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Leading with Numbers, Teaching with Vision: Reimagining Teacher Readiness for Transformative Mathematics Education

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ABSTRACT

Teaching with vision requires more than mastery of subject matter. It calls for professional depth, pedagogical versatility and the ability to lead change within evolving educational landscapes. Mathematics teachers play a critical role in this transformation, yet many face challenges in aligning their readiness with the demands of 21st-century classrooms. This study aims to reimagine teacher readiness by developing a comprehensive model that supports mathematics teachers as proactive agents of educational change. The present study adopted a Design and Development Research (DDR) approach and was implemented in three sequential phases. The first phase involved qualitative interviews with 14 experts in curriculum and mathematics education to explore existing challenges and foundational needs related to teacher readiness. In the second phase, the Fuzzy Delphi Method was applied with 13 experts to evaluate, refine and reach consensus on the components and structure of the prototype model. The third phase utilised the Modified Nominal Group Technique with 16 participants to assess the prototype's usability, practicality and relevance within real educational settings. The analysis led to the identification of four main components central to mathematics teacher readiness. These components are teacher readiness itself, professional knowledge, pedagogical skills and teaching and learning practices. Each component comprises essential elements that reflect the competencies needed for mathematics teachers to drive meaningful learning and respond to educational reforms with confidence and clarity. The developed model offers a strategic and validated framework that bridges theory with practice. It provides guidance for policymakers, teacher educators and school leaders to enhance professional development initiatives in mathematics education. By shifting focus from technical compliance to vision-driven teaching, this study contributes a practical solution to cultivate future-ready mathematics teachers who lead with expertise and inspire transformation in the classroom.

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1. Introduction

Nowadays, the role of teachers in education extends beyond delivering subject content. Teachers are expected to act as agents of change by facilitating meaningful learning, nurturing critical thinking and driving instructional improvement. Mathematics education is experiencing a significant shift as the global focus turns toward science, technology, engineering and mathematics integration, artificial intelligence and future-focused skills [1]. In this context, mathematics teachers are expected to be not only content specialists but also instructional leaders who can respond effectively to the demands of contemporary classrooms [2].

In Malaysia, this transformation is supported by the Malaysia Education Blueprint, which positions teacher quality as a central driver of student achievement [3]. Although many national-level training programs and coaching initiatives have been implemented, there are still persistent challenges in improving classroom instruction, especially in mathematics. Many teachers struggle to translate pedagogical content knowledge into meaningful practice and school-based coaching through initiatives such as School Improvement Specialist Coaches has shown only moderate success [4]. These issues raise concerns about whether teachers are truly equipped to deliver instruction that aligns with current reforms and innovations.

Teacher readiness in this context refers to a teacher’s ability to integrate professional knowledge, pedagogical skills and a constructive mindset to perform effectively in a changing educational landscape [5,6]. Existing frameworks and professional standards in Malaysia provide general guidance for teacher development, but they are often too broad oriented toward policy compliance or disconnected from classroom realities. More importantly, they are not specifically designed for mathematics educators and tend to overlook the subject-specific instructional complexities that mathematics teaching entails [7].

Furthermore, most of these frameworks are not developed through structured validation processes [8]. They are rarely grounded in expert-driven methodologies such as the Fuzzy Delphi Method or the Modified Nominal Group Technique, which are useful in achieving consensus and refining model components. These limitations highlight a clear gap in the availability of a validated, context-specific model that supports mathematics teachers in preparing for and responding to educational change. A readiness model that focuses specifically on mathematics, grounded in expert insight and structured methodology, is urgently needed to support meaningful reform [9].

This study addresses that gap by introducing a prototype model for mathematics teacher readiness that integrates professional knowledge and pedagogical skills [10]. The model responds to current classroom challenges and provides a practical guide for teachers to improve their instructional approaches while embracing curriculum change. It contributes to both theoretical understanding and practical application by offering a research-informed framework that is grounded in the Malaysian context and adaptable to future developments in education [11].

Therefore, the objective of this study is to design and develop a prototype model of mathematics teacher readiness that integrates professional knowledge and pedagogical skills. The model is intended to support teachers in addressing current classroom challenges and equip them to lead meaningful improvements in teaching and learning practices.

