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From Framework to Practice: Leveraging Topic-Specific Pedagogical Content Knowledge (TSPCK) for Online Lesson Planning and Micro-Teaching in Pre-Service Teacher Education

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From Framework to Practice: Leveraging Topic-Specific Pedagogical Content Knowledge (TSPCK) for Online Lesson Planning and Micro-Teaching in Pre-Service Teacher Education

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Abstract

The shift to online teacher education has increased the need for structured frameworks to support pre-service teachers in lesson planning and instructional practice. The purpose of the current study was to examine how engagement with the Topic-Specific Pedagogical Content Knowledge (TSPCK) framework influenced pre-service teachers' lesson planning and micro-teaching practices in an online programme. Guided by a qualitative descriptive case study design, data were collected from 81 pre-service teachers through TSPCK-informed lesson plans and from 36 micro-teaching observations based on revised lesson plans. Data were analysed using a two-stage approach comprising quantitative descriptive analysis of rubric scores and qualitative analysis of assessors' comments, guided by the five TSPCK components. Findings indicate that the TSPCK framework supported structured and comprehensive lesson planning, with most participants engaging with all five components. However, the depth of engagement was limited, particularly in addressing learners' misconceptions and justifying instructional decisions. In contrast, the enactment of TSPCK during micro-teaching was uneven, with many participants unable to translate planned components into practice, often relying on teacher-centred approaches. The study highlights a gap between planning and enactment, suggesting that while TSPCK provides a valuable scaffold for pedagogical reasoning, its effective application requires sustained practice, feedback, and support. The findings have implications for strengthening the integration of structured pedagogical frameworks in online teacher education.

Keywords: lesson planning; micro-teaching; online teacher education; pedagogical content knowledge; pre-service teachers; TSPCK

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Introduction

The shift to online and flexible modes of teacher education, accelerated by the COVID-19 pandemic, has highlighted the need for structured pedagogical frameworks to support pre-service teachers in lesson planning and instructional practice. While digital platforms expand access, they also require deliberate instructional design and pedagogical clarity to support meaningful learning in virtual environments (Addae-Kyeremeh et al., 2025; Omidire & Maroga, 2022). A key challenge in teacher education is enabling pre-service teachers to transform content knowledge into forms that are accessible to learners. Pedagogical Content Knowledge (PCK) (Shulman, 1986), conceptualises this transformation, yet novice teachers often struggle to move beyond procedural teaching towards conceptual engagement (Aydın et al., 2014). In response, Topic-Specific Pedagogical Content Knowledge (TSPCK) provides a more focused lens by foregrounding the transformation of specific topics into teachable forms through components such as learner prior knowledge, curricular saliency, conceptual challenges, representations, and teaching strategies (Mavhunga & Rollnick, 2013). The use of TSPCK is particularly relevant in online teacher education and micro-teaching contexts, where structured guidance is needed to bridge the gap between planning and practice. This study examines how engagement with the TSPCK framework influences pre-service teachers' lesson planning and micro-teaching practices in an online programme. Accordingly, the research question guiding this study is:

How does engagement with the TSPCK framework influence pre-service teachers' lesson planning and micro-teaching practices?

Although the empirical study was conducted in India, the study is situated within African scholarship on TSPCK and contributes to ongoing debates about strengthening teacher education through flexible learning. The study, therefore, extends evidence on the application of an African-developed pedagogical framework beyond its original context while generating insights relevant to online teacher education across diverse educational settings.

Literature review and theoretical framework for the study

In this literature review, we examine the conceptual and empirical foundations underpinning this study. We begin by exploring PCK and its evolution into TSPCK, highlighting key debates and the rationale for adopting TSPCK as an analytical lens. We then discuss the five components of TSPCK as the framework for the study and their significance for lesson planning and instructional decision-making. Finally, we consider the application of TSPCK

within micro-teaching and online teacher education contexts, with particular attention to how structured frameworks can support pre-service teachers in bridging the gap between planning and practice.

Conceptualising TSPCK

Although existing studies highlight the value of TSPCK in supporting pedagogical reasoning, most research has focused on face-to-face teacher education contexts, with limited attention to online environments. Furthermore, while studies have examined pre-service teachers' engagement with TSPCK during planning, fewer have explored how this engagement translates into teaching practice. This indicates a need for research that examines the relationship between TSPCK-informed lesson planning and its enactment in online micro-teaching contexts. The current study addresses this gap.

Teaching requires more than subject matter knowledge; it involves the transformation of content into forms that are accessible to learners. This idea is captured in Shulman's notion of PCK which emphasises the blending of content and pedagogy in effective teaching. Within teacher education, PCK has been widely recognised as central to instructional quality, particularly in enabling teachers to represent content in ways that promote conceptual understanding (Aydın et al., 2014; Mavhunga & Rollnick, 2013). However, PCK has also been critiqued for its broadness and lack of analytical specificity, particularly when examining how teachers engage with the demands of teaching particular topics. In response to this limitation, Mavhunga and Rollnick (2013) proposed TSPCK as a more granular construct that foregrounds the transformation of specific content topics into teachable forms. Empirical studies have shown that focusing on topic-specific pedagogical reasoning can support pre-service teachers in developing deeper conceptual understanding and more deliberate instructional decision-making (Mavhunga, 2014; Nyamupangedengu & Lelliott, 2018).

