

# The Nexus of Curricular Reforms and Teacher Preparation: Assessing Pedagogical Content Knowledge and Instructional Alignment in Zimbabwe's Competence-Based Mathematics Framework

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**Abstract:** This study scrutinizes the congruence between pedagogical content knowledge and the competencies of pre-service primary teachers within the context of Zimbabwe's competence-based mathematics curriculum. Addressing the gap as to how adequately teacher training institutions prepare pre-service teachers for the requisite pedagogical content knowledge—compelling them towards critical pedagogy in mathematics teaching—an area concerning teachers, who as implementers of conceived reforms determine their success, was taken into account. The research underscores the need for adequately trained mathematics teachers embracing the contemporary Zimbabwean educational paradigm which moves away from purely content-driven curricula towards competence-based approaches. Mathematicians turned educators willing to think beyond some 'safety net' of content mastery face a syntactic maze demanding them to possess not just sound knowledge on mathematical concepts but also sophisticated strategic teaching techniques geared towards fostering learners' reasoning, problem-solving abilities, and their adeptness at applying learned material in real-life contexts. The study employed a mixed-methods research design comprised of structured questionnaires administered to 341 pre-service primary teachers as well as in-depth interviews with 30 participants, from whom qualitative data were withdrawn. Quantitative analyses stemming from the questionnaire data revealed gaps among pre-service teachers pertaining to levels of PCK which, in tandem with strengths across certain content areas while lacking significantly in others remained absent within effective use of technology and differentiated instruction integration contributed towards awarding these coexisting, paradoxical phenomena upon diverging pathways toward self-discovery. Results indicated that there is a gap between the concentration on active learning in the course and pre-service teachers' predominant use of passive traditional teaching techniques. Finally, this study showed that although pre-service teachers have some grasp of mathematical concepts, their pedagogical content knowledge (PCK) and instructional skills educational level does not meet the expectations of the competence-based mathematics curriculum in Zimbabwe. It calls for an urgent review of programs aimed at equipping teacher trainees with PCK to enable them to effectively teach in rigorous reformed curriculum contexts, including better focus on inquiry teaching, assessment for learning, and use of manipulatives and technologies.

**Keywords:** Pedagogical Content Knowledge; Pre-Service Primary Teachers; Competence-Based Curriculum; Mathematics Education; Teacher Education; Curriculum Reform; Teacher Preparation; Zimbabwe

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## 1. Introduction

Any educational system is fundamentally built on the effectiveness of its teachers, especially their pedagogical content knowledge (PCK). The blending of subject matter with relevant teaching strategies forms PCK, which helps in translating curriculum content into learning (Adipat et al., 2023). Pre-service educators are poised to become the mainstay of a country's education system. Hence, exploring the gaps between their PCK and skills and curricular expectations becomes important. It is also equally essential to study whether pre-service primary teachers can deliver instruction aligned with the Zimbabwean competence-based mathematics curriculum's core principles which emphasizes application and problem solving. This study explores this gap towards understanding the level of preparedness that primary school teacher trainees have in nurturing mathematical competencies among children in Zimbabwean primary schools.

On a global scale, teacher PCK and its relationship with curriculum changes has received attention from researchers. For example, Singapore is internationally recognized for its mastery of mathematics education as the teachers' colleges train them to deliver deep PCK tailored to national emphasis on modeling, problem solving, and conceptual understanding (Choy & Dindyal, 2024). Equally important is Finland's reputation for having a more progressive approach wherein educators are being trained to emphasize creative and critical thinking which aligns with the student-centered focus of the curriculum (Ridwan, 2024). Closer to home in Kenya and South Africa where there is an emerging interest in competence-based curricula, there have been some studies observing gaps between their pre-service training and teaching practice competencies required to successfully teach these curricula. Within Zimbabwe, the adoption of a competence-based curriculum raises concern about how well pre-service teacher education programs equip students with appropriate PCK and skills necessary for quality mathematics instruction.

With the adoption of a competence-based curriculum aimed at equipping learners with relevant 21st-century skills and knowledge, Zimbabwe undertook a notable educational reform. This revision places emphasis on comprehension and application of problem solving and critical thinking alongside the use of mathematics in real-world contexts. Nevertheless, the successful execution of this curriculum is greatly dependent on teachers' readiness, especially their skill to meet the curriculum goals through meaningful engaging lessons crafted around active learning paradigms. While some time has elapsed since the introduction of the new curriculum, one looks in vain for studies exploring its alignment with pre-service primary level teacher training pedagogy—curriculum taught at degree granting colleges—and pedagogical content knowledge and skills (Mufanechiya, Kanyopa and Mokhele-Makgalwa, 2024). There appears to be an evidence-based divergence between policy objectives pertaining to curricular reforms and actual classroom practices informed by these policy practices. Risiro (2021), for example, reported that a number of teachers were unable to adopt activity-based learning approaches due to lack of proper training and resources.

In addition, the preliminary observations conducted in primary grade levels indicate a persistent use of a teacher-centered approach within the teaching of mathematics, which may be detrimental to the cultivation of competencies (Sunzuma and Luneta, 2023). The aim of this study is to address the gap in understanding the degree and one pre-service teachers' PCK and competencies with respect to Zimbabwe's competence-based mathematics curriculum syllabus. This lack of understanding will likely undermine attempts to refine teacher education initiatives. Informed by the existing gap, this study has outlined the following objectives: 1) to measure the pedagogical content knowledge (PCK) of pre-service primary teachers in mathematics within the framework of Zimbabwe's competence-based curriculum. 2) To assess the pre-service primary teachers' competencies in applying relevant and effectively challenging teaching processes that foster problem-solving, critical thinking, and practical use of mathematics. 3) To assess emphases of pre-service teachers on their training gaps toward effective delivery of a competence-based education in comparison to other educational curricula. 4) To formulate suggestions aimed at Zimbabwean primary teacher education policies which relate more directly with curricular demands and thereby improve the teaching of mathematics in primary schools. Thus far, this study seeks to examine comprehensively how aligned PCK and skills of pre-service primary teachers are with Zimbabwe's advanced requirements for a competence-based mathematics curriculum.

## 2. Literature Review

Any curriculum implementation, especially one as sophisticated as Zimbabwe's competence-based mathematics curriculum, relies heavily on the readiness of its instructors. This review focuses on the critical alignment between the PCK and competencies of pre-service primary teachers with the requirements of the new curriculum. Understanding this gap is important to project outcomes in teacher education and inform school-based teacher education programs in relation to intended outcomes.

### 2.1 Defining Pedagogical Content Knowledge (PCK) in Mathematics

The definition of teaching efficacy shifted with the introduction of Pedagogical Content Knowledge (PCK) by Lee Shulman in 2013. Teaching effectiveness is not solely centered on subject matter knowledge or pedagogical techniques; rather, it involves an integration of both. To effectively teach mathematics (or any other subject for that matter), one needs to possess PCK, which goes beyond knowing the content to encompass instructional strategies tailored towards alleviating students' developmental hindrances (Shulman, 2015). This suggests that students should appreciate a great deal more than what is sophisticated in the learning process. Rather, it requires the ability to appropriately represent appealing and engaging ideas at different levels, along with a deep grasp on why these ideas matter for learners. Such understanding expands far beyond simply knowing what makes learners tick within their heads to appreciate how deep phenomena connects with mental models long after they learn that material.

Building upon Shulman's seminal contributions, Grossman and Fraefel editors (2024) have done a remarkable job of extending the boundaries of PCK by adding elements such as knowledge of curriculum and assessment. This is important in light of curriculum developments such as Zimbabwe's competence-based curriculum which is focused on the application of theory into practice (Sunzuma et al., 2025). A teacher with strong PCK would understand the mathematics not just as abstract concepts but how it was vertically and horizontally integrated within the educational curriculum framework, across grade levels, other subjects and how to assess students' grasp of key concepts aligned with curriculum expectations. It requires a sound grasp of the instructional outcomes, the metrics used for evaluation, and philosophy underpinning teaching captured within the curricular architecture. In addition, it requires adaptability in terms of modifying teaching styles to effectively deliver lessons and embrace all learners in their differing abilities. Aligning instruction and assessment with robust PCK makes one stand out among fellow educators.

The particular facets of PCK applicable to mathematics are intricate and demand a particular form of knowledge that goes beyond pedagogy. This includes the aspect of a teacher's knowledge—a sophisticated acquaintance with the framework of mathematical knowledge—enabling them to understand how various concepts intertwine and navigate students through their intellectual pathways (Ormond, 2021). Moreover, it includes identifying strategies for teaching which represent mathematical concepts through physical materials, drawings, contemporary technology, or even real life scenarios so as to foster learning appreciation among pupils (Difficulties) learners who decode information in diverse ways. A teacher endowed with great PRU can change Spanish to English freely and explain varied aspects effortlessly taught over different pupils' responses during lessons (Matitaputty et al., 2024). Sakaria, Maat and Matore (2023) note KCS and KCT as vital components associated with PCK in mathematics. KCS encompasses recognizing the pre-conceived notions students have as well as their misconceptions about certain mathematically defined ideas (Borke, 2021). Evaluating PCK requires special attention within professional training programs offered to instructors.

PCK in Mathematics can be evaluated using different tools and techniques like self-assessments, lesson plan critique for assessment integration, as well as classroom evaluation where teachers' instructional activities are systematically elaborate (Moh'd, Uwamahoro and Orodho, 2022). Advanced teaching strategies designed to develop PCK among pre-service teachers include courses tailored specifically to the pedagogy of mathematics through its teaching components, lesson study where instructors work together to plan, implement, observe, and critique lessons on teaching practice, and practical teaching placements accompanied by rigorous reflective frameworks so that pre-service teachers may grasp the connection between theory and practice while developing their PCK (Asvat, 2024). As has been established earlier in this chapter with the aid of a number of cited experts who contributed to the body of literature concerning PCK development it is a gradual process which

demands relentless thought and endeavor. It builds through teaching experience complemented by professional development activities such as collaboration with peers or engagement with scholarly work aimed at advancing one's understanding of PCK alongside enhancing instruction in mathematics.