2. Background

A strong theoretical foundation is essential in guiding the development of a model that aims to strengthen instructional quality and support transformational change. In this study, the theoretical framework conceptualises teacher readiness as a dynamic and integrated construct that includes professional knowledge, pedagogical competence, instructional mindset and practical classroom engagement. Drawing from established global theories and aligning with Malaysia's educational landscape, this framework informs the design, structure and validation of a prototype model for mathematics teacher readiness [12,13]. The model comprises four key components:

i. mathematics teacher readiness
ii. professional knowledge
iii. pedagogical skills
iv. mathematics teaching and learning.

The component of mathematics teacher readiness is informed by the Transformational Theory of Educational Change proposed by Michael Fullan. Fullan [14,15] emphasises that meaningful change occurs when individuals within the education system, particularly teachers, develop the capacity to act with clear purpose, strong moral responsibility and collaborative leadership. Teachers are not passive recipients of policy or reform initiatives. Instead, they are active participants who must interpret, adapt and sustain improved practices in their own teaching environments. In this context, readiness involves more than just having knowledge and technical skills [16]. It also includes the development of mindset, reflective thinking and responsiveness to change. These qualities enable mathematics teachers to take on leadership roles in transforming classroom practices and contributing to long-term educational improvement [17].

The second component, professional knowledge, is grounded in Shulman's knowledge base for teaching. Shulman categorises teacher knowledge into several domains, including content knowledge, pedagogical content knowledge and curricular knowledge. These are particularly important for mathematics teachers who must accurately represent mathematical ideas and facilitate conceptual understanding across topics. This study also incorporates horizon content knowledge, which reflects a teacher's awareness of how mathematical concepts are sequenced and interconnected throughout the curriculum. Such knowledge enables teachers to plan instruction that is coherent and developmentally appropriate.

The third component, pedagogical skills, refers to a teacher's ability to deliver effective and meaningful instruction by applying a combination of deep subject knowledge, educational psychology and instructional strategies. According to Ikromova, pedagogical skills reflect a teacher's high level of intellectual and professional competence, encompassing mastery of content and effective teaching methods. Qosimov [18] adds that in modern classrooms, teachers must foster independent, creative and reflective learning through student-centred activities and innovative approaches. Polly *et al.,* [8] emphasises that expert teachers differ from novice educators in their ability to apply pedagogical content knowledge flexibly and skilfully. Therefore, in this model, pedagogical skills include clear communication, appropriate method selection, classroom facilitation and the use of visual and interactive strategies that are crucial for making mathematics concepts accessible and engaging.

The final component, mathematics teaching and learning, is supported by Vygotsky's Sociocultural Theory of Learning. Vygotsky [19] argues that learning is a socially mediated process, whereby knowledge is co-constructed through interaction with more knowledgeable others. In the mathematics classroom, this translates into a teaching approach that emphasises scaffolding, collaborative dialogue and the use of tools and representations to support student understanding. Central to this is the Zone of Proximal Development, which represents the gap between what a learner can do independently and what they can achieve with guided support [20]. Mathematics teachers must design instruction that not only delivers content but also builds student thinking through interaction, questioning and problem solving. This aligns with national curriculum aims that advocate for higher-order thinking, reasoning and communication in mathematics [21].

Taken together, these four components create a comprehensive structure that reflects both theoretical depth and practical relevance. By integrating Fullan's perspective on change leadership, Shulman's knowledge domains, Vygotsky's sociocultural view of learning and international standards of teaching effectiveness, the model provides a contextually valid and research-informed foundation for improving mathematics education. It not only defines the essential competencies mathematics teachers need but also offers structured guidance for empowering them to lead instructional improvement [22,23]. The model positions mathematics teachers as reflective professionals who are not only competent in their practice but also proactive in shaping the direction of educational transformation. In doing so, the model embodies the core philosophy of leading with structured knowledge and teaching with visionary purpose, offering a reimagined approach to mathematics teacher readiness in a landscape shaped by evolving educational expectations.

3. Methodology

This study adopted a Design and Development Research (DDR) approach to construct a prototype model of mathematics teacher readiness that integrates professional knowledge and pedagogical skills. The research design unfolded in three systematic phases:

i. Need Analysis
ii. Design and Development
iii. Usability Evaluation [24].