TSPCK builds on the foundations of PCK, however, differs in its explicit focus on the topic level rather than general subject knowledge. While PCK is often understood as inherently topic-specific, the TSPCK perspective makes this specificity more visible and analytically accessible by identifying key components that teachers must consider when planning and enacting teaching for topics. In this way, TSPCK serves as a heuristic for unpacking the reasoning processes that underpin instructional decision-making at the topic level.

Despite its growing use, TSPCK is not without critique. Some scholars argue that PCK

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is already topic-specific and that further differentiation may be unnecessary (Mazibe et al., 2020). Acknowledging this critique, the current study adopts TSPCK not as a separate construct from PCK, but as a pragmatic analytical lens that enables a more structured examination of how pre-service teachers engage with the transformation of content in specific teaching contexts. This positioning aligns with research that treats TSPCK as an operationalisation of PCK for empirical investigation rather than a wholly independent theoretical construct (Mavhunga & Rollnick, 2013).

Lesson planning

Lesson planning is widely recognised as a central component of effective teaching and a core professional activity in schools (Kosnick & Beck, 2009). Accordingly, preparing pre-service teachers to design instruction that meets learners' needs is a key goal of teacher education programmes (Rusznyak & Walton, 2011). Teaching pre-service teachers how to plan lessons is, therefore, a foundational aspect of their professional preparation (John, 2006). Despite its importance, research indicates that lesson planning remains a significant challenge for pre-service teachers, who often struggle to integrate content, pedagogy, and learner considerations in coherent ways (Derri et al., 2014). A contributing factor is the difficulty of balancing structured guidelines that support novice teachers with the complexity required for meaningful and coherent lesson design (Rusznyak & Walton, 2011). Scaffolding has been identified as a critical approach in supporting the development of lesson planning skills, enabling pre-service teachers to engage more effectively with the underlying logic of instructional design (Nyamupangedengu & Randler, 2023). In online teaching contexts, these challenges are further amplified, as lesson planning must account for reduced interaction, increased reliance on digital tools, and the need for carefully designed instructional sequences to support student engagement and understanding. This highlights the importance of structured frameworks, such as TSPCK, in supporting pre-service teachers to plan for both conceptual understanding and effective enactment in online environments.

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TSPCK in micro-teaching and online teacher education

In addition to lesson planning, the current study also investigated how the TSPCK framework supports micro-teaching, a widely used method in teacher education that offers structured opportunities for pre-service teachers to rehearse instructional techniques in a controlled environment. Micro-teaching bridges theory and practice by allowing pre-service teachers to experiment with key teaching behaviours such as set induction, questioning, explanation, stimulus variation, and closure, within short, focused lessons delivered to their peers. Through peer and faculty feedback, students can identify strengths and areas for growth, thereby developing both confidence and competence (Msimanga, 2021). Feedback is recognised as a cornerstone of micro-teaching, guiding behaviour modification and refining teaching strategies over time. However, existing literature suggests that micro-teaching does not automatically lead to the development of pedagogical reasoning, unless it is supported by structured frameworks (Bishop & Denley, 2007). Without such frameworks, pre-service teachers may focus primarily on general teaching behaviours rather than on how to transform content for learning. In online contexts, these challenges are further amplified. Research on online teacher education indicates that the effectiveness of digital teaching depends not only on access to technological tools, but also on the quality of pedagogical design and instructional support (Addae-Kyeremeh et al., 2025; Omidire & Maroga, 2022). Pre-service teachers often struggle to translate pedagogical intentions into practice in virtual environments, particularly when they lack experience or structured guidance. Within this context, TSPCK functions as both a conceptual framework and a pedagogical scaffold. Conceptually, it provides an analytical lens for examining how pre-service teachers plan and enact teaching. Pedagogically, it structures the learning process by making explicit the key considerations involved in transforming content knowledge into teachable forms. This dual role positions TSPCK as a useful tool for supporting the development of pedagogical reasoning in online teacher education settings.

The five TSPCK components: The theoretical framework for the study

This study adopts a five-component model informed by Geddis (1993) and further developed in TSPCK research (Mavhunga & Rollnick, 2013) as the theoretical framework for the study. The selection of these five components is theoretically grounded in literature that emphasises the importance of teachers' knowledge of learners, content structure, and instructional strategies in facilitating conceptual learning (Aydın et al., 2014; Geddis,

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1993; Mavhunga & Rollnick, 2013; Mavhunga, 2014; Nyamupangedengu & Lelliott, 2018). While these studies share a focus on the transformation of content knowledge for teaching, they differ in how they conceptualise this process. Mavhunga and Rollnick (2013) propose TSPCK as a structured framework, while Aydın et al. (2014) treat PCK as inherently topic specific. This reflects an ongoing tension in the literature regarding whether separate constructs such as TSPCK are necessary or whether they represent refinement of PCK. TSPCK, with its five components, is, however, adopted in the current study, because it provides a structured and operationalizable framework for analysing topic-specific instructional decision-making. Unlike broader PCK models, TSPCK explicitly identifies components that make pedagogical reasoning visible and assessable. This enables systematic analysis of how pre-service teachers transform content into teachable forms and provides a practical scaffold for both teaching and research. The five components of TSPCK used as a lens in the current study are learners' prior knowledge, including misconceptions, curricular saliency, topic-specific conceptual challenges, representations and conceptual teaching strategies. These components are described in some detail below.