## **2.2 Competence-Based Curriculum: Global Trends and Zimbabwe's Context**

Competence-based education (CBE) is a transformative approach to teaching and learning that moves away from the traditional hours-based, content-driven, curriculum towards focusing on demonstration of mastery of specific skills and knowledge (Mwita, 2023). At its core, CBE stresses authentic assessment, self-directed pathways through personalized learning experiences, and outcome-based education with planned results that are frequently aligned with real-life scenarios (Catacutan et al., 2023). The focus stands in stark contrast to traditional models which center on rote memorization and standardized testing. This has led to widespread advocacy for the adoption of CBE. Countries such as Finland, Canada, and Australia have led the way by incorporating CBE into their educational frameworks, often utilizing strategies like flexible pacing, competency-based grading, and individualized learning plans tailored to diverse student needs and learning styles (Javed, 2025). These global cases provide important lessons on what national policy makers need to consider when contemplating the adoption of CBE within an entire educational system, as well as highlight the urgency for a shift in approach designed to equip students for the ever-changing demands of a 21st century workforce.

Zimbabwe's curriculum in mathematics integrates education with national development priorities by focusing on acquiring practical skills and relevant problem-solving capabilities. Notable elements of this curriculum include core competencies which students are to develop during their mathematical education, including critical thinking, communication and the application of mathematics to real-world situations (Mashingaidze, Mukaro and Chauraya, 2024). Within these frameworks, assessment criteria shift from conventional examinations to more authentic forms such as project assignments, portfolios, and performance-based tasks where students demonstrate the application of skills gained (Age, 2025). The strategies for teaching that have been suggested span active learning focused on student collaboration within problem-centered contexts to use of appropriate technological tools that stimulates learning and understanding of mathematics (Fadzil and Osman, 2025). An intensive review of other available curriculum documents highlights an intentional gap in the development of a mathematically literate population who will be able to participate meaningfully in the nation's socio-economic growth.

As promising as CBE is, its benefits come with complex challenges and opportunities related to its implementation. Moving away from standardized testing toward authentic assessments design calls for a complete overhaul in teacher-training programs concerning evaluative processes shaped at measuring student competencies. In addition, personalized learning pathways alongside flexible pacing systems demand a monumental shift in school culture, structure, and resources (Idowu, 2024). Moreover, ensuring equitable outcomes is especially important with regard to the systemic underlying issues of resource distribution and technology that can disproportionately widen competence gaps among students from varying socioeconomic backgrounds (Peer, 2024). That said, the successful overcoming of these obstacles stands to significantly improve student engagement as well as skill development for workforce demands while advancing some core principles of equity within education: more effective delivery systems and preparation for success in the 21st century.

## **2.3 Alignment of PCK and Competence-Based Mathematics Education**

The alignment of pedagogical content knowledge (PCK) with the objectives of the curriculum remains one of the key sustaining elements to effectively integrate competence-based mathematics education (CBME). The nature of teaching within a CBME framework requires that educators have granular understanding of what specific competencies are expected at each level, and how to design rich learning experiences that cultivate these competencies (Gustafson et al., 2024). In addition, teachers must accurately assess progress in relation to the defined competencies. This transformation focuses on PCK that leads to stronger emphasis in formative assessment and differentiated instruction designed for real-time understanding.

With respect to evaluation, a focus on formative assessment invites new possibilities from teachers beyond predefined curriculums toward more responsive educational frameworks where dynamic understanding shifts shaped by ongoing assessment guide learning pathways (Yadav et al., 2025). Achieving this goal fundamentally alters the educator role from standing at the front to facilitate the application of critiqued mathematical skills tailored through active assessments.

Looking internationally at the implementation of competence-based curricula aids in understanding the best approaches and possible gaps that may exist in integrating PCK with curriculum objectives. Singaporean research underscores the need for teachers to comprehend how to foster deep conceptual understanding along with engaging problem-solving task design, as this is essential for effective teacher training (Toh and Chua, 2025). Investigations into the impact of teacher PCK on student performance in CBE have consistently shown that teachers possessing robust PCK are far better equipped to facilitate learner progression towards attaining competencies (Koh and Wang, 2024). These studies emphasize the importance of ongoing training focused on enhancing educators' grasping of defining competencies, assessment methods, and tailor instruction designed to address all levels of a diverse classroom population.

Nevertheless, a possible misalignment between pre-service teachers' PCK and the expectations of a CBME curriculum like the one used in Zimbabwe is something that needs to be addressed. These gaps may result from lack of content knowledge, lack of knowledge regarding the assessment of competencies, or challenges in crafting instructional activities aimed at particular competencies (Cabauatan Jr and Dacles, 2021). Suggested mitigation strategies include advancing targeted professional development addressing those gaps within teachers' PCK frameworks, mentorship programs pairing veteran teachers and novices to CBME, and the development of systematic curriculum materials for educators which promote teacher education focused on implementing competence-based teaching (Tsarkos, 2024). Actively addressing these mismatches with appropriate support would strengthen teachers' PCK to implement and sustain competence-based mathematics education as a cross-subject instruction framework.

#### **2.4 Pre-Service Teacher Education and PCK Development in Mathematics**

The teaching methodologies and syllabus offered in pre-service programs for mathematics teachers significantly influence their future educators' Pedagogical Content Knowledge (PCK). While some programs follow a conventional approach with an emphasis on 'content' knowledge, others attempt to foster innovative understanding of how students learn mathematics (Rehman, Huang and Mahmood, 2025). The ability of these teacher-training programs to adequately prepare their students for competence-based education depends on the integration of practical experience and theory – how well the pre-service teachers are trained/tested on the content as far learning outcomes is concerned, and what skill sets are in place to enable them encourage effective learning at all levels (Mpate, 2025). More effective practices revealed through research include constructivist approaches, problem-based learning or technology-focused methodologies aimed at developing PCK.

Practical experiences and mentor-ships are important for the formation of PCK because they allow pre-service teachers to use their theoretical knowledge in tangible class-room situations. The learners' context is equally important, as situated experience like teaching or doing an internship is crucial to gain an understanding of the art of teaching (Bay 2021). Mentorship helps everyone, but specifically aids pre-service teachers in gaining access to guides who are seasoned professionals with ample skills for offering feedback and modeling ways of effective teaching. These structured mentorships form a strong coherence with competence oriented pedagogical goals which gives pre service teachers an upper hand towards teaching learning diversity within classrooms, innovative pedagogical techniques and addressing the varied learning levels presented by different students in one classroom (Nesje and Lejonberg 2022). Attention needs to be given on how practical experiences are framed so that they include reflective thinking, collaboration, and improvement through iteration, seamless design loops driven by analysis, and refinement cycles based on self-assessment.

Assessment as well as feedback are critical components of pre-service teacher education in relation to developing PCK, both in shaping it and recognizing the need for improvement. Various approaches such as self and peer assessments, lesson plan evaluations, and classroom observations can be leveraged to assess PCK (Yadav et al., 2025). Feedback guides reflection for action, with its effectiveness calling on specificity, timeliness, and the provision of clear next steps. Pre-service teachers should aim to refine their practices based on reflective thinking influenced by effective feedback. Data-driven formative assessment mechanisms beset with technology offer promising avenues for providing tailored support through pre-defined metrics enabling pre-service teachers to monitor their performance while identifying recurring themes that warrant closer inspection within their practice (Huijin & Eunjeong, 2023). Moreover, encompassing peers alongside instructors and clinicians into collaborative assessment design may drive collective responsibility aimed at rigorously preparing proficient

mathematics teachers through embedded continuous improvement cycles.

## 2.5 Challenges and Opportunities for Zimbabwe's Context

The ongoing resource deficits and infrastructural inadequacies within Zimbabwe's education system pose considerable obstacles to the effective teaching of mathematics and the development of Pedagogical Content Knowledge (PCK) in pre-service teachers. Limited access to technology, overcrowded classrooms, inadequate classroom resources such as textbooks and manipulatives, along with a lack of trained specialists negatively impact quality mathematics instruction (Graham, 2023). Moreover, rural schools are particularly vulnerable to these constraints because qualified teachers often have little to no access to basic goods essential for teaching or critical to their occupation, which exacerbates the already insufficient levels of quality mathematics education available (Mncube, 2023). The limited range of appropriate educational materials combined with a lack of training on how best to use the provided materials makes it harder for pre-service teachers to develop strategies and a sound understanding of the mathematical concepts that are crucial for successful PCK development (Olawale, 2024). Addressing any one of these challenges within this framework calls for more inventive approaches including utilizing locally available materials or incorporating technology where it is possible alongside providing funding and advancing infrastructure development.

The considerations of culture and society are equally important with respect to mathematics education in Zimbabwe. Attitudes emanating from cultural systems typically impose certain traditional constraints with regard to the teaching and learning of mathematics. For example, mathematics is generally viewed as a complex or very abstract discipline, which tends to be the case when students are exposed predominantly to rote learning strategies. This perception leads to a lack of commitment amongst learners (Emelda, Mubemba and Thelma, 2024). Moreover, some traditional cultural views may shape attitudes towards the subject which are not encouraging especially towards women where it has been suggested that societal expectations are designed towards lower participation and achievement in STEM (Msambwa et al., 2024). On the positive side, community engagement can greatly enhance the learning of mathematics. For instance, organizing parents and community members into structured numeracy workshops or problem-solving sessions enhances their perceived value towards mathematics which aids in creating a supportive atmosphere for learning (Tytler, Anderson and Williams, 2023). These factors reveal that sociology and culture provide greater understanding in addressing equity issues within curriculum frameworks focused on all learners.

To advance Pedagogical Content Knowledge (PCK) development among pre-service primary teachers in Zimbabwe within the existing limitations, a number of recommendations are vital. As pointed out by Sujatha and Vinayakan (2023), curriculum design must focus on practical relevance by integrating mathematical concepts with students' daily lives and cultural heritages. Also, teacher education logistics have to include active learning modalities like collaborative problem-solving, lesson study, and microteaching that enable reflection-focused hands-on experiences for pre-service teachers to deepen their PCK (Kehinde, Foluso and Dupe 2024). Assessment efficacy should include use portfolio frameworks with performance tasks and situated assessments that illustrate students' comprehension of mathematical principles along with their application skills across varied contexts. Lastly, equitable allocation of resources must ensure access disparities controlled vis-a-vis access to technology and professional development materials for all educators irrespective of geographical location or school setting. Grounded on the principles of equity, access, and quality alongside these recommendations strengthens preparedness amongst all educators to meaningfully deliver a competence-based mathematics curriculum while equipping learners with confident maths skills shaped them as successful learners during foundational years of schooling.