Each phase was aligned with specific research objectives and guided by the principles of methodological rigour and expert validation. A purposive sampling technique was applied in all three phases, involving participants with specialised backgrounds in mathematics education, curriculum development, instructional coaching and school leadership. To ensure transparency and clarity, the overall research flow is illustrated in Figure 1, highlighting the sequence, design and methods used at each stage of the study.

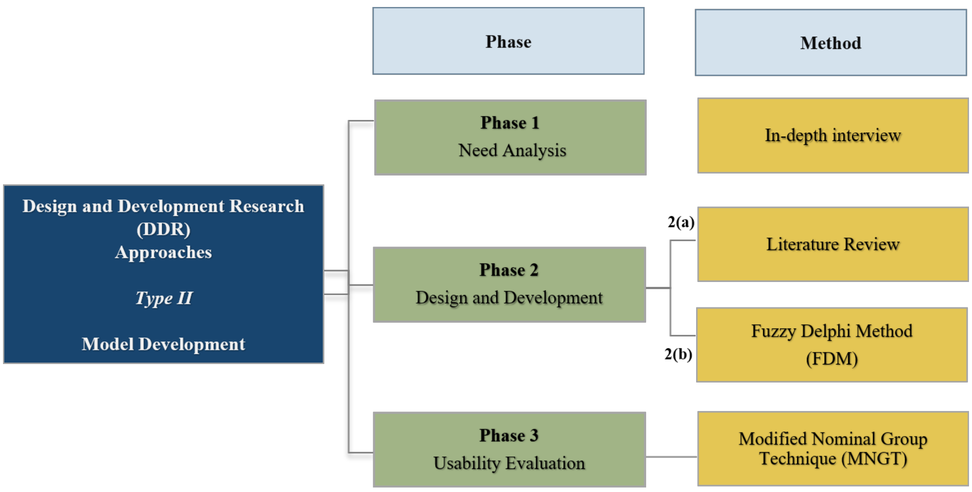

Fig. 1. Research flow chart

3.1 Need Analysis Phase

The first phase aimed to explore the underlying issues, challenges and key elements required to support mathematics teacher readiness. A qualitative research design was employed through in-depth interviews, which allowed the researcher to gather detailed and contextually rich insights directly from subject-matter experts [25]. This phase served as the foundation for identifying the initial components and elements of the prototype model.

A total of 14 participants were selected using purposive sampling. The sample consisted of curriculum officers, experienced mathematics educators and instructional leaders with deep involvement in professional development and education reform. Participants were selected based on their professional experience, relevance to the research focus and ability to provide expert insight into mathematics teacher preparation and readiness [26].

Data were collected using a semi-structured interview protocol developed for the purpose of this study. The instrument consisted of open-ended questions covering themes such as professional knowledge, pedagogical practices, instructional challenges and teacher transformation. The protocol was reviewed by field experts to ensure clarity, content relevance and alignment with research objectives.

The data collected from the interviews were analysed using thematic analysis following the six-phase method proposed by Braun *et al.,* [27]. This process involved familiarisation with the data, generating initial codes, identifying themes, reviewing and refining themes, defining them clearly and writing the findings. The analysis helped to derive meaningful categories that informed the preliminary design of the teacher readiness model.

3.2 Design and Development Phase

The second phase of the study involved validating and refining the initial prototype model of mathematics teacher readiness using the Fuzzy Delphi Method. This method was chosen for its ability to systematically combine expert judgment with quantitative analysis, allowing for structured evaluation and prioritisation of each model component. FDM is especially suitable in educational research where expert consensus is needed to assess the relevance and clarity of model elements. As highlighted by Omar *et al.,* [28], expert feedback plays a crucial role in improving item quality through critique and suggestions. In this study, the use of FDM enabled experts to review and assess the components of the model based on their professional experience, ensuring the framework was both conceptually sound and practically applicable.

A total of 13 expert panel members were selected using purposive sampling. These individuals were identified based on specific criteria, including a strong background in mathematics education, professional development, curriculum design or instructional coaching. Similar to the sampling approach applied by Jaya *et al.,* [29] and Braun *et al.,* [27], purposive sampling was employed to ensure that the selected participants possessed adequate teaching experience, subject-specific expertise and familiarity with instructional reforms. The experts included teacher trainers, university lecturers, master teachers and ministry officials who could provide informed and reflective feedback. As noted by Lin *et al.,* [30], expert knowledge can be found throughout various layers of the school ecosystem and teacher educators often play a critical role as role models and thought leaders in guiding instructional quality.