Learners' prior knowledge involves identifying the kind and nature of the knowledge that learners bring to class. Teachers' understanding of learners' prior knowledge plays a critical role in shaping instruction, particularly in identifying and addressing misconceptions that may hinder conceptual change (Deshmukh, 2012). Failure to engage with learners' existing ideas often results in superficial learning. Curricular saliency involves identifying and sequencing key ideas within a topic. This component aligns with literature that highlights the importance of structuring content in ways that reflect disciplinary logic and promote conceptual progression (Geddis, 1993). Topic-specific conceptual challenges refer to difficult-to-teach concepts. A consideration of such challenges allows teachers to anticipate learning barriers. Studies on PCK development indicate that novice teachers often struggle to recognise conceptual difficulty without structured support (Mavhunga, 2014). The use of representations including analogies and examples is central to effective teaching, particularly in making abstract ideas accessible. Research suggests that the selection and justification of representations are critical indicators of developed pedagogical reasoning (Mavhunga & Rollnick, 2013). The component conceptual teaching strategies refers to the selection of teaching strategies that promote conceptual understanding rather than procedural learning. Teachers with more developed PCK are more likely to use flexible, conceptually oriented strategies rather than rigid, algorithmic approaches (Aydın et al., 2014).

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While presented as discrete components, the components of TSPCK are interrelated in practice. Learners' prior knowledge forms the starting point for instruction and influences how teachers identify topic-specific conceptual challenges. Misconceptions, in particular, shape what learners find difficult and therefore, inform the selection of appropriate representations and teaching strategies. Curricular saliency interacts with all other components by determining which concepts are prioritised and how they are sequenced, thereby shaping instructional decisions. Representations are closely linked to conceptual challenges, as more difficult or abstract concepts require carefully selected analogies, diagrams, or examples to make them accessible. At the same time, representations must connect with learners' prior knowledge to be meaningful. Conceptual teaching strategies act as the mechanism through which the other components are enacted, bringing together knowledge of learners, content structure, and representations into coherent instructional practice. These interactions highlight that effective teaching is not about applying isolated components, but about coordinating them in ways that support meaningful learning. The integration of these components reflects deeper pedagogical reasoning, where decisions about what to teach, how to teach it, and why, are made in relation to one another.

In the context of the current study, looking at online teaching contexts, the importance of the TSPCK components becomes even more pronounced as opportunities for spontaneous interaction and real-time adjustment are more limited. In online environments, teaching relies heavily on deliberate planning and structured pedagogical decision-making as outlined below. Firstly, the reduced visibility of student thinking in online settings makes it more difficult for teachers to gauge learners' prior knowledge and identify misconceptions during instruction. As a result, these elements must be more carefully anticipated and embedded during lesson planning. Secondly, online teaching places greater emphasis on digital tools as representations such as slides, videos, and simulations as the primary means through which concepts are communicated. The effectiveness of teaching therefore depends on how well these representations are selected and aligned with conceptual goals. Thirdly, online environments often constrain interaction, which can limit opportunities to respond dynamically to learners' difficulties. This places increased importance on identifying conceptual challenges in advance and designing teaching strategies that actively engage learners despite these constraints. Finally, the tendency of online teaching to become teacher-centred highlights the need for deliberate use of conceptual teaching strategies that promote interaction, questioning, and learner engagement. Therefore, in this context, the integrated use of the five TSPCK components provides a structured way of addressing the pedagogical demands of online teaching. It supports pre-service teachers in

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planning instruction that anticipates learner needs, uses appropriate representations, and promotes conceptual understanding, even in environments where teaching is mediated by technology.

Research approach and method

The current study adopted a qualitative descriptive case study design to explore how pre-service teachers engaged with the TSPCK framework in an online teacher education programme. The exploratory nature of the research question, which seeks to understand how engagement with TSPCK influences both lesson planning and teaching practice, necessitated a qualitative approach focused on capturing participants' experiences and practices (Bradshaw et al., 2017).

Although multiple forms of data were generated during the programme, this paper focuses specifically on two primary data sources: pre-service teachers' lesson plans; and micro-teaching observations. These sources were selected because they provide direct evidence of engagement with TSPCK in both planning (intended practice) and enactment (implemented practice).

