirect or foundational. In one-to-one pop singing, an instructor's ability to diagnose a student's vocal issues (part of knowledge of student understanding) is critical, but the application of that diagnosis through a specific curricular adjustment or an effective instructional strategy is what directly drives progress. It acts as an essential diagnostic tool that informs the other, more actionable PCK components.

Non-Significance of Conceptions of Purpose for Teaching Subject Matter: The finding that Conceptions of Purpose for Teaching Subject Matter was not a significant predictor is particularly interesting. In many academic disciplines, an instructor's overarching philosophy or goals for teaching a subject profoundly shapes their pedagogy. However, in the immediate, performance-driven context of one-to-one pop singing instruction, the "why" or broad purpose might be more implicitly understood or less of a differentiating factor among instructors who are already operating within the specific goals of a conservatory pop music program. It is possible that while instructors hold diverse personal philosophies, the practical demands of developing performance skills for examinations and industry readiness might lead to a more convergent application of PCK, where the "how" (strategies) and "what" (curriculum) become the primary drivers of measurable achievement. This finding suggests that in highly specialized, vocational, and performance-oriented fields, the more tangible and actionable elements of PCK may exert a more direct and measurable influence on student outcomes than overarching pedagogical philosophies.

This study's findings largely align with the broader PCK literature, which consistently affirms the crucial role of PCK in influencing student achievement across various disciplines (Depaepe et al., 2013; Gess-Newsome et al., 2019; Jacob, John, & Gwany, 2020; Kind & Chan, 2019; Neumann et al., 2019). The strong overall correlation between PCK and student achievement observed in this study reinforces the generalizability of PCK's importance beyond traditional academic subjects.

However, this research provides a unique contribution by focusing on pop singing education, a domain where PCK research is notably scarce (Manila, 2020; Sarkar et al., 2024). While previous music education research has touched upon general teaching in higher music education (Conway, 2020) or teacher preparedness in instrumental music (Denis, 2025), this study specifically dissects the manifestation and impact of PCK within contemporary vocal genres. The finding that Curricular Knowledge and Instructional Strategies are the most influential components is particularly relevant for performance-based disciplines. This contrasts with some PCK research in more theoretical subjects where, for instance, knowledge of student misconceptions might play a more dominant role. This study suggests that in performance education, the immediate and practical application of knowledge through curriculum design and diverse teaching techniques is paramount for observable student progress. It implies that PCK in performance-based disciplines might prioritize the actionable elements of teaching over more abstract pedagogical orientations.

These findings carry significant implications for various stakeholders within pop singing education and the broader music industry.

For Pop Singing Instructors: The results underscore the critical importance for instructors to continuously develop their Curricular Knowledge and Knowledge of Instructional Strategies. This includes staying updated on contemporary pop music trends and repertoire, mastering diverse vocal techniques, and expanding their repertoire of teaching methods (e.g., effective feedback mechanisms, use of technology, strategies for fostering creativity and stage presence). Professional development programs should prioritize these areas, moving beyond mere content knowledge to focus on the pedagogical transformation of that content.

For Conservatories in China: The study provides empirical data to inform curriculum development and pedagogical reform within pop singing programs. Institutions should invest in resources that support instructors in designing effective curricula and developing innovative instructional strategies. Furthermore, these findings can guide hiring and evaluation processes, emphasizing not just an instructor's performance prowess, but also their demonstrated PCK, particularly in curriculum design and instructional delivery. This can lead to more targeted training programs and a more effective teaching workforce, ultimately enhancing the quality of pop music education.

From a theoretical perspective, this study refines and extends Shulman's PCK theory by empirically demonstrating how its components' impact on student achievement can vary across disciplines. In a specialized, performance-oriented field like pop singing, the 'how' (instructional strategies) and 'what' (curricular knowledge) of teaching emerged as more direct drivers of student outcomes than the broader 'why' (conceptions of purpose). This contributes to a more nuanced, context-specific understanding of PCK, emphasizing the actionable elements of pedagogical expertise in performance education. This contributes to a more nuanced, context-specific understanding of PCK, emphasizing the actionable elements of pedagogical expertise in performance education.

Notwithstanding these contributions, this study is subject to several limitations that warrant consideration:

Sample Size and Generalizability: The sample size of 55 instructors, while adequate for the chosen statistical analyses, is relatively small and drawn from three specific conservatories in Chengdu. This limits the generalizability of the findings to all pop singing instructors across China or to other cultural contexts. Future research with larger and more geographically diverse samples would enhance generalizability.

Measurement: The reliance on a self-report questionnaire for PCK measurement introduces the potential for social desirability bias, where instructors might over-report their knowledge or skills. While expert validation and reliability checks were conducted, direct observation of teaching practices could provide a richer and more objective assessment of enacted PCK. Additionally, student achievement was measured using existing annual examination scores, which, while standardized within the conservatories, may not fully capture the multifaceted nature of musical achievement.