The research instrument for this phase was a structured questionnaire, developed based on the themes derived from the need analysis phase. The instrument contained items that corresponded to each model component and was rated on a seven-point Likert scale, ranging from “strongly disagree” to “strongly agree” [31]. Before distribution, the questionnaire underwent expert review for clarity, relevance and face validity to ensure the items captured the core concepts of mathematics teacher readiness in an accurate and practical manner.

The data collected were analysed using fuzzy logic procedures, which allowed for the interpretation of linguistic expert input using quantitative thresholds. Three criteria were applied to determine consensus among the experts:

i. a threshold value (d) less than or equal to 0.2
ii. at least 75 percent of expert agreement
iii. a defuzzification score of 0.5 or above [32].

Components and elements that met all criteria were retained in the refined model, while those that did not meet consensus were revised or removed. This process ensured that the resulting model reflected both expert consensus and practical applicability within the context of mathematics education in Malaysia.

3.3 Usability Evaluation Phase

The third and final phase of this study focused on evaluating the usability, practicality and contextual relevance of the prototype model developed in the earlier phases. This evaluation is a crucial element of the Design and Development Research (DDR) approach, as it determines whether the prototype meets its intended goals within authentic settings. Usability, as defined by Tracey (2009), refers to the extent to which a model or product can be effectively and satisfactorily applied in the environment for which it is designed. According to Ellis *et al.,* [33], usability evaluation must demonstrate that the prototype addresses the core problem and performs as expected in its operational context.

To achieve this, the Modified Nominal Group Technique (MNGT) was employed as the primary method for data collection and validation. The MNGT is a structured, face-to-face group process designed to reach consensus through individual idea generation, structured sharing and collective prioritization. It is particularly valuable in ensuring inclusive participation, especially in contexts where some individuals may be overshadowed in open group discussions [34,35]. This method was selected for its efficiency in facilitating structured dialogue and its proven applicability in educational settings, especially in evaluating innovations such as curriculum tools and teaching frameworks.

A total of 14 participants were selected through purposive sampling, consistent with best practices suggested by Srivastava *et al.,* [36] and Burrows *et al.,* [37], who recommend small group sizes ranging from 7 to 12 as optimal for meaningful group engagement. The selected participants were mathematics educators, curriculum experts and school leaders with relevant experience in instructional practice and teacher development. Their inclusion was based on expertise, familiarity with mathematics pedagogy and leadership roles in school-based change initiatives. This deliberate selection ensured that feedback captured was both informed and relevant to the intended application of the model.

The structured evaluation workshop was conducted face-to-face and began with an introductory briefing to establish the objective, context and flow of activities. Participants engaged in model review, brainstorming and individual assessments using a structured questionnaire based on a 7-point Likert scale. The workshop included facilitation by a trained moderator, following a Standard Operating Procedure (SOP) that ensured balanced participation and clarity of purpose [38]. All interactions were designed to maintain focus on the model’s practicality, relevance and usability.

Data gathered from the workshop were analysed using descriptive statistics to determine central tendencies and distribution of agreement. This phase also aligned with the internal design validation approach suggested by Richey *et al.,* [39], in which usability documentation captures the extent to which a model can be used effectively, efficiently and satisfactorily in its intended context [40]. The evaluation affirmed the model's applicability to real-world educational environments, confirming its viability in supporting mathematics teachers as agents of change [41].

4. Findings and Discussion

4.1 Overview of the Model Structure

This study has led to the development of an integrated and evidence-based model aimed at strengthening mathematics teacher readiness as a catalyst for educational transformation. The model emerged through a structured design and development research process, involving in-depth qualitative interviews, expert validation using the Fuzzy Delphi Method and a structured usability evaluation workshop. It synthesises diverse perspectives and empirical data to ensure both theoretical grounding and practical applicability [42].

The model comprises four interrelated components:

i. mathematics teacher readiness
ii. professional knowledge
iii. pedagogical skills
iv. mathematics teaching and learning.

These components are not conceived as isolated or sequential; rather, they function as a holistic and dynamic system. Each component plays a distinct role, yet simultaneously reinforces the others, contributing to the overall coherence, effectiveness and sustainability of the model.