Context and participants

The study was conducted with 81 pre-service teachers enrolled in a two-year Bachelor of Education programme at a College of Education in India. Participants specialised in a range of subject areas, including languages, science, mathematics, social sciences, and economic management sciences. All participants engaged in lesson planning activities using the TSPCK framework (n=81). From this group, 36 pre-service teachers were observed during micro-teaching. The selection of 36 pre-service teachers for micro-teaching observations was purposive. Participants were chosen based on their submission of revised lesson plans following feedback, as these were considered to reflect more developed engagement with TSPCK. This allowed the study to examine the translation of improved planning into teaching practice. Table 1 shows participant information.

Table I: Participants information

Subject	Lesson Plan (n=81)	Observations (n=36)
Language	14	6
Science	20	11
Math	19	9
History	9	3

Geography	11	4
Commerce	3	1
Economics	5	2
Totals	81	36

Data collection instruments

Data collection was embedded within a 20-hour online programme designed to introduce pre-service teachers to the TSPCK framework and support its application in lesson planning and micro-teaching. The programme was divided into twenty 1-hour sessions as shown in Table 2.

Table 2: Details of the 20-hour online training programme

Session Number	Session Details
1	Introduction to the online programme
2-3	Understanding micro-teaching
4-6	Understanding PCK and TSPCK
7-14	Applying the five components of TSPCK
15	Explaining the Lesson Plan template
16-17	Lesson planning
18-20	Microteaching

For the purposes of the current study, two data sources were prioritised:

Lesson plans and assessment rubrics (n=81)

Pre-service teachers completed lesson plans using a TSPCK-informed template (see Appendix 1), which guided them to engage with five components: learner prior knowledge; curricular saliency; what is difficult to teach and learn (topic-specific conceptual challenges); representations; and conceptual teaching strategies. Lesson plans were assessed using a structured rubric aligned with these components (see Appendix 2).

Micro-teaching observation rubrics (n=36)

Pre-service teachers conducted micro-teaching sessions based on their lesson plans. These sessions were observed and assessed using a rubric that captured both TSPCK components and micro-teaching skills (see Appendix 3).

Both the lesson plan and the microteaching assessment rubrics were developed by the

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first author, face validated by the second author who is a specialist in PCK and discussed with the four faculty members for further refinement and validation. The rubrics allowed for qualitative descriptions of the level of achievement of pre-service teachers in both their lesson planning and micro-teaching. According to Fluckiger (2010), specific written feedback on various aspects of students' work helps them in knowing areas of their studies that need improvement.

Description of the online programme

As indicated earlier, twenty 1-hour online sessions were planned for and conducted with the pre-service teachers. The main objective behind the sessions was to introduce pre-service teachers to the TSPCK framework so that they would know what the framework is about and how to apply it in planning. Below the online programme is described in some detail.

Introducing the programme (session 1)

The first session was an introductory session in which the objectives for conducting the course were discussed. The researchers gave an outline of the expected work to be done by both the faculty members and the pre-service teachers.

Understanding micro-teaching (sessions 2 and 3)

In sessions 2 and 3, the concept of micro-teaching, its principles, and all the six micro-teaching skills, which are listed in the literature review section, were discussed: (i) set induction skill; (ii) skill of probing questions; (iii) skill of explanation; (iv) skill of stimulus variation; (v) skill of black-board writing; and (vi) skill of achieving closure were discussed.

Understanding PCK and TSPCK (session 4-6)

Sessions 4, 5, and 6 were conducted on Content Knowledge and PCK and the framework of TSPCK. PCK was explained in terms of its genesis, exodus, current conceptions and its importance in education. The TSPCK framework was explained using the works of Mavhunga and Rollnick (2013) and Geddis (1993).

Applying the five components of TSPCK (sessions 7-14)

In sessions 7 to 14, the five content-specific components of TSPCK and how they can be integrated with micro teaching skills were discussed. During these sessions, the pre-service

teachers were encouraged to share examples of these components using any topic of their choice and to make suggestions on how these could be applied during micro-teaching. Faculty members were also invited to participate in these sessions by giving feedback on the examples that the students from their subject areas were giving, and where students were struggling to provide examples. This was done to make the sessions interactive and to clear up the doubts of the pre-service teachers. At the completion of each session, the pre-service teachers were given a task to do on their computer and upload onto the e-learning management system. The authors would then assess the task and share the feedback on which discussions would be held at the beginning of the next session.

Explaining the lesson plan template (session 15)

In session 15, pre-service teachers were taken through the lesson plan template which had all the components of TSPCK. The four faculty members assisted the researchers by explaining the various parts of the template according to their respective subjects. An exemplar of a lesson plan and a completed rubric for each learning area were shared with the pre-service teachers, for them to have an idea of what is expected of them as they plan and what to expect after submission of their lesson plan drafts. At the end of session 15, pre-service teachers were requested to design their micro-teaching lesson plans and upload them on Google drive.