## 2.6 Theoretical Framework

Many theoretical perspectives already exist that help examine the alignment of Pedagogical Content Knowledge (PCK) and competencies of pre-service primary teachers with Zimbabwe's competence-based mathematics curriculum. To begin with, Shulman's PCK framework is critical to assess the scope of a teacher's subject matter knowledge in relation to his or her pedagogical knowledge. It captures the fact that teaching mathematics at any level requires more than just the bare content; it demands knowing how learners understand—or fail to understand—the subject and how best the content can be presented and modified to suit different learning styles. This framework supports inquiry into how prospective teachers are acquiring

their capacity to transform mathematics knowledge into forms that are accessible and applicable to their students, bearing in mind the Zimbabwean syllabus in which functional and practical skills dominate.

Second, learning theory constructivism as developed by Piaget and Vygotsky offers insight into how pre-service teachers facilitate mathematics teaching and learning as an active process of meaning-making. This framework indicates that learners develop understanding of the mathematical concepts through engagement with their environment and peers. Thus, it becomes critical in determining whether or not pre-service teachers have the competencies needed to create appropriate instructional contexts where learners grapple actively with challenging mathematical problems instead of being recipients of information passively. Understanding this situation requires an examination of teacher's activities, methods used, and group work techniques employed – problem-solving – to determine the level at which pre-service teachers have been prepared to design activities' aimed at developing learners understanding toward the mathematical concepts articulated in the competences-based curriculum of Zimbabwe.

Ultimately, Bandura's social cognitive theory sheds light on the evolution of self-efficacy and its influences on pre-service teachers' implementation of the competence-based curriculum. This theory suggests that the belief an individual holds regarding their ability to perform a specific task has considerable bearing on motivation, effort, and persistence. In terms of mathematics education, pre-service teachers with high self-efficacy are more likely to adopt new teaching models, visit obstacles head-on, and foster positive learning environments for their students. Therefore, this framework allows researchers to investigate how pre-service teachers' self-efficacy calibrates against their PCK skills in relation to Zimbabwe's mathematics curriculum—examining where gap theories may exist to intervene and aid in boosting teaching confidence and effectiveness.

### **3. Research Methodology**

This study aims to examine the congruence of Pedagogical Content Knowledge (PCK) and associated competencies of pre-service primary teachers with the expectations of Zimbabwe's competence-based curriculum in mathematics. Given that the curriculum seeks to develop and assess problem-solving, critical thinking skills, and application of mathematics in everyday situations, it is important to evaluate whether PCK is adequately provided by teacher preparation programs. In this part, I describe the methods that were used including: research strategy and design; philosophy, sampling techniques and instruments used; pilot study testing; analysis done with collected data; measures taken concerning reliability and validity; as well as ethical aspects regarding the study.

#### **3.1 Research Approach**

This study employed a mixed-methods research approach. As described by Shan (2022), mixed methods encompass the collection, analysis and integration of qualitative and quantitative data within a single study or multiple interrelated studies. This approach was chosen in order to understand more fully the complex interplay between pre-service teachers' pedagogical content knowledge (PCK) and the demands of the competence-based curriculum. Quantitative measurement of PCK through structured questionnaires enabled us to gauge PCK levels among a larger sample of pre-service teachers. The qualitative data from interviews contextualized and deepened our understanding regarding the challenges pre-service teachers faced, thus enriching and expanding the quantitative data. The rationale for this approach aligns with the pragmatic paradigm as discussed by Dawadi, Shrestha and Giri (2021), which focuses on the implications of conducting research. One of the purposes of the study was to improve teacher education programs in Zimbabwe which necessitated both qualitative and quantitative approaches.

#### **3.2 Research Design**

The study utilizes a convergent parallel mixed-methods design which is a subtype of mixed-methods design where both qualitative and quantitative data are collected and analyzed separately before being integrated or merged in the interpretation stage (Bhairawa et al., 2022). Within this framework, qualitative and quantitative data are treated with equal significance. The quantitative component gathered through questionnaires, yielded a statistical snapshot of preservice teachers' PCK. At the same time, qualitative data garnered through interviews illuminated the intricate challenges and opportunities pertaining to the implementation of the competence-based curriculum in more nuanced detail. This is an appropriate design because

it provides multiple ways of validating and triangulating findings thereby enhancing claimed rigor and credibility for understanding the phenomenon under investigation. In this regard, therefore, achieving the objectives aligned with identifying areas of convergence as well as divergence offered robust insights into pre-service teachers collaboratively revealing alignment (or misalignment) derivatively framed between their PCK and curriculum requisites quantified through mixed results encapsulated qualitatively juxtaposed against quantitatively interpreted outcomes.

### 3.3 Research Strategy

The selected research methodology is a combination of surveys and case studies all tied together with a mixed-methods approach. The survey method collected quantitative data from a large group of pre-service teachers which makes the data more reliable and the results could be generalized (Johannesson et al., 2021). A structured questionnaire which was sent to the participants made it possible for every one of them to respond to identical questions, making it easier to intercompare answers and distinguish uniform responses through comparison analysis. Simultaneously, a case study strategy was applied for the qualitative part which entailed interviewing a small number of pre-service teachers in detail. This case study contributed towards evidence on broad contextual inquiry that was also purposefully quantitative in nature (Hancock, Algozzine and Lim, 2021). These two strategies combined within the mixed-methods framework provided an extensive understanding of the research problem at hand. For this study, the philosophy of research that applies is pragmatism.

### 3.4 Research Philosophy

Focusing on the work of Shook (2023), we can describe pragmatism as paying attention to the practical outcomes of the research and why a particular method is chosen. This approach works in practice because it does not impose a rigid binary choice between positivism and interpretivism; rather, it considers what is most useful within a given framework (Gillespie, Glăveanu and de Saint Laurent, 2024). In this case, mixed-methods research design is justified from a pragmatic perspective. It incorporates both quantitative and qualitative data to deepen understanding of the situation at hand and make more informed decisions—actionable insight. The focus here is on generating knowledge aimed toward actionable insights intended for designing teacher education programs or realigning pre-service teachers' pedagogical content knowledge with the demands of teaching the competence-based curriculum in mathematics.

### 3.5 Sampling/Sampling Techniques/Population of the Study

The study's sample frame includes all pre-service primary teachers training in the established teaching colleges of Zimbabwe, particularly those who are completing their practical's and about to transition into the primary teaching workforce. This is important because these are the educators that would be in charge of actualizing the competence-based mathematics primary curriculum which is structured for learners at the foundational level. Considering the practical difficulties associated with surveying all pre-service teachers from every college in Zimbabwe, a representative sample becomes necessary. The choice of sampling technique is influenced by several criteria such as desired precision level, available resources, and population characteristics, among others. A combination of stratified random sampling and cluster sampling could provide an effective approach. As described earlier, stratification entails dividing a given population into subgroups (strata) using academic relevant and identifiable factors such as the nature of the teacher training college (government, church private), geographical region of the college, or specific major within primary education. This captures diverse training contexts and student backgrounds. Random selection of colleges within each stratum forms clusters.

Consequently, individual pre-service teachers from the chosen colleges would be randomly selected to take part in the study.

As a starting point, we can use Cochran's sample size formula where the population is limited. This approach takes into account the precision margin of error, confidence level, and variance of the population. The formula is:

$$n = (N * Z^2 * p * (1-p)) / (e^2 * (N-1) + Z^2 * p * (1-p))$$

Where:

n = required sample size

N = population size (the estimated number of pre-service primary teachers in Zimbabwe)

Z = Z-score that corresponds with the level of confidence desired e.g. 1.96 for 95%

p = proportion estimate that has the attribute being measured; usually set to 0.5 if unknown as this elevates sample size

requirements.

$e$  = margin of error, simply put, how far off results are permissible (0.05 for a 5% margin)

For easier calculation let us take  $N$  to be 3000 which is an estimation of preschool primary school teachers in Zimbabwe. Aiming for the usual target (95%) places  $Z$  at 1.96 and giving a five percent margin on equal 0.05( $e$ ). For these calculations using  $p=0.5$ , we will perform it based off previous settings:

$$n = (3000 * 1.96^2 * 0.5 * (1-0.5)) / (0.05^2 * (3000-1) + 1.96^2 * 0.5 * (1-0.5))$$

$$n = (3000 * 3.8416 * 0.25) / (0.0025 * 2999 + 3.8416 * 0.25)$$

$$n = 2881.2 / (7.4975 + 0.9604)$$

$$n = 2881.2 / 8.4579 \approx 340, 6$$

Based on this reasoning, the precise estimation and confidence requirements suggest that a sample of around pre-service primary teachers is optimal at approximately we expect to achieve after rounding off to a clean number while acknowledging these assumptions. Collecting data from this carefully calculated sample will make it possible to comprehensively evaluate the relationship between PCK and pedagogical skills possessed by these future educators with respect to their suitability for Zimbabwe's competence-based mathematics curriculum reconstruction by stratified random sampling coupled with cluster sampling methods.

For the qualitative part, in this case interviews, I used purposive sampling selecting an audience that was highly focused such as mathematic educators which resulted in selecting thirty individuals who were perceived as knowledgeable or experts who offer critical response. These students were chosen because of their strong academic performance and interested studying in teaching willing to participate through whether they want or need data collection conducted on them tends towards math education courses did mathematics related subjects .

### 3.6 Research Instruments

Structured questionnaires and semi-structured interviews are the two primary instruments that were applied in this research. In this case, the questionnaire collected quantitative information regarding pre-service teachers' pedagogical content knowledge (PCK) concerning mathematics. The questionnaire took the form of multiple-choice questions alongside some Likert-scale items as well as open-ended questions. These questions sought to evaluate their understanding of key mathematical concepts, relevant instructional methods, and blending both teaching and learning principles. The Shulman (2015) PCK framework alongside Zimbabwe's competence-based curriculum for mathematics offered guiding literature which informed the construction of the questionnaire.