At the centre of the model is mathematics teacher readiness, which represents the willingness, confidence and capability of teachers to lead, innovate and adapt in response to educational change. This readiness is deeply influenced by two critical enablers:

i. professional knowledge
ii. pedagogical skills.

Professional knowledge encompasses content mastery, curricular literacy and an understanding of learner diversity. Pedagogical skills include a wide range of instructional strategies, classroom management techniques, assessment practices and the ability to scaffold learning effectively.

These three elements converge in the domain of mathematics teaching and learning, which represents the practical enactment of readiness, knowledge and skills within the classroom. This component captures how teachers design learning experiences, engage students meaningfully and foster understanding through contextually relevant and student-centred practices. To illustrate the relationship among these components, Figure 2 provides a visual representation of the model. It highlights the central role of mathematics teacher readiness and how it is empowered by professional knowledge and pedagogical skills, culminating in high-quality teaching and learning practices [17]. The model promotes a holistic vision of teacher development, positioning mathematics teachers to succeed in the face of curriculum changes, policy reforms and diverse learner needs.

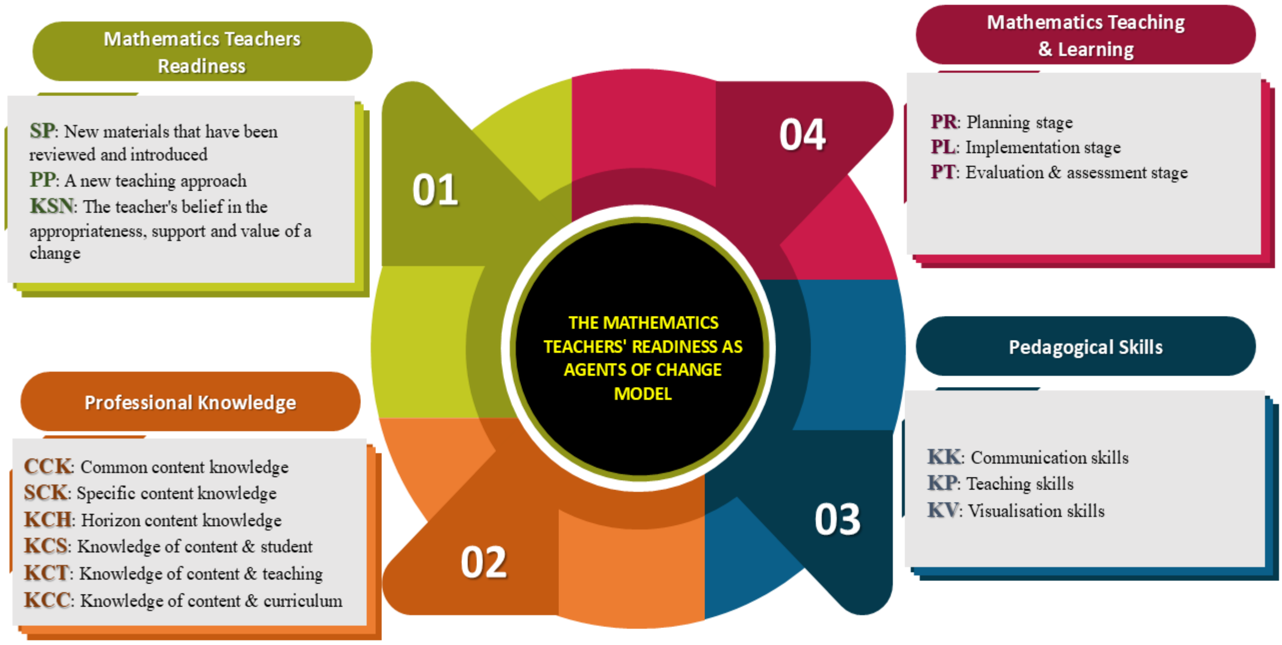

Fig. 2. A visual representation of the model

4.2 Integrated Analysis of the Four Model Components

The mathematics teacher readiness model developed in this study consists of four foundational yet deeply interconnected components:

i. Mathematics Teacher Readiness
ii. Professional Knowledge
iii. Pedagogical Skills
iv. Mathematics Teaching and Learning.

Although conceptually distinct, these components function synergistically to form a coherent framework that supports mathematics teachers in becoming reflective, competent and proactive change agents.