Lesson planning (sessions 16 and 17)

Sessions 16 and 17 were remote sessions during which participants prepared their lesson plans. All 81 pre-service teachers submitted their online lesson plans. The researchers and the faculty assessed these lesson plans and gave feedback, which was followed by resubmission. Thirty-six participants reworked on and resubmitted their work. While all 81 participants did the microteaching, the study streamlined the participants to the 36 who had reflected on their first lesson plans and had submitted revised ones.

Microteaching (sessions 18-20)

After satisfactory submissions of lesson plans, online micro-teaching presentations were conducted. Five breakout rooms, one for each learning area, namely Language, Math, Science, Social Studies, and Economic Management Sciences, were created. The authors and the four faculty members were each allotted a breakout room with the pre-service teachers according to their areas of specialisation. Both the revised lesson plans and the microteaching presentations were assessed. Each pre-service teacher was allotted 20

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minutes. Fifteen minutes for the lesson presentation and five minutes for feedback. The micro-teaching presentations were based on the lesson plans which they had resubmitted. The presentations were conducted to allow the researchers and the faculty to assess how the pre-service teachers were transforming their lesson plans and knowledge into action during their lesson presentation. After the presentations, brief formative oral online feedback was given. Detailed feedback was provided on the individual rubric sheet.

Data analysis

Data analysis was guided deductively by the five components of TSPCK. Lesson plans and micro-teaching rubrics were coded according to these components. In the first stage, quantitative descriptive analysis was conducted to determine patterns of engagement. In the second stage, qualitative data from assessors' comments were analysed to identify recurring patterns in the depth and quality of engagement. Both researchers independently coded a subset of the data and discussed discrepancies to reach consensus, thereby enhancing analytical reliability. Trustworthiness was further supported through prolonged engagement with the data and the use of structured rubrics.

Figure 1 shows coded lecturer comments on a completed science lesson plan assessment rubric. The coding is in the form of the researcher's qualitative comments highlighted in gray. Figure 2 shows the coding of a lecturer's comments which was done independently by the two researchers on the micro teaching rubric. It is these codes (comments) which were analysed to identify recurring patterns in the depth and quality of engagement by the pre-service teachers.

Performance criteria	**Teachers' Feedback on Achieved performance**	**Teachers' Feedback on Expected performance**
Curricular saliency (Identification and sequencing of concepts)	*Correctly listed the mathematical concept to be taught under the topic of angles* *Correctly identified concepts to be taught*	*Should include with justification the sequence of teaching the concepts.* *Teaching sequence not indicated*
Learners' prior knowledge (Identification of learner prior knowledge including misconceptions)	*Identified types of angles as learner prior knowledge.* *Learner prior knowledge identified*	*No misconceptions mentioned* *Misconceptions not mentioned*
What is easy and/or difficult to teach-has the student identified with reasons, the concepts that are easy or difficult to teach and for learners to understand)	*Blank* *Easy and difficult to teach and learn concepts not identified*	*blank*

Figure I: Completed lesson plan rubric with researcher's comments highlighted

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Performance criteria	Teachers' Feedback on Achieved performance	Teachers' Feedback on Expected performance
Learners' prior knowledge: How does the pre-service teacher engage with learners' prior knowledge. Misconceptions- (Has the pre-service teacher corrected the misconception if there in the topic)	*Successfully used questions to identify learner prior knowledge and misconceptions.* Engaged with component learner prior knowledge	*Learners were spoon-fed with the necessary knowledge instead of facilitating through teaching strategies like discussions.* *No* engagement with learner misconceptions
Learners' prior knowledge: How does the pre-service teacher engage with learners' prior knowledge. Misconceptions- (Has the pre-service teacher corrected the misconception if there in the topic)	*Exposed learners' prior knowledge through question-and-answer discussions. Used questions well to assess and confirm learners' understanding.* Engaged with component learner prior knowledge	*The misconception that was mentioned in the lesson plan was not dealt with in the lesson.* No engagement with learner misconceptions

Figure 2: Coding of a lecturer's comments (highlighted in gray) which was done independently by the two researchers

Ethical Considerations

Ethical clearance for the study was obtained from the relevant institutional authority. Participation in the research was voluntary, and informed consent was obtained from all participants. To avoid coercion, participation in the research was clearly distinguished from participation in the course, and participants were informed that their academic progress would not be affected by their decision to participate or withdraw. Anonymity and confidentiality were maintained by removing identifying information from all data sources.

Findings

The current study examined how engagement with the TSPCK framework influenced pre-service teachers' lesson planning and micro-teaching practices. The findings are presented according to the five components of TSPCK: learners' prior knowledge and misconceptions; curricular saliency; what is easy or difficult to teach and learn; representations; and conceptual teaching strategies.

Within each component, findings from lesson planning (n=81) and micro-teaching enactment (n=36) were presented comparatively to highlight the relationship between intended and enacted instructional practices. This structure enabled an integrated analysis

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of how pre-service teachers translated pedagogical intentions developed during planning into classroom practice. The section begins with an overview of the quantitative analysis of the completed lesson plan rubrics and micro-teaching observations, followed by a qualitative discussion of each TSPCK component. Table 3 presents the results of the analysis of the completed lesson plan rubrics (n = 81).