The focus of the semi-structured interview was aimed at gathering qualitative information that concern experience, perceptions, and experienced challenges by pre-service teachers towards teaching mathematics under a competence-based curriculum. Such interview guidelines featured open-ended questions so respondents could freely expand on their answers while giving more depth to their accounts. Topics from within this focus included understanding components of the curriculum; employing appropriate strategies; assessing learner performance; identifying factors contributing to their strength or weaknesses across these competencies.

### 3.7 Pilot Study

Prior to the principal data collection, a preliminary study was held with a small group of pre-service teachers who did not conform to the main sample. This study aimed to evaluate the clarity, validity, and reliability of the research instruments. Moreover, it sought to uncover any possible issues with the data collection processes (Kunselman, 2024). In response to feedback provided by pilot study participants, both the questionnaire and interview protocol underwent modifications in order to enhance relevancy and precision. Furthermore, identifying logistical issues and refining data collection processes were other objectives which were fulfilled through pilot studies.

### 3.8 Data Analysis

Quantitative information extracted from questionnaires was assessed using both descriptive and inferential statistics. Means, standard deviations, frequencies, and other forms of descriptive statistics summarized the data in order to depict sample characteristics. To evaluate inter-group differences among pre-service teachers as well as determine relationships between some associated variables within the groups, some inferential statistics such as t-tests and ANOVA were employed. These statistical analyses were conducted using SPSS software designed for social sciences. The qualitative data obtained from the

interviews were analyzed through thematic analysis which is a method of identifying and analyzing patterns (themes) within qualitative data (Lochmiller, 2021). The steps of thematic analysis include: (1) transcribing the interviews; (2) reading and re-reading the transcripts to become familiar with the data; (3) generating initial codes; (4) searching for themes; (5) reviewing and refining the themes; and (6) defining and naming the themes. To assist with coding and analyzing interview data, ATLAS.ti qualitative data analysis software was employed.

### 3.9 Reliability and Validity

As for quantitative data, certain strategies were implemented to ensure accuracy and trustworthiness. Derived from relevant theoretical models, a reliable framework was crafted that underwent validation in a pilot study. The internal consistency reliability of this framework was measured using Cronbach’s alpha coefficient. An alpha value exceeding 0.7 would affirm reliability suggesting that all items within the questionnaire pertained to one shared concept or construct.

To maintain the credibility and consistency of the qualitative data, methods such as triangulation, member checking, and peer debriefing were used. As stated by Vu (2021), triangulation consisted of corroborating the results with various data sources like interviews and documents. In participant verification or member checking, participants were shown the preliminary conclusions so that they could confirm whether those results reflected their reality. Other researchers provided feedback through peer debriefing, which subsequently highlighted possible biases related to the study.

### 3.10 Ethical Considerations

Ethical factors were taken into account throughout every stage of the research. Ethical clearance from relevant institutional review boards was gained before beginning data collection. All participants granted informed consent whereby they fully understood the purpose of the research, its processes, and their ability to withdraw at any point during it. The identities of participants were protected by pseudonyms alongside secure storage of sensitive information ensuring confidentiality and anonymity was upheld. Potential risks to participants’ well-being were minimized alongside protective measures in place considering balanced against benefits derived from conducted researched sessions followed by immediate aftermath intervention analyses via sessions studying drawn conclusions during gathered info intervals addressing holistic ethics abiding BERA guidelines established for such instructional scientific undertakings

## 4. Presentation of Data, Analysis and Discussion

The purpose of this study was to explore the alignment of pedagogical content knowledge and skills among pre-service primary teachers with Zimbabwe’s competence-based mathematics curriculum using a mixed-methods approach. This study analysed the distributed questionnaires whilst merging them with the qualitative output and aligning with the literature review vis a vis theoretical frameworks.

### 4.1 Questionnaire Response Rate

The investigation consisted of the administration of three hundred and forty one structured questionnaires and thirty interviews, each of which was finished by all respondents and participants. This results in a response rate of 100%, which is excellent since it ensures that every respondent is represented in the sample. The statistical breakdown of the questionnaire responses is shown down below in table 1.

Table 1 Questionnaire Responses Statistical Breakdown

Distributed Questionnaires	Returned Questionnaires	Intended Interviews	Interviews Conducted	Response Rate
150	150	30	30	100%

Source: Researcher’s Construct (2025)

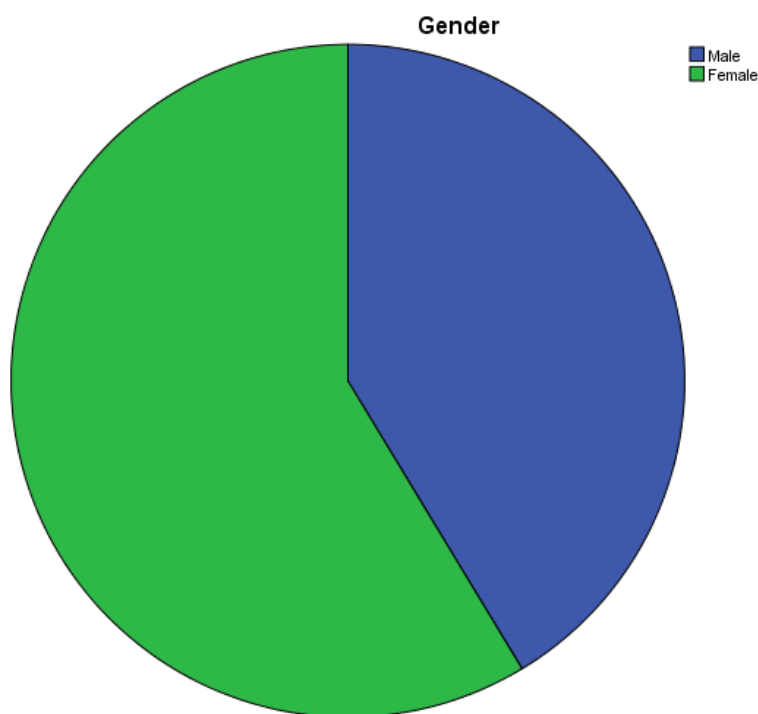
Before presenting the trade data, it is important to outline the demographic profile of the participants who were interviewed qualitatively in the preceding table in order to give context which is key to appreciating the range of views that shaped the qualitative analysis. Table 1 presents the demographic data.

#### 4.1.1 Gender

The study comprised a sample of 341 pre-service primary teachers from whom females constituted the majority (58.7%) with

200 participants, while males represented 41.3% with 141 participants. This disparity of one gender to another mirrors an overarching pattern within the teaching profession, especially in primary education where there is a predominance of female teachers when compared to their male colleagues (Ferreira, Silva and Gomes, 2025). The disproportionate share of women noted in this study supports findings which indicate that the early childhood and primary teaching continues to be stand dominated by women, likely because of cultural norms and occupational pathways informed by gender stereotypes (Scholes and McDonald, 2022). This specific case or example reveals interest pedagogy directly within context and deploy relevant content knowledge are skills integrated Zimbabwe's competence-based mathematics curriculum; hence analyzing the impact of gender becomes integral considering social norms may navigate preference tailored towards subject matter impact one's teaching style effectiveness relative to curriculum delivery engagement (Lee and Boo, 2022). Therefore, understanding how pre-service teachers' examined gender influenced preparedness concerning professional development strategies designed targeted tailored towards deepening their exposure competence advanced mathematics instruction strongly enhances rigor relevance proportional academics strategic deliberate interventions confront realities aimed professional frameworks supportive structures addressing gaps noticed gaps constrained targeting focused determined-sharp limited educational prospects offered exacting purpose.

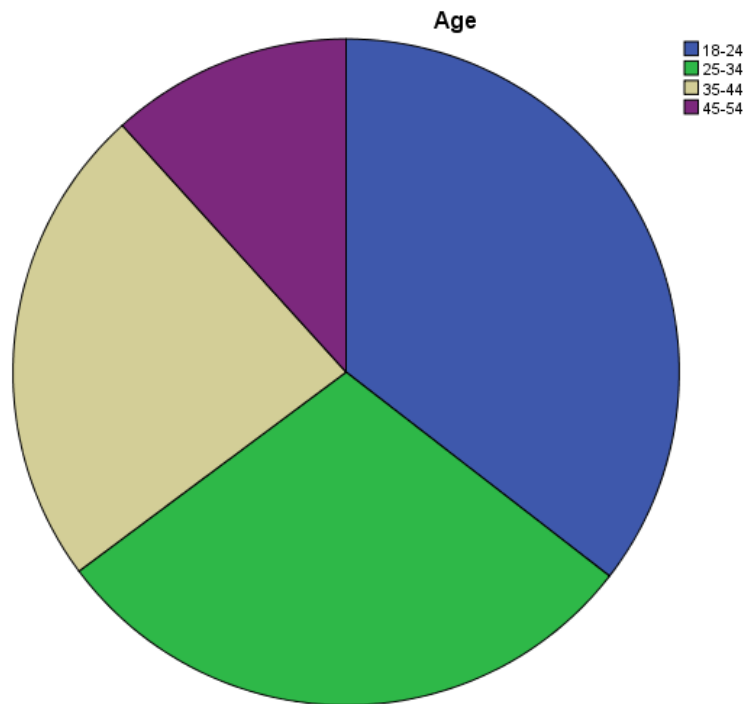
Figure 1 Gender



#### 4.1.2 Age

A considerable proportion (35.5%) is accounted for by the 18-24 age group, which consists of individuals likely coming straight from secondary education and entering teacher training programs immediately. The sample also includes the 25-34 year olds, who make up 29.3%, suggesting they may be students with some work experience or those who have previously studied in a different field before entering teaching. Individuals aged 35-44 years in pre-service training account for 23.5%. This suggests a portion of people who are possibly looking to change careers or pursue further professional qualifications much later into their working life. Finally, within the age range of 45-54 years, we find 11.7% of the sample which may consist of people with other extensive prior experience or those returning to school to refine their teaching skills formally. This blend of younger teachers and older professionals adds tremendous value as it ensures that there is diversity in age which could enhance teaching methods while pre-service teachers enrich classroom instruction on pedagogical approaches and content knowledge. As noted by Tan et al., (2021), teachers' pedagogical content knowledge hinges on their experiences and knowledge, thus spanning multiple decades creates opportunities for adaptable robust teaching strengths within the cohort.