At its core, Mathematics Teacher Readiness refers to a teacher's holistic capacity to lead and adapt within evolving educational landscapes. Readiness extends beyond technical competence; it reflects the internal disposition, confidence and agency to implement meaningful changes in teaching and learning. Drawing on Thiers's [43] perspective, readiness is shaped by intrinsic motivation, collaboration and a sense of moral purpose. Effective change stems from teachers who operate within cultures of trust and shared responsibility, embracing continuous professional growth as a core practice.

Readiness is strengthened by Professional Knowledge, which forms the cognitive and epistemological foundation for effective teaching. As highlighted by Nasrul [12] and Koerfer *et al.,* [17], professional knowledge includes subject matter expertise, pedagogical content knowledge, curriculum understanding and awareness of learner diversity. Du *et al.,* [1] extends this further to include digital fluency, emphasising the importance of integrating emerging technologies, such as artificial intelligence, into instructional planning. Güner *et al.,* [44] also notes that a teacher's beliefs and values play a critical role in shaping how professional knowledge is enacted in practice.

Complementing professional knowledge are Pedagogical Skills, which enable teachers to translate knowledge into effective instruction. Ramaligela [45] identifies several limitations in teacher readiness that result from weak pedagogical practice, such as poor lesson introductions and low student engagement. Teachers must possess the ability to link new content with prior knowledge, manage classroom dynamics, pose purposeful questions and assess understanding in real time. Lu *et al.,* [46] underscores the importance of in-the-moment decision-making and adaptive instruction to meet the diverse needs of learners. Without these practical skills, even a solid knowledge base may fail to translate into meaningful classroom practice.

The fourth component, Mathematics Teaching and Learning, represents the point where readiness, knowledge and skills intersect in action. Rooted in Vygotsky's cultural-historical theory, this domain emphasises that learning is socially mediated and grounded in meaningful interactions. As noted by Stoltz *et al.,* [47], Vygotsky views consciousness as emerging through interaction with cultural tools, emotions and conceptual thinking. Teachers are thus positioned as facilitators of higher mental processes who create opportunities for students to co-construct knowledge in socially and emotionally rich environments.

One of Vygotsky's key contributions, the Zone of Proximal Development (ZPD), as elaborated by Taber [48], plays a central role in this model. It reinforces the idea that learning occurs most effectively when instruction is pitched just beyond a student's independent capability but within reach through scaffolding. Teaching within the ZPD demands responsive planning, formative assessment and tailored support. This pedagogical focus aligns with the model's vision of deep, conceptual and learner-driven mathematics instruction.

Furthermore, the integrated nature of the model ensures that teacher development is coherent and sustained. Keay *et al.,* [49] cautions that fragmented or disconnected learning weakens long-term professional growth. By aligning knowledge, skills and reflective practices across domains, the model supports meaningful integration and professional coherence. Collaborative learning, cross-disciplinary dialogue and shared leadership are encouraged to strengthen teacher agency and build collective efficacy.

In summary, the mathematics teacher readiness model offers more than a checklist of competencies. It provides a structured yet flexible pathway for identifying developmental needs and fostering continuous growth. It serves both as a reflective lens and a practical tool to guide teacher transformation. By weaving together theoretical insights and empirical findings, this model equips mathematics teachers not only to teach effectively but also to lead educational innovation within their classrooms and wider school communities.

4.3 Contribution and Theoretical Significance

This study contributes a theoretically anchored and empirically grounded model that reconceptualises mathematics teacher readiness as a multifaceted construct, combining professional knowledge, pedagogical skills and authentic teaching practices. The proposed model transcends fragmented approaches by offering a holistic framework that accounts for both the internal dispositions of teachers and the external demands of contemporary classrooms. It provides a new lens through which mathematics teacher development can be understood and operationalised, especially in the context of education systems undergoing rapid transformation.

The model's theoretical foundation rests upon the integration of three major strands. First, it draws from Michael Fullan's theory of educational change [14], which positions teachers as central agents of transformation who are most effective when driven by intrinsic motivation, collaborative culture and moral purpose. Second, it integrates Shulman [50] domain-based model of teacher knowledge, particularly the interplay between content knowledge, pedagogical content knowledge and curricular understanding. Third, it is grounded in Vygotsky's sociocultural theory of learning, particularly the concept of the Zone of Proximal Development, which emphasises the critical role of mediated social interaction in the development of higher-order thinking [19].