Table 3: Results of the analysis of the completed lesson plan rubrics (n=81)

TSPCK Components	No of the pre-service teachers who mentioned the components	No of pre-service teachers who did not mention the components	Number of pre-service teachers whose component description needed improvement
1 a. Prior knowledge	78	3	54
1 b. Misconceptions	27	54	12
2. Curricular saliency: Big ideas/concept & sequencing	67	14	51
3. What makes a topic easy or difficult to understand?	69	12	51
4. Representations including analogies and metaphor	71	10	56
5. Conceptual teaching strategies	81	0	47

Qualitative discussion of each TSPCK component

Learners' prior knowledge and misconceptions: Most pre-service teachers (78 of 81) identified learners' prior knowledge in their lesson plans, although responses often lacked specificity and conceptual relevance. Engagement with misconceptions was more limited, with only 27 participants explicitly identifying misconceptions. Even where misconceptions were included, these were not always linked to instructional strategies. In microteaching, although all participants used introductory activities during teaching, only approximately 25 actively probed learners' prior knowledge through questioning. Of these, very few adjusted their teaching in response to learners' answers and only four participants

attempted to address misconceptions during enactment. These findings reveal a notable gap between planning and enactment. While pre-service teachers could identify prior knowledge and misconceptions at a planning level, they struggled to respond pedagogically to learner thinking during teaching.

Curricular saliency: Sixty-seven participants demonstrated some engagement with curricular saliency by identifying key concepts and sequencing content. However, many struggled to justify the organisation and prioritisation of ideas. During micro-teaching, approximately half of the participants made explicit curricular connections during teaching. Links between the topic, prior learning, and broader curriculum goals were often implicit or absent. Therefore, the emerging pattern was that curricular saliency appeared more visible in written planning than in enacted teaching, suggesting difficulty translating curricular understanding into pedagogical action.

What is easy or difficult to teach and learn: Most pre-service teachers (69 of 81) attempted to identify concepts that learners would find difficult to understand. However, these explanations were often vague and lacked sufficient pedagogical justification. In many instances, participants identified abstract concepts as difficult without explaining the specific aspects that might challenge learners or linking these difficulties to learners' prior knowledge and cognitive demands. These findings suggest that while pre-service teachers demonstrated an emerging awareness of conceptual difficulty, their pedagogical reasoning remained underdeveloped. During micro-teaching, pre-service teachers demonstrated some awareness of learners' conceptual difficulties through questioning and classroom interaction. All participants used questions at basic or intermediate levels, while only a small number employed higher-order questions to probe learners' understanding more deeply. Although some participants recognised learners' difficulties during teaching, many struggled to respond effectively or adapt their explanations accordingly. The findings indicate that pre-service teachers could better identify conceptual difficulties during planning than respond to them during enactment. While lesson plans reflected an awareness of potentially challenging concepts, translating this awareness into responsive pedagogical action during teaching remained difficult.

Representations: Most pre-service teachers (71 of 81) incorporated representations such as diagrams, examples, and analogies into their lesson plans. However, many of these representations were included descriptively rather than purposefully, with limited explanation of how they would support conceptual understanding. In several cases, representations were not clearly aligned with the topic or learning challenges

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identified. These findings suggest that although participants recognised the importance of representations, they struggled to justify their pedagogical value. During micro-teaching, representations were commonly used particularly through diagrams and presentation slides. Most participants relied on static representations rather than interactive or dynamic forms of explanation. Few participants effectively used digital tools such as whiteboards or video demonstrations during teaching. Nevertheless, representations appeared to be enacted more readily than some of the other TSPCK components. Compared to other components, representations appeared easier for pre-service teachers to enact during teaching. This may be attributed to their tangible and pre-planned nature, which reduced the need for real-time pedagogical reasoning during instruction. In addition, the online teaching environment may have supported the use of visual tools while simultaneously constraining opportunities for interactive engagement. Although representations were frequently included and enacted, their pedagogical integration and justification remained limited.

Conceptual teaching strategies: All pre-service teachers (81 of 81) identified teaching strategies in their lesson plans. However, nearly half of these strategies required further development. In many cases, strategies were listed without explanation or justification, making it difficult to determine how they would support conceptual understanding. Although participants demonstrated familiarity with a range of instructional strategies, these were not always clearly connected to the content being taught or to anticipated learner difficulties. This suggests a tendency towards procedural, rather than conceptually driven planning.

Although a variety of teaching strategies were identified during planning, their enactment was more limited during micro-teaching. Most participants relied primarily on lecture-based approaches combined with basic question-and-answer techniques. More interactive and learner-centred strategies, such as group work or collaborative activities, were rarely implemented. Consequently, teaching practices remained largely teacher-centred, with limited evidence of strategies designed to promote deeper conceptual engagement. These findings reveal a clear difference between planned and enacted teaching strategies. While pre-service teachers could identify a range of strategies during planning, they struggled to implement these in ways that promoted active learner engagement and conceptual understanding during teaching.