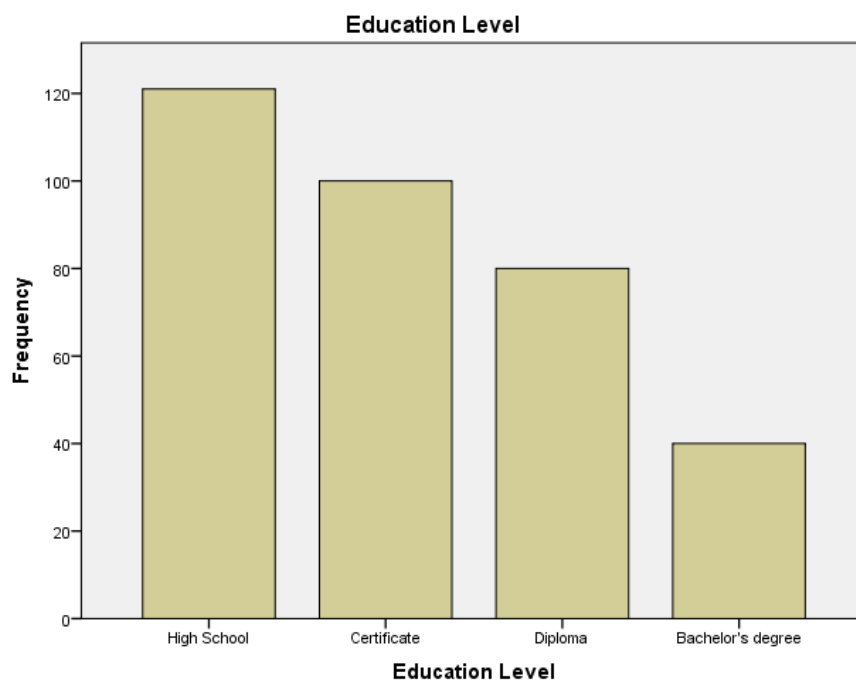
Figure 2 Age



### 4.1.3 Education Level

The earlier mentioned factors are of great importance as they indicate the probable influences on Pedagogical Content Knowledge (PCK), due to varying educational experiences, along with Zimbabwe’s competence-based mathematics curriculum. A sizeable proportion 35.5% holds only secondary schooling which, is suggestive of a lack of formal pedagogical training in mathematics instruction at higher levels. Approximately 29.3% seems to hold a certificate which suggests some basic teacher training and its focus on mathematics education is uncertain. Additionally, 23.5% having a diploma makes sense as this represents a greater duration of pre-service teacher training along with enhanced exposure to better teaching methodologies and relevant mathematical content as compared to those holding only certificates.

Figure 3 Education Level

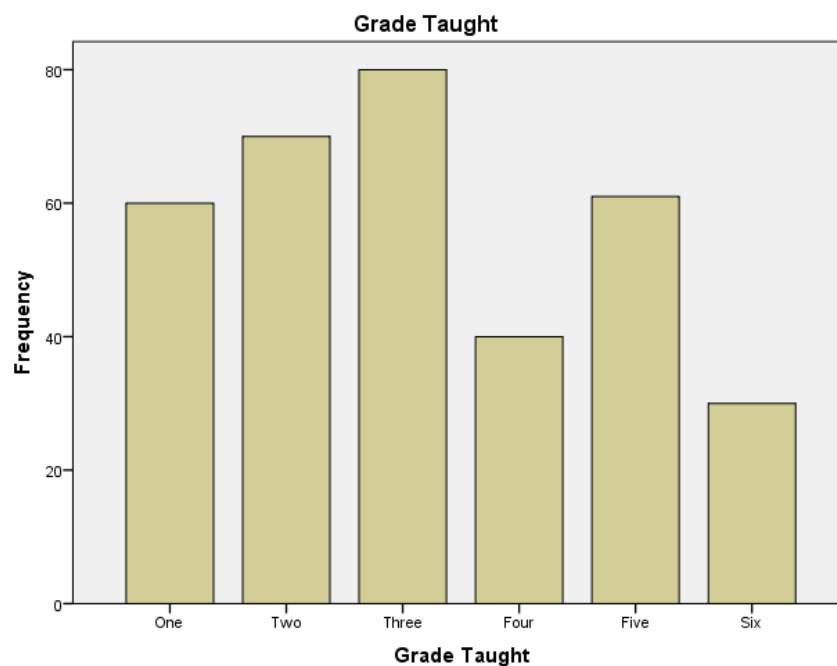


Lastly, the fact that only 11.7% of pre-service teachers hold a Bachelor's degree is indicative of limited subject matter knowledge and pedagogical understanding (Catacutan et al., 2023). Moreover, this infusion raises concerns about the readiness of pre-service instructors with regard to curriculum implementation since greater exposure to formal education generally translates to enhanced content mastery and teaching proficiency (Li, Liu and Su, 2022). Given the low figure of trained pre-service teachers who have bachelor degrees, suggests there is urgent need for further appropriate action directly aimed at addressing professional gaps in PCK/ Competence-Based Curriculum Skills across all levels in light of Zimbabwe's competence-based mathematics curriculum.

#### 4.1.4 Grade Taught

Significantly, Grade Three was the modal grade taught, occurring in 23.5% of the sample (n = 80). This was followed by Grade Two with 20.5% (n=70) and Grade Five with 17.9% (n=61). Grade One had a frequency just below this at 17.6%, while Grade Four comprised 11.7% (n=40), and Grade Six was least represented with 8.8% (n=30). This distribution indicates that the pre-service teachers in the sample have different levels of exposure to primary mathematics teaching. The stronger representation of Grades Two and Three suggest that there is more focus during training on mathematical skills taught at these levels, as per Zimbabwe's Competence-Based Curriculum which aims at developing a solid foundational understanding in early primary years as early as possible. However, the lower representation of Grade Six is striking, as it raises issues related to how well prepared pre-service teachers are for more advanced content and teaching methods concerning upper primary Mathematics; this needs further study related to their Pedagogical Content Knowledge (PCK) and PCK skills.

Figure 4 Grade Taught

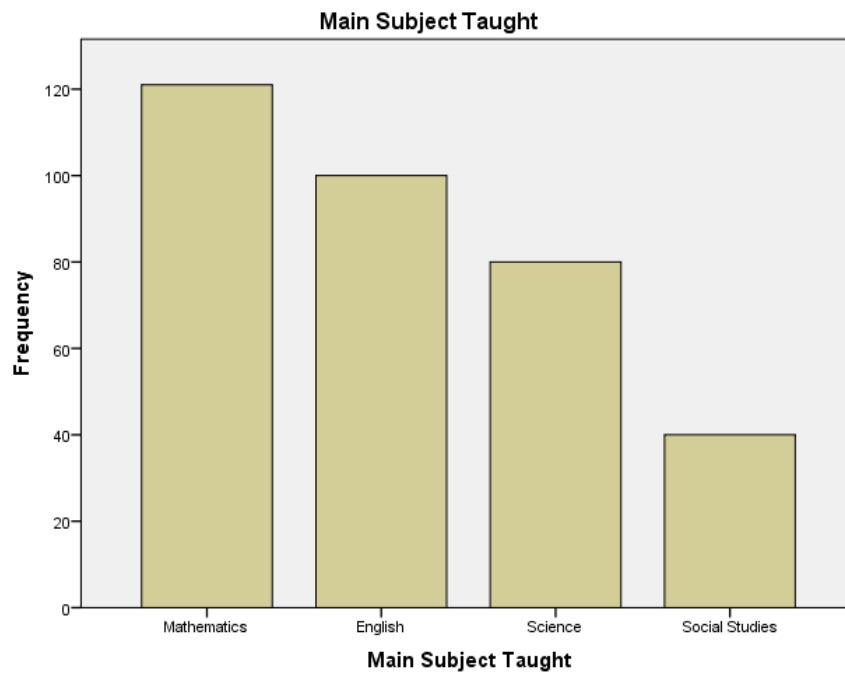


#### 4.1.5 Main Subject

Analyzing the PCK and teaching competencies of pre-service primary school teachers in Zimbabwe about the mathematics curriculum shows diversity, with mathematics being the most frequently taught subject among 35.5% of respondents, while English was 29.3%, Science 23.5%, and Social Studies 11.7%. This could indicate that either more focus is placed on teaching mathematics in the colleges, or there are more pre-service teachers who intend to teach mathematics than other subjects. The work Mönch and Markic did in 2022 proved how important PCK is when they stated that teachers must know how to explain a subject so students can understand it. Since mathematics is the most commonly taught subject by the pre-service teachers, it is essential that their mathematical pedagogical content knowledge (PCK) is strong, especially considering its alignment with Zimbabwe's competence-based curriculum which emphasizes practical and problem-solving skills. The differences in the percentages across the subjects highlight and reinforce the requirement for customized training that fulfills

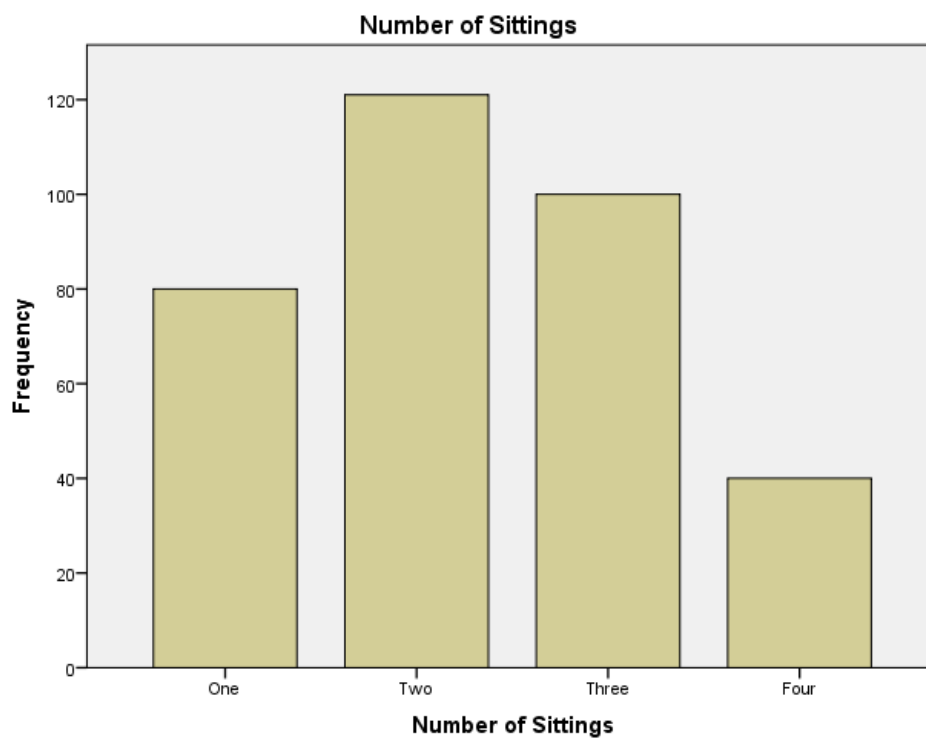
the PCK needs of every discipline, as mentioned by Vettriselvan et al. (2025). To optimally equip pre-service teachers from all subject areas, it is important to enhance their capability to utilize their content knowledge through appropriate teaching methods which improves learners’ performance throughout instruction aligned with the objectives emphasizing competencies.