By synthesising these perspectives, the model bridges the gap between theory and practice. It provides not only a conceptual structure but also a practical roadmap for cultivating mathematics teachers who are pedagogically skilled, professionally informed and contextually responsive [51]. This integration addresses a well-documented shortfall in the literature:

i. the lack of development models that are simultaneously evidence-based
ii. pedagogically coherent
iii. responsive to current educational realities.

Moreover, the model advances the discourse on mathematics teacher education by emphasising the interdependence of teacher readiness, instructional competence and meaningful learning design. It challenges the traditional view of professional learning as a discrete or linear process, instead promoting an ecosystemic view of teacher growth that evolves through continuous reflection, situated practice and systemic support. In doing so, it supports the vision of mathematics teachers not merely as implementers of reform, but as architects of instructional improvement and equity-driven change [52,53]. In sum, the theoretical significance of this study lies in its contribution to a more integrative, agentic and practice-sensitive understanding of teacher readiness. The model has potential utility as a guiding framework for future research, teacher education programmes and professional development initiatives that aim to cultivate transformative capacities in mathematics educators.

4. Conclusions

This study responds to the growing need for a structured and holistic model that can guide the preparation of mathematics teachers as change agents in the twenty-first-century classroom. Positioned at the intersection of research, practice and policy, the Mathematics Teacher Readiness Model developed in this research offers a comprehensive and empirically grounded framework built upon four integrated components:

i. teacher readiness
ii. professional knowledge
iii. pedagogical skills
iv. mathematics teaching and learning.

The study affirms that mathematics teachers must not only possess mastery of subject content and pedagogy but also cultivate the confidence, adaptability and reflective disposition required to engage students meaningfully and lead instructional transformation.

Beyond offering a conceptual contribution, the model directly addresses the research objective of strengthening teacher readiness through an evidence-based and developmentally aligned approach. Each component was identified and refined through a rigorous process involving expert consensus via the Fuzzy Delphi Method and validation through usability testing. The findings underscore the pivotal role of professional knowledge in shaping instructional decisions, while also affirming that such knowledge must be supported by strong pedagogical skills that are responsive, context-sensitive and grounded in student needs. The final model illustrates how these interdependent domains intersect in actual classroom practice, particularly in the way mathematics teaching is enacted, scaffolded and adapted to diverse learners.

This research acknowledges several limitations. Although expert validation was conducted with experienced educators and curriculum specialists, the sample size may not reflect the full diversity of educational contexts across different regions or school types. Additionally, the study focused primarily on secondary mathematics teachers in Malaysia, which may limit the generalisability of findings to other subject areas or international settings.

Future research should explore the model's adaptability across various cultural and educational systems, including its application in primary education and other STEM fields. Longitudinal studies could provide insight into how teacher readiness evolves with targeted interventions. In addition, experimental designs could evaluate the model's effectiveness in improving teaching quality and student outcomes when implemented through professional development programs. A deeper exploration of how digital tools and artificial intelligence can be embedded within each model component would also expand its relevance in technology-enhanced learning environments.

Moving forward, this model opens new pathways for policy makers, instructional leaders and teacher educators to revisit how readiness is defined, nurtured and evaluated. It serves as a tool for diagnosing teacher competencies, designing professional development initiatives and shaping teacher education curricula that emphasise both depth and integration of skills and knowledge. Its application could also inform teacher appraisal systems and instructional coaching strategies, particularly within educational systems aiming to cultivate teachers who can lead innovation, inspire students and transform classroom practice through informed and intentional pedagogy.

Bridging numbers and vision, this study affirms the growing imperative to develop mathematics teachers who are both data-informed and pedagogically visionary. Teachers who possess strong professional knowledge alongside adaptive instructional skills are better prepared to navigate diverse learning contexts, respond to evolving curricular expectations and foster inclusive and student-centred mathematics experiences. The model presented serves not only as a blueprint for teacher readiness but also as a catalyst for nurturing mindsets grounded in innovation, critical reflection and sustained growth. As education systems continue to demand transformation anchored in both empirical insight and humanistic values, this model offers a timely and forward-thinking contribution to shaping mathematics educators who can lead with clarity, act with purpose and inspire meaningful change.

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