Overall, across all five TSPCK components, pre-service teachers demonstrated stronger engagement during lesson planning than during enactment. While the framework

appeared to support structured pedagogical planning, translating these plans into responsive classroom practice remained challenging. The gap between planning and enactment was particularly evident in relation to addressing learners' misconceptions, responding to conceptual difficulties, and implementing learner-centred teaching strategies. These findings suggest that although engagement with the TSPCK framework supported the development of pedagogical awareness, the enactment of TSPCK required forms of real-time pedagogical reasoning that many novice teachers were still developing.

Discussion of findings

The current study examined how engagement with the TSPCK framework shaped pre-service teachers' lesson planning and micro-teaching practices in an online learning environment. The findings can be understood through a developmental view of pedagogical content knowledge, where awareness of pedagogical concepts precedes the ability to enact them responsively in practice. From this perspective, engagement with TSPCK supported pre-service teachers in making aspects of pedagogical reasoning more explicit during lesson planning, however, the enactment of these ideas during teaching remained uneven and cognitively demanding.

The findings from the lesson planning phase suggest that the TSPCK framework provided pre-service teachers with a useful structure for engaging with key dimensions of pedagogical reasoning. Most participants demonstrated awareness of all five TSPCK components, indicating that the framework enabled them to think more deliberately about learner prior knowledge, conceptual difficulties, representations, and teaching strategies. This supports research, arguing that structured pedagogical frameworks can make tacit dimensions of PCK more accessible to novice teachers (Mavhunga & Rollnick, 2013; Nyamupangedengu & Lelliott, 2018). In this regard, TSPCK functioned as a scaffold that organised pre-service teachers' thinking about teaching. However, participants' engagement with these components often remained at a surface level. While the participants were generally able to identify representations and strategies, many struggled to justify why these were pedagogically appropriate for supporting learner understanding. This finding aligns with Aydın et al. (2014) and Mavhunga (2014), who argue that novice teachers often demonstrate emerging awareness of pedagogical concepts before developing deeper pedagogical reasoning. The findings, therefore, suggest that while TSPCK can support awareness of pedagogical considerations, sophisticated pedagogical reasoning develops gradually through practice and reflection. Particularly notable was the limited engagement with learners' misconceptions. Although many participants recognised the importance

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of prior knowledge, fewer anticipated or addressed misconceptions meaningfully. This suggests that participants may still have viewed teaching primarily as content transmission rather than as engagement with learner thinking. Addressing misconceptions requires teachers to anticipate incorrect learner reasoning, interpret learner responses, and respond instructionally in the moment. Such pedagogical responsiveness is a complex aspect of PCK that develops over time. As Deshmukh (2012) notes, identifying and addressing misconceptions is often one of the most difficult dimensions of teacher competence development for novice teachers.

In contrast to lesson planning, the enactment of TSPCK during micro-teaching was more limited and inconsistent. Although most participants demonstrated awareness of TSPCK components in their lesson plans, fewer could enact these components effectively during teaching. This gap between planning and enactment is one of the most significant findings of the study, because it highlights the developmental nature of pedagogical competence. Lesson planning occurs in a relatively controlled environment where pre-service teachers have time to think carefully about instructional decisions. Teaching, however, requires simultaneous attention to content explanation, learner participation, questioning, pacing, and instructional responsiveness. The enactment of pedagogical reasoning therefore involves complex real-time decision-making that is cognitively demanding, particularly for novice teachers. This supports literature suggesting that responsive teaching requires the integration of content knowledge, pedagogical knowledge, and knowledge of learners in dynamic teaching situations (Aksu & Kul, 2016). The findings indicate that while participants demonstrated emerging declarative knowledge of TSPCK during planning, many had not yet developed the adaptive pedagogical reasoning needed to enact these ideas responsively during teaching. These challenges were further intensified by the online environment in which the micro-teaching occurred. Online teaching may reduce spontaneity and limit opportunities for immediate pedagogical interaction, making it more difficult for novice teachers to interpret learner responses and adjust instruction responsively. Limited access to non-verbal cues and immediate feedback may have constrained participants' ability to engage meaningfully with learner thinking. As a result, most participants relied more heavily on teacher-centred approaches, possibly because these approaches offered greater control within a technologically mediated environment. This finding is consistent with Msimanga (2021), who argues that novice teachers often revert to familiar transmission-oriented approaches when faced with the pressures of teaching. The findings also suggest that technological demands increase the cognitive load associated with teaching. Participants were simultaneously required to manage digital tools,

lesson pacing, content explanation, and learner interaction. The limited use of interactive digital representations suggests that many participants may not yet have developed the technological fluency needed to support pedagogically responsive teaching in virtual environments. This aligns with the findings of Omidire and Maroga (2022) and Addae-Kyeremeh et al. (2025), who argue that effective online teaching requires not only access to digital technologies, but also the ability to integrate those technologies meaningfully into instructional practice.