Figure 5 Main Subject



#### 4.1.6 Number of Sitzings

Figure 6 Number of Sitzings



Analysis of the data indicates that a notable proportion, 35.5% (n=121), had attempted the mathematics examination on two occasions suggesting some level of familiarity with the assessment processes. Also notable is that 29.3% (n=100) had attempts at three sittings, potentially indicating efforts to improve and meet certain benchmarks. Conversely, 23.5% (n=80) only had one attempt which raises questions regarding their previous exposure to mathematics assessment. An even smaller

segment, 11.7% (n=40), sat for the test four times which may reveal some ongoing struggle to meet needed thresholds. These results highlight important differences in mathematical knowledge, prior examination experience and training among pre-service teachers which poses challenges for instructional alignment combining pedagogical content knowledge and skills centered on Zimbabwe’s competence-based curriculum for Mathematics (Olawale, 2024). The findings also underscore gaps in curriculum expectations designed for prior learning frameworks demonstrating differentiated instruction tailored to pre-service teacher training in Mathematics aimed at refining instructional frameworks design aligned to elements suited to the varying needs and prior experiences of pre-service teachers.

### 4.2 Normality Tests

Normality tests including Kolmogorov-Smirnov and Shapiro-Wilk tests show that none of the main factors of interest – Age, Pedagogical Content Knowledge (PCK), Teaching Strategies Skills, Training Adequacy Perceptions, Teacher Education Recommendations – were normally distributed within the sample of pre-service primary teachers. For all variables assessed in this model both tests produced significant results ( $p < .001$ ) suggesting non-normality. The Kolmogorov-Smirnov statistic ranged from .217 to .438 and Shapiro-Wilk from .571 to .845 adding further evidence for non-normality. These findings corroborate those observed in educational research whereby subjective assessments such as perceptions and recommendations tend to diverge from central tendency metrics owing to systematic bias induced by various contextual influences (Cook, Watson and Webb, 2024). It is particularly interesting that Pedagogical Content Knowledge and Teaching Strategies Skills are not normally distributed, perhaps indicating the extent to which pre-service teachers’ prior experiences and learning styles informed their skills development relative to the benchmarks set out by a competence-based curriculum. In parallel, individual expectations based on prescriptive mindsets are likely contributing to non-normally distributed perceptions of training adequacy.

Table 2 Tests of Normality

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Age	.217	341	.000	.845	341	.000
Pedagogical Content Knowledge	.438	341	.000	.571	341	.000
Teaching Strategies Skills	.303	341	.000	.693	341	.000
Training Adequacy Perceptions	.318	341	.000	.585	341	.000
Teacher Education Recommendations	.252	341	.000	.828	341	.000

a. Lilliefors Significance Correction

### 4.3 Reliability Test

Table 3 Reliability Test

Table 3 shows the overall Cronbach’s Alpha coefficient.

Reliability Statistics		
Cronbach’s Alpha	Cronbach’s Alpha Based on Standardized Items	N of Items
.855	.855	4

As presented in Table 3, the overall Cronbach’s Alpha coefficient was found to be .855. This indicates a high level of internal consistency among the 10 items comprising the instrument. Furthermore, the Cronbach’s Alpha Based on Standardized Items was also .855, suggesting that standardizing the items did not significantly alter the reliability. These results confirm that the instrument reliably measures the intended construct, ensuring the validity and trustworthiness of subsequent analyses and interpretations regarding the alignment of PCK and skills with the curriculum.

### 4.4 Descriptive Analysis

The study sought to explore the alignment of pedagogical content knowledge and skills among pre-service primary teachers

with Zimbabwe's competence-based mathematics curriculum. A number of objectives were closely scrutinized which included: 1) to assess the level of pedagogical content knowledge (PCK) of pre-service primary teachers in mathematics concerning the core concepts of Zimbabwe's competence-based curriculum. 2) To evaluate the skills of pre-service primary teachers in utilizing effective teaching strategies that promote problem-solving, critical thinking, and practical application of mathematical concepts. 3) To explore the perceptions of pre-service teachers regarding the adequacy of their training in preparing them to implement the competence-based mathematics curriculum effectively. 4) To recommend strategies for improving teacher education programs to better align with the demands of the curriculum and enhance the quality of mathematics education in Zimbabwean primary schools. These were analysed below using quantitative and qualitative methods of analysis.

#### 4.4.1 Pedagogical Content Knowledge (PCK) of Core Mathematical Concepts

Table 4 Pedagogical Content Knowledge (PCK) of Core Mathematical Concepts

##### Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pedagogical Content Knowledge	341	1	4	1.51	.535
Pedagogical Content Knowledge	341	1	4	1.52	.534
Pedagogical Content Knowledge	341	1	2	1.50	.501
Pedagogical Content Knowledge	341	1	5	1.55	.610
Valid N (listwise)	341				

The claim that instructors have adequate Pedagogical Content Knowledge (PCK) of fundamental concepts in mathematics is coupled with a need to view it through the prism of qualitative comments and descriptive statistics. While the data paints an optimistic picture as mean scores approaches 1.5 on a scale, as yet undefined, the straddling standard deviations (.535, .534, .501, and .610) indicate some level of perception toward knowledge strength amongst this collection of 341 individuals. This lends credence to Wang and Zhan's (2023) argument about PCK not being a singular construct but rather a multi-dimensional fusion of content knowledge and teaching strategies which can be personalized or customized."

More specifically, the data indicates a moderate agreement for all four statements relating to PCK. The convergence on the four statements as depicted by the means reinforces a positive self-evaluation of understanding foundational concepts and articulating them in diverse ways, addressing misconceptions and connecting mathematics to everyday life in Zimbabwean settings. Nevertheless, those scores while quantitative suggest an overarching narrative that require deeper contextual exploration. To illustrate, agreeing with the statement "I can connect real-life situations with mathematical concepts" could pertain to standard textbook frameworks rather than actual interactions envisioned in relation to their students' contexts.

In addition, the educators' responses to the research question provide essential qualitative perspectives that either corroborate or dispute the quantitative results. For instance, if a significant proportion of participants fails to explain how they would teach fractions in relation to everyday life in Zimbabwean contexts, this poses a challenge to the uniformly high self-reported PCK reported in the descriptive statistics. Quotations from participants expressing their difficulty in subconscious relevance identification anger within real-life applicability or voicing resource limitation grievances amplify the dissonance between perceived and actual PCK. These posed constraints, including limited access to culturally applicable examples or relevant manipulatives, have also been pointed out by other scholars (Tuithof et al., 2023) who argue that PCK is situated and highly context-dependent. Thus, while descriptive statistics offer illuminating insights on basic patterns and relationships of data collected during initial reconnaissance inquiries—and therefore are highly valuable—an investigation integrated with richly textured qualitative findings provides depth that surpasses prescriptive flat narratives around educators' core understanding of fundamental mathematical concepts.

#### 4.4.2 Skills in Implementing Effective Teaching Strategies

Table 5 Skills in Implementing Effective Teaching Strategies

##### Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Teaching Strategies Skills	341	1	4	1.51	.535
Teaching Strategies Skills	341	1	4	1.54	.566
Teaching Strategies Skills	341	1	5	1.52	.551
Teaching Strategies Skills	341	1	5	1.52	.551
Valid N (listwise)	341				

The findings indicate a significant under-evaluation by respondents concerning their effectiveness in teaching mathematics problem-solving and critical thinking skills. With  $n=341$ , the answers to the four items averaged between 1.51 and 1.54, with standard deviations of .535 to .566. These figures suggest that, on average, practitioners in this study believed that they only modestly “agreed” with statements concerning their competence in fostering problem-solving skills, adapting to various learners/teaching skills, measuring learning outcomes curriculum-based assessments and creating multi-layered assessments. These results seem to contradict the expectations of a competence-based curriculum because as one of the participants commented while answering: “It emphasizes critical thinking skills.” This illustrates a discrepancy wherein the curriculum expects promotion of very strong critical thinking skills while teachers express minimal confidence in teaching such levels critically.

Understanding this disparity further emerges from qualitative data where teachers described the activities that they would employ. To illustrate, one educator suggested a mathematically framed activity that aimed to foster critical thinking skills: “I would give them a cost-benefit analysis for a school event’s budgeting which involves evaluating the costs, justifying needs versus wants, and making decisions.” This indicates an appreciation of constructivism in learning theory which posits that students actively build their knowledge through meaningful engagement with tasks. The quantitatively assessed data suggests that there is lower achievement in taking action on these skills and in one’s perceived ability to do so, which strays from this powerful theory. Another teacher explained their evaluation technique saying “I would evaluate how these skills were developed through observational assessment focusing on problem solving, explanation of reasoning within his decision-making process, and analyzing the budget proposal drawn at the end.” This quotation illustrates Shulman’s PCK framework as it shows understanding of the adaptation of mathematics into teaching practice reflecting assessment principles allied with higher order thinking.