Cross-sectional Design: As a quantitative, cross-sectional study, it can only establish correlations, not causation. While the regression model suggests predictive relationships, it cannot definitively prove that higher PCK causes higher student achievement. Other unmeasured factors could influence both PCK and student outcomes.

Context Specificity: The findings are specific to the context of one-to-one pop singing instruction in Chinese conservatories. Cultural, educational, and industry-specific nuances in China may influence the manifestation and impact of PCK, meaning the findings may not be directly transferable to different musical genres or educational systems without further investigation.

Based on the findings and limitations of this study, several avenues for future research are suggested:

Replication and Expansion: Replicate this study with larger and more diverse samples of pop singing instructors across different regions of China and in other cultural contexts to enhance the generalizability of the findings.

Mixed-Methods Approaches: Conduct qualitative or mixed-methods studies to gain a deeper understanding of how specific PCK components are enacted in real-world pop singing instruction. This could involve classroom observations, in-depth interviews with instructors and students, and analysis of lesson plans and teaching materials to capture the nuanced, often intangible aspects of PCK.

Longitudinal Studies: Implement longitudinal studies to track the development of PCK in pop singing instructors over time and its long-term impact on student achievement. This would provide stronger evidence regarding causal relationships.

Investigating Other Factors: Explore other potential factors influencing student achievement in pop singing, such as student motivation, practice habits, access to resources, and the influence of the broader music industry environment.

Comparative Studies: Conduct comparative studies examining PCK in pop singing versus other music genres (e.g., classical, jazz) or other performance-based disciplines to further understand context-specific differences in PCK's manifestation and impact.

Conclusion

This study aimed to investigate the level of pedagogical content knowledge (PCK) among pop singing instructors in Chinese conservatories and its relationship with student achievement in one-to-one pop singing courses. It revealed overall high levels of Pedagogical Content Knowledge (PCK) among instructors in one-to-one pop singing courses, with most scoring between 80 and 100 on the PCK assessment.

Among the four components of PCK, Curricular Knowledge ($\text{Beta}=0.509$, $p<0.001$) and Instructional Strategies ($\text{Beta}=0.447$, $p<0.001$) emerged as the strongest predictors of student achievement, underscoring their critical role in fostering educational outcomes. Knowledge of Student Understanding demonstrated a moderate influence ($\text{Beta}=0.192$, $p<0.05$), indicating that while understanding students' needs is important, its effectiveness is

enhanced when paired with strong curriculum design and teaching strategies. In contrast, Conceptions of Purpose for Teaching Subject Matter had no significant effect on student achievement ($\text{Beta}=0.144$, $p>0.05$), suggesting that this dimension may hold less relevance in the context of performance-based education such as pop singing.

The findings consistently demonstrated a high overall level of PCK among the instructors, closely aligning with established benchmarks. Crucially, the research revealed a strong and statistically significant positive relationship between instructors' overall PCK and student achievement. More specifically, Curricular Knowledge and Knowledge of Instructional Strategies emerged as the most influential components of PCK, significantly predicting student success in pop singing. While Knowledge of Student Understanding also played a significant role, Conceptions of Purpose for Teaching Subject Matter did not show a direct statistical influence on student outcomes in this context.

The findings emphasize the need for professional development initiatives that prioritize strengthening curricular knowledge and instructional strategies, while also exploring ways to refine the measurement and application of conceptions of purpose in specialized fields. The study highlights critical areas for enhancing teaching effectiveness in pop singing education. To optimize student achievement, it is recommended to strengthen professional development programs focusing on curricular knowledge and instructional strategies, as these components emerged as the strongest predictors of student success. Targeted training workshops and curriculum design initiatives can equip instructors with the skills and tools needed to effectively deliver content and engage students. Additionally, the study underscores the need to refine the measurement of "Conceptions of Purpose" within PCK frameworks to better capture its relevance in performance-based disciplines like pop singing. This may involve adapting the framework to align more closely with the unique demands of pop music education. In the future, educational policymakers play a pivotal role in ensuring the high quality of pop singing education by integrating PCK-focused assessments and training into teacher certification and evaluation processes. This would ensure instructors are well-prepared to meet the unique and diverse needs of students in specialized fields like pop singing.

This study makes a substantial contribution to the understanding of PCK, particularly within the under-researched domain of contemporary music education. By providing empirical evidence from the unique context of Chinese conservatories, it not only enriches theoretical frameworks of PCK but also offers practical insights for enhancing teaching practices and student outcomes in specialized performance-based disciplines.

Ultimately, this study underscores the indispensable role of pedagogical content knowledge in shaping effective instruction. It highlights that in specialized teaching contexts like one-to-one pop singing, an instructor's ability to expertly design curriculum and employ diverse instructional strategies is paramount to fostering student achievement and developing the next generation of musical talent.

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