A key contribution of the current study therefore lies in highlighting the distinction between planned pedagogical reasoning and enacted pedagogical competence. While TSPCK effectively scaffolded lesson planning, engagement with pedagogical frameworks at the level of planning did not automatically translate into responsive teaching practice. Rather, enacted PCK develops gradually through repeated opportunities for planning, enactment, reflection, and feedback (Carlson et al., 2019; Eames et al., 2011).

Beyond the immediate context of the current study, the findings have broader significance for teacher education through flexible learning in Africa. TSPCK has its intellectual roots in African science education research and has been widely promoted as a framework for strengthening pedagogical reasoning in teacher education. By examining its implementation within an online teacher education programme outside Africa, this study provides evidence of the transferability of this African-developed framework across educational contexts. Many African teacher education institutions continue to expand online and blended learning programmes while facing similar challenges of supporting pre-service teachers to move from lesson planning to effective enactment. The findings, therefore, contribute to ongoing conversations within African Open Distance and e-Learning (ODeL) about how structured pedagogical frameworks can strengthen teacher preparation in digitally mediated environments. Rather than presenting an India-specific case alone, the study offers insights that are directly relevant to teacher educators seeking to support pedagogical reasoning in flexible learning contexts across Africa.

Implications for teacher education

The findings have important implications for teacher education. Firstly, teacher education programmes should provide sustained opportunities for iterative practice through repeated cycles of planning, teaching, reflection, and feedback. Secondly, there is a need for more explicit scaffolding in areas such as identifying misconceptions, selecting meaningful representations, and responding to learner thinking during instruction. Finally, the findings

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highlight the importance of preparing pre-service teachers for digitally mediated pedagogy by developing competence in online questioning, interactive representations, and learner engagement. These recommendations are particularly relevant for African teacher education institutions that continue to expand flexible and online modes of delivery. Structured pedagogical frameworks such as TSPCK may provide an important mechanism for supporting pedagogical reasoning where opportunities for classroom-based mentoring are limited.

Conclusions and limitations

Overall, the study demonstrates that while TSPCK supports structured lesson planning, the development of enacted pedagogical competence is gradual and contextually mediated. The findings, therefore, highlight the importance of sustained pedagogical support in helping pre-service teachers translate pedagogical reasoning into responsive teaching practice.

The study has several limitations. The micro-teaching sample represented only a subset of participants, and the relatively short duration of the intervention may not have allowed sufficient time for deeper pedagogical development. In addition, reliance on rubric-based assessment may not have fully captured the complexity of enacted pedagogical reasoning. Future research could, therefore, explore longitudinal implementations of TSPCK across diverse teacher education contexts and examine how sustained engagement with planning, enactment, and reflection supports the development of enacted pedagogical competence over time.

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Appendix I: TSPCK lesson plan template

Topic		**Subtopic**	
Name		**Assessor**	
Components of TSPCK			**Qualitative comments**
1	Prior Knowledge 1.1 Students already know_____ 1.2 Misconceptions_____		
2	Curricular Saliency 2.1 Big ideas_____ 2.2 Sequence of teaching_____ 2.3 Importance of the topic in the curriculum_____		
3	What is difficult to teach and learn? 3.1 Which concept/s is/are difficult to teach and learn? _____ _____ 3.2 What makes the concept difficult? _____ _____		
4	Representations including analogies_____		
5	Conceptual teaching strategies_____		

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Appendix 2: The Lesson plan assessment rubric

Performance criteria	Teachers' Feedback on Achieved performance	Teachers' Feedback on Expected performance	How I will revise to better meet criteria TSPCK
Curricular saliency (Identification and sequencing of concepts)			
Learners' prior knowledge (Identification of learner prior knowledge including misconceptions)			
What is easy and/or difficult to teach-has the student identified with reasons, the concepts that are easy or difficult to teach and for learners to understand)			
Representations-Are the chosen representations appropriate for the concepts to be taught?			
Conceptual teaching strategy- Is the teaching strategy appropriate for the content being taught?			

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Appendix 3: Microteaching assessment rubric

Rubric for assessing TSPCK guided micro teaching		
Performance criteria	**Teachers' Feedback on Achieved performance**	**Teachers' Feedback on Expected performance**
Microteaching skills		
Introduction skill-skill of introducing a lesson		
Skill of probing questions-skill of probing learners for answers		
Skill of explanation-skill of explaining		
Skill of stimulus variation		
Skill of achieving closure		
Learners' prior knowledge: How does the pre-service teacher engage with learners' prior knowledge. Misconceptions (Has the pre-service teacher corrected the misconception if there in the topic)		
Curricular saliency: Big ideas/sequencing of concepts/ importance of the topic / connection with other concepts/ topics/was the importance of the concepts shared with the learners?		
What is easy and difficult to teach: To what extent did the participant show consideration of the level of difficulty of the concepts they were teaching.		
Representations: Were the representations appropriate? Were they effectively used?		
Conceptual Teaching Strategies: Were the teaching strategies appropriate for the content being taught, i.e., to likely lead to an understanding of the concepts		

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