Once more, however, the means suggest lacking confidence translates to there existing an imbalance between knowing and doing. This may derive from limited opportunities for professional development that integrate practice into classroom settings, such as applying Bandura’s social cognitive theory, which emphasizes learning through observation and modeling. The teachers may have the motivation alongside the theoretical understanding, but often perceive themselves as lacking the skill or experience required to enact palpable teaching strategies that promote critical thinking in their primary learners. Exploring the rationale behind these self-assessments would further identify areas of support and training pinpointing motivation, making targeted interventions more effective.

#### 4.4.3 Perceptions of Training Adequacy

The effectiveness of a teacher’s confidence and preparedness hinges on the specific teacher training received prior because it integrates different perspectives related to available curricula. Guided by Shulman’s (1986) PCK, constructivist learning theory, and Bandura (1977) social cognitive theory, this study aims at Zimbabwean primary school teachers’ perceptions of their training adequacy concerning the competence-based mathematics curriculum (CBC). We posit alongside many scholars that effective teacher training should not solely provide adequate theoretical frameworks, instead it should simultaneously

enhance practical skills and confidence facilitating implementation. Participants expressed a positive perception regarding training adequacy based on generated descriptive statistics ( $N = 341$ ).

Certainly, educators had a uniform affirmative response regarding the efficacy of the training programs toward their implementation of the competence-based mathematics curriculum (Mean = 4.41, SD = 0.712). This indicates that at some level, the training programs are proficient in meeting teachers' knowledge demands. This positive perception also carried over to their confidence regarding resource and material utilization for the curriculum (Mean = 4.36, SD = 0.821), which further signifies familiarity and competence that Bandura's self-efficacy theory would predict. Teachers perceived all offered training sessions as giving adequate chances to practice teaching mathematics using a competence-based approach (Mean = 4.40, SD = 0.759). This echoes constructivist learning theories which advocate for active involvement in knowledge construction through doing rather than mere passive receiving of information. The perception where primary schooling instructors believed strongly that the training programs provided reasonable attention to relevant issues and prospects concerning primary school mathematics instruction in Zimbabwe also reinforces this picture (Mean = 4.40, SD = 0.711).

The qualitative feedback indicates specific strengths and possible improvements for training programs, which starkly contrasts with the positive perception captured by the quantitative data. Teachers recalled valuing lessons that had an applied component, particularly observation of classes already in progress. One participant described, "I remember watching senior teachers teach. It helped me with ideas." Another participant said, "Practicing and seeing how the lessons are done was very helpful." These statements relate to what Shulman (1986) discusses regarding a fusion of content knowledge and pedagogy. The focus on practical components pertains to the constructivist theory of learning, which values learning through active engagement with material.

Regardless of the positive perceptions, certain educators pointed out deficiencies in their preparation. A few of the teachers commented that the training offered was not sufficient for covering all aspects of the new curriculum. One teacher mentioned, "We need to know more about what we are going to teach." This shortfall may adversely affect a teacher's PCK and their capacity to design appropriate and impactful learning opportunities within their classes. To conclude, the results capture the predominant favorable perceptions held by teachers regarding training adequacy alongside gaps that remain unresolved.

*Table 6 Perceptions of Training Adequacy*

**Descriptive Statistics**

	<b>N</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Std. Deviation</b>
Training Adequacy Perceptions	341	1	5	4.41	.712
Training Adequacy Perceptions	341	1	5	4.36	.821
Training Adequacy Perceptions	341	1	5	4.40	.759
Training Adequacy Perceptions	341	1	5	4.40	.711
Valid N (listwise)	341				

#### **4.4.4 Recommendations for Improving Teacher Education**

The collected data indicates that substantial changes are required within teacher education programs to equip educators with skills necessary for the effective implementation of competence-based mathematics curricula. I believe there is a need to reform teacher education towards more hands-on differentiated teaching, practice-based instruction, clinical apprenticeship models, guided practice, prospective reflection, and continual professional growth activities. This position can be strongly justified through the quantitative and qualitative research data collected from educators alongside Shulman's PCK (Pedagogical Content Knowledge) constructivism and Bandura's social cognitive theory. Many authors stress the prevalence of theoretical knowledge in literature, while this research presents an alarming lack of practical application alongside a surplus of theoretical frameworks revealing a disconnect requiring revision in models of today's teacher education systems.

The picture painted by the descriptive statistics is intuitive: there was general agreement among respondents regarding the

need for further refinement. With a sample size of 341 participants, the mean responses for all four recommendations were between 4.33 to 4.36 out of 5 which indicates consensus. In particular, the supporting statement that called for practical applications of mathematics achieved a mean score of 4.33 (SD = .866). This resonates strongly with the advice provided by participants, as one teacher noted, “New teachers need to see mathematics in action, not just in textbooks. Show them how to connect abstract ideas to real world problems.” This statement aligns well with constructivist learning theory which argues that knowledge is constructed by learners through participation and hands-on experiences.

The need for training on differentiated instruction received strong support with a mean of 4.35 and SD of .797 (Teaching Certificate). This finding underscores the appropriateness and alignment with the diverse learning needs of students in contemporary classrooms. Participants elaborated further on this necessity, proposing something like, “Teach them [new teachers] strategies that will allow them to reach all learners no matter their background or how they prefer to learn. Differentiation is key!” The quote illustrates Shulman’s PCK Model: PCK reflects an educator’s capability to modify and understand different pedagogical techniques according to the learners’ diversity and differences.

The suggestion to increase observational learning opportunities also showed strong agreement (Mean = 4.36, SD = .821). It aligns perfectly with Bandura’s social cognitive theory that emphasizes modeling and observation in learning. As participants pointed out, “Pairing new teachers with experienced mentors who are successfully using the competence-based curriculum. Let them observe, ask questions, and learn from the best.” The last recommendation highlights the continuing professional development and support measures as critical (Mean = 4.35, SD = .800) reinforces learning as a lifelong process integrally tied to both Bandura and PCK. One teacher expressed concern saying, “Don’t throw them in the deep end and expect them to swim. Provide ongoing support, workshops, and resources to help them grow and improve.”

Table 6 Recommendations for Improving Teacher Education

**Descriptive Statistics**

	N	Minimum	Maximum	Mean	Std. Deviation
Teacher Education Recommendations	341	1	5	4.33	.866
Teacher Education Recommendations	341	1	5	4.35	.797
Teacher Education Recommendations	341	1	5	4.36	.821
Teacher Education Recommendations	341	1	5	4.35	.800
Valid N (listwise)	341				

**4.4.5 Anova T-tests**

Shulman argued pedagogy within the context of the subject content (PCK) while constructivist learning theory alongside Bandura’s social learning theory lend credence toward my belief that pre-service primary school teachers possess some understanding of TSS but lack robust Pedagogical Content Knowledge does require strong refinement to meet Zimbabwe’s progressive competence based multi-dimensional mathematics curriculum demands

The results from the one-sample t-test demonstrated significant positive mean differences for both PCK ( $t(340) = 185.245, p < .001, \text{Mean Difference} = 6.07918$ ) and TSS ( $t(340) = 115.544, p < .001, \text{Mean Difference} = 6.09091$ ), suggesting that a baseline level of competence surpasses a hypothetical null value. However, what is critical is not the mere presence of these skills but their profundity, flexibility, and contextual suitability within Zimbabwe’s educational framework. In the context of these findings, it is important to note prior research on the relevance of PCK and TSS in teaching effectiveness (Reynolds and Park, 2021), while contrasting them with those studies documenting a vast chasm between teacher knowledge and practice in real classroom settings (Kriz et al., 2021). Thus, the overarching challenge remains to transcend this baseline competence and cultivate in pre-service teachers an integration of subject matter content, pedagogy, instructional design, and student learning processes, curriculum implementation at various levels of sophistication grounded in systematic frameworks aimed

at nurturing authentic mathematical understanding among learners. This necessitates a move toward focused, context-based training structured around learning through reflection and collaboration as well as guided pre-service teaching whereby the trainees develop their understanding of effective mathematics teaching informed by constructivist principles and social cognitive theory.

Table 7 Anova T-tests

**One-Sample Test**

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Pedagogical Content Knowledge	185.245	340	.000	6.07918	6.0146	6.1437
Teaching Strategies Skills	115.544	340	.000	6.09091	5.9872	6.1946

**4.4.6 Anova T-tests**

The one-sample t-test with a null hypothesis of zero provides an insight into the alignment of pedagogical content knowledge (PCK) and skills of pre-service primary teachers concerning Zimbabwe’s competence-based mathematics curriculum. There are notable differences among pre-service teachers’ self-reported perceptions of training sufficiency ( $t = 207.193$ ,  $df = 340$ ,  $p < .001$ , Mean Difference = 17.56891) and their educational expectations ( $t = 153.371$ ,  $df = 340$ ,  $p < .001$ , Mean Difference = 17.39589) as compared to a theoretical point of zero alignment suggesting no difference on the premise. These results imply awareness rather than complete disassociation from reality indicating suggest perception of training adequacy alongside assumption that PCK being offered was well designed yet not sufficient enough to fulfill the his or her expectations alluding to needing further refinement so as to satisfy the new competency demands underline envisioning a robust constructivist approach towards education. This supports constructivist learning theories where it is posited that pre-service teachers are trying to make sense of effective teaching through their training experiences in mathematics instruction influenced via training observation as advanced by Bandura’s social cognitive theory.

Even though the information indicates an overwhelmingly positive perception, it is important to investigate if such perception transforms into effective practice in the classroom. According to Shulman’s PCK, which stands for pedagogical content knowledge, there exists a vivid interplay of subject matter knowledge, pedagogical knowledge, and contextual knowledge. This paradigm demonstrates that having a strong appreciation of training adequacy does not mean one will be able teach mathematical subjects in an insightful way where learners internalize foundational concepts. Thus further research is needed on how pre-service teachers apply their training into practical teaching competencies and what particular aspects of PCK need bolstering in order to address the disparity between perceived training and unrivaled classroom effectiveness.

Table 8 Anova T-tests

**One-Sample Test**

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Training Adequacy Perceptions	207.193	340	.000	17.56891	17.4021	17.7357
Teacher Education Recommendations	153.371	340	.000	17.39589	17.1728	17.6190

#### 4.4.7 Correlations

Table 9 Correlations

##### Correlations

		Pedagogical Content Knowledge	Teaching Strategies Skills	Training Adequacy Perceptions	Teacher Education Recommendations
Pedagogical Content Knowledge	Pearson Correlation	1	.222**	.058	.029
	Sig. (2-tailed)		.000	.287	.600
	N	341	341	341	341
Teaching Strategies Skills	Pearson Correlation	.222**	1	.024	.083
	Sig. (2-tailed)	.000		.661	.125
	N	341	341	341	341
Training Adequacy Perceptions	Pearson Correlation	.058	.024	1	.268**
	Sig. (2-tailed)	.287	.661		.000
	N	341	341	341	341
Teacher Education Recommendations	Pearson Correlation	.029	.083	.268**	1
	Sig. (2-tailed)	.600	.125	.000	
	N	341	341	341	341

\*\* . Correlation is significant at the 0.01 level (2-tailed).

The effectiveness of any issued curriculum depends on its teachers' readiness. This is especially the case for Zimbabwe's newly adopted competence-based mathematics curriculum which requires not only knowledge of mathematical concepts but also mastery of how to teach in a way that fosters deep learning. When investigating the Pedagogical Content Knowledge (PCK) and teaching practices of primary pre-service teachers in relation to the new curriculum, I argue that although pre-service teachers possess some understanding of PCK, its actual application stems largely from perceptions about available training and consequently their suggestions concerning the designed training programs for prospective educators. The stance I have taken is corroborated by correlational evidence from my research as well as literature concerning Shulman's PCK framework, constructivist theory of learning, and Bandura's social cognitive theory, while also noting ways in which my findings deviate from conventional wisdom.

Based on my research, I found that there exists a statistically significant positive correlation ( $r = .222$ ,  $p < .01$ ) between pedagogical content knowledge and teaching strategies skills. This means that for pre-service teachers who understand how to teach mathematics concepts, they are trained to use effective teaching strategies with some degree of likelihood. Shulman's foundational work on PCK supports this as he integrates subject matter knowledge with pedagogical knowledge (Shulman, 1986). For Shulman, PCK is not merely knowing mathematics and knowing how to teach; it is about how certain topics can be made accessible to learners based on what they already know and the misconceptions they may hold.

The positive correlation indicates that at least pre-service teachers willing to deepen their understanding of PCK will gain more ability in applying it within their actual teaching. In addition, this correlates well with the constructivist learning theory which advocates the active involvement of learners in creating their own understanding through experiences and interactions. Teachers possessing deep PCK are positioned best to enable learners to conduct constructive processes by designing appropriate learning experiences.

The shortcomings of the correlation also raise some issues. It indicates that having PCK does not mean a teacher is effective in practice. Perhaps there are other competencies, such as self-efficacy or classroom management, that strategically mediate the PCK-teaching skills relationship. This reinforces what other studies have shown regarding the difficulty of applying

knowledge in practice (MacMahon, Leggett and Carroll, 2022). Put differently, knowledge of concepts' underlying principles certainly helps, but success during implementation in a primary school setting—characterized by its fluidity and complex interactivity—remains far from certain. Curiously, the relationship between perceived training adequacy with both pedagogical content knowledge ( $r = .058, p > .05$ ) and teaching strategies skills ( $r = .024, p > .05$ ) are well within the bounds of being irrelevant. This indicates that a pre-service teacher's perception regarding how adequate a provided training program was does not have verifiable impact on PCK or teaching skills. However, it is worth noting that there is a significant positive correlation with training adequacy perceptions and teacher education recommendations ( $r = .268, p < .01$ ). This suggests that pre-service educators tend to hold positive views about the recommendations they make when they regard their training as adequate. At this point in my research is where I aim to build upon foundational theory. One would assume that stronger training correlates directly with enhanced levels of PCK and teaching skills achieved. Rather, data points toward an alternate narrative where perception surrounding training adequacy influences a pre-service teacher's perception of the program more so than their actual level of PCK or demonstrable skills.

This underscores the importance of pre-service teachers' subjective realities and invites speculation with regard to Bandura (1977) and social cognitive theory—namely, self-efficacy. Pre-service teachers who believe they are prepared tend to be more confident in their teaching and willing to try new approaches, even if their PCK is not significantly higher than average. On the opposite end, those who feel unprepared likely possess a wealth of knowledge that they do not have the confidence to put into practice. This agrees with research showing that educator self-efficacy explains student outcomes (Lauermaann and ten Hagen, 2021).

In addition, the significant correlation between perceptions of training adequacy and recommendations for teacher education reveals that pre-service teachers may supply considered recommendations based on what they found useful within their education. This is an important aspect of teacher education program responsiveness to ensure continuous improvement cycles in meeting the needs of future educators based on feedback from prospective candidates. While perceived adequacy might not directly improve PCK metrics, it can strengthen goodwill which invites attempts at constructive change—for everyone's benefit.

## 5. Conclusion and Recommendations

In this regard, the investigation discloses an alarming gap concerning the pre-service primary teachers' pedagogical content knowledge (PCK) in relation to Zimbabwe's competence based mathematics curriculum. It appears that most pre-service teachers tend to have a very basic grasp of mathematical concepts; however, their ability to teach and foster competence and understanding at the primary school level is lacking significantly. The study indicates a number of inconsistencies with regards to lesson planning, assessment, and selection and use of appropriate teaching materials. The absence of integration among relevant content knowledge and teaching strategies deeply impedes the implementation of the curriculum that emphasizes practical work, problem-solving, critical thinking skills, and value driven learning. These findings create demand for immediate action within the teacher education system aimed at strengthening pre-service teachers' PCK by equipping them with adequate competencies required for effective teaching within a complex framework of competence based mathematics syllabus.

In view of these findings, a number of strategies are critical to addressing the disparity between pre-service teacher training and the demands posed by the Zimbabwean mathematics curriculum. To start with, educator programs must focus on developing PCK through authentic, practical teaching experiences including lesson study, micro-teaching, and extensive practicum placements in diverse classrooms that include participant and guided reflective teaching with professional mentorship. In addition, constructivist pedagogy should be reinforced so that content knowledge courses are taught in direct relation to appropriate instructional methods and practices. It is necessary to deepen the engagement and relevance of mathematics for learners by applying problem-based approaches as well as learning through innovative technology-assisted tools. Moreover, the evaluation of pre-service teachers' PCK competencies should shift from exclusively written examinations towards a mixed approach which integrates performance evaluations based on lesson planning and instruction that includes differentiation, formative assessment strategy implementation aligned with a competence-based curriculum

framework. Lastly, teachers should be provided with opportunities for professional self-renewal and updating their PCK to engage in collaborative environments where both pre-service and in-service teachers work together towards a common goal of solving best practices related to the changing face of mathematics education in Zimbabwe.

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## Research Instruments

### Appendix A: Questionnaire

This questionnaire is structured around four key areas, each corresponding to a core objective concerning pre-service teachers and the competence-based curriculum. The results of such an assessment can be instrumental in informing adjustments to teacher education programs, ultimately contributing to a more effective implementation of the mathematics curriculum in Zimbabwean primary schools.

#### Demographic Information: (TICK WHERE APPLICABLE)

Question	Response Options
Gender	Male / Female / Other
Age	.....
Teacher Training Institution	(List of Relevant Institutions)
Year of Study	1st Year / 2nd Year / 3rd Year / 4th Year
Prior Education Level (before teacher training)	O’ Level / A’ Level / Diploma / Other

The following sections detail the core areas of investigation, each presented in a table format with a Likert scale for responses. The scale is as follows:

- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neutral
- 4 = Agree
- 5 = Strongly Agree

### Section 1: Pedagogical Content Knowledge (PCK) of Core Mathematical Concepts

Statement	1	2	3	4	5
I possess a strong understanding of the core mathematical concepts outlined in the competence-based curriculum.					
I can effectively explain mathematical concepts in multiple ways to cater to diverse learning styles.					
I am confident in my ability to identify and address common misconceptions students may have about mathematics.					
I can connect mathematical concepts to real-life situations and examples relevant to Zimbabwean contexts.					

### Section 2: Skills in Implementing Effective Teaching Strategies

Statement	1	2	3	4	5
I am proficient in using teaching strategies that promote problem-solving skills among primary school students.					
I can effectively facilitate activities that encourage critical thinking and analytical skills in mathematics.					
I am skilled in adapting teaching approaches to suit the varying learning needs within a classroom.					
I can design and implement assessments that accurately measure students' understanding and application of mathematical concepts.					

### Section 3: Perceptions of Training Adequacy

Statement	1	2	3	4	5
My teacher training program has adequately prepared me to implement the competence-based mathematics curriculum.					
I feel confident in my ability to effectively utilize the resources and materials provided for the curriculum.					
The training I received provided sufficient opportunities to practice teaching mathematics using the competence-based approach.					
I believe my teacher training program adequately addressed the challenges and opportunities associated with teaching mathematics in Zimbabwean primary schools.					

### Section 4: Recommendations for Improving Teacher Education

Statement	1	2	3	4	5
Teacher education programs should place greater emphasis on practical application of mathematical concepts.					
More training is needed on how to differentiate instruction to meet the diverse learning needs of students in mathematics.					
Teacher education programs should include more opportunities for pre-service teachers to observe and learn from experienced teachers who are effectively implementing the competence-based curriculum.					
Ongoing professional development and support are crucial for teachers to effectively implement the competence-based mathematics curriculum.					

### Appendix B: Interview Guide

1. Can you describe a specific mathematical concept in the primary curriculum and explain how you would teach it in a way that encourages students to apply their knowledge to real-world problem-solving scenarios?
2. What challenges do you anticipate in implementing this approach, and how would you address them?
3. The competence-based curriculum emphasizes critical thinking skills. Can you provide an example of a mathematical activity or lesson you would use to promote critical thinking in your primary students?
4. How would you assess their development of these skills?
5. Reflecting on your training, what aspects of the teacher education program do you believe have best prepared you for teaching mathematics using a competence-based approach?
6. What aspects, if any, do you feel were lacking or could be improved? Please provide specific examples.
7. Imagine you are tasked with training newly qualified teachers on how to effectively implement the competence-based mathematics curriculum. What advice or strategies would you share with them based on your own experiences and understanding? What resources would you recommend?