

In-service teachers' beliefs about the nature of mathematics between rural and urban contexts: A beginning step towards critical mathematics education in Indonesia

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This study examines differences in Indonesian in-service teachers' beliefs about the nature of mathematics across rural and urban contexts. Despite growing interest in teachers' beliefs, limited research has explored how these vary across socio-geographical settings in Indonesia. A survey design was employed with 200 purposively selected teachers (100 rural, 100 urban). The data were analysed using independent t-tests and Rasch models. Results indicate that rural teachers are significantly more likely than urban teachers to endorse absolutist views of mathematics, while no significant differences were found in fallibilist beliefs. However, teachers' beliefs did not fit a strict absolutist–fallibilist dichotomy. Instead, many demonstrated hybrid and contextually mediated belief systems, often holding dual orientations. Many viewed mathematics as both fixed and dynamic while remaining hesitant toward sociocultural interpretations. These findings challenge rigid classifications and emphasise the socially situated nature of teachers' beliefs. The shared presence of fallibilist tendencies across contexts suggests potential for advancing Critical Mathematics Education (CME) in Indonesia. These findings emphasise the necessity of context-sensitive professional development that supports teachers in integrating mathematical reasoning with social and cultural relevance.

Keywords: teachers' beliefs; nature of mathematics; in-service teachers; critical mathematics education

Introduction

Teachers' beliefs about the nature of mathematics play a key role in shaping instructional practices and mediating how curriculum reforms are enacted (Beswick, 2012; Kasa et al., 2024; Philipp, 2007). Beliefs act as a filter through which educational reforms are understood and enacted, meaning that even when curricula promote innovative pedagogies, classroom practices may remain traditional if teachers' underlying beliefs are unchanged. A key framework for understanding these beliefs is proposed by Ernest (1991) who distinguishes between two broad perspectives: absolutist and fallibilist. Absolutist beliefs conceptualise mathematics as a fixed, objective, and universal body of knowledge, often associated with teacher-centred instruction. In contrast, fallibilist beliefs conceptualise mathematics as dynamic and socially constructed, aligning with inquiry-based and student-centred learning.

In the Indonesian context, reforms such as *Kurikulum Merdeka* and approaches like ethnomathematics emphasise inquiry, flexibility, and cultural relevance (Ministry of Education, Culture, Research and Technology, 2021). These reforms align closely with fallibilist perspectives and the Critical Mathematics Education framework (Skovsmose, 1994), which highlights equity, critical thinking and social engagement.

However, the school-level enactment of these reforms is likely influenced by teachers' underlying beliefs, which are shaped by their social and contextual factors.

Indonesia's urban-rural divide is shaped by unequal access to resources and professional development, as well as its complex geography as an archipelago of over 17,000 islands (BPS, 2025). This divide contributes to disparities in educational infrastructure and professional networks, particularly in rural areas. Drawing on Bourdieu (1986), such disparities in cultural, social, and economic capital may influence teachers' beliefs about how they understand mathematics. However, empirical evidence comparing these beliefs across contexts remains limited. Therefore, this study aims to compare and identify the beliefs about the nature of mathematics held by in-service teachers across these contexts and to explore their implications for the development of Critical Mathematics Education (CME) in Indonesia.

Literature review

Teachers' beliefs are commonly understood as subjective assumptions that individuals accept as true and use to interpret their experiences (Richardson, 1996). These beliefs act as cognitive filters, shaping instructional decisions, often more strongly than formal knowledge (Pajares, 1992). Rather than existing in isolation, beliefs are organised in interconnected systems (Green, 1971). Where central beliefs tend to be stable and resistant to change, while peripheral beliefs are more flexible (Rokeach, 1968).

In mathematics education, beliefs about the nature of mathematics are considered foundational, as they influence both teaching approaches and classroom practices. Ernest (1989, 1991) identifies three philosophical views: instrumentalist, Platonist, and problem-solving, which are broadly grouped as absolutist and fallibilist orientations. However, recent research suggests that such distinctions may oversimplify the complexity of teachers' beliefs, which are increasingly understood as dynamic, context-dependent, and socially situated (Philipp, 2007; Skott, 2015). Research further shows that such beliefs are influenced by sociocultural and institutional factors (Conley et al., 2004; Pintrich, 2002). These perspectives suggest a need to examine how beliefs are enacted within specific contexts, such as rural and urban educational settings.

Methodology

This study employed a quantitative survey design (Creswell, 2023) as part of a Master's dissertation in Mathematics Education (2025). It addressed the following research question: *Is there any significant difference in teachers' beliefs about the nature of mathematics held by in-service teachers between urban and rural areas?* The study involved 200 teachers: 100 from urban areas (Jakarta) and 100 from rural areas (Bogor Regency and West Bandung Regency), with equal representation from primary and secondary levels. Participants were selected through purposive sampling based on the Indonesian Central Bureau of Statistics (BPS, 2025) classification of urban and rural areas. Data were collected using a 10-item Likert-scale questionnaire developed from Ernest's (1991) framework, measuring two belief orientations: five items for absolutist and five items for fallibilist. Content and cultural validity were established through expert review, and a small-scale pilot study was conducted to assess face validity and item clarity. Internal consistency reliability was examined using Cronbach's alpha. Data were collected using a paper-based format to ensure accessibility, particularly for teachers in rural areas with limited digital access. Data analysis was conducted using SPSS. Normality was assessed using Q-Q plots, and homogeneity of variance was tested prior to conducting independent-samples t-tests ($\alpha = .05$). Additionally, Rasch

model analysis (Bond & Fox, 2015) was employed to further identify participants' dominant belief orientation and belief orientation patterns.

Findings

The findings reveal differences in in-service teachers' beliefs about the nature of mathematics between urban and rural contexts, as indicated by normality tests, independent-samples t-tests, and Rasch model analysis.

Normality test

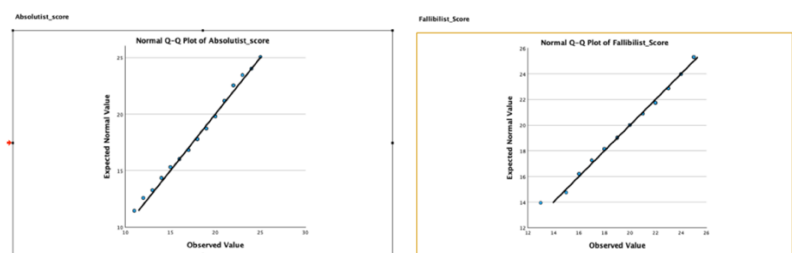


Figure 1 Q-Q plots normality test

Q–Q plots (Figure 1) for both absolutist and fallibilist scores showed data points closely aligned with the diagonal line, indicating that the distributions were approximately normal. This supported the use of parametric statistical tests.

Independent sample t-test

The independent sample t-test revealed a statistically significant difference in absolutist belief items between the two groups ($p = .003 < .05$). Rural teachers ($M = 18.65$, $SD = 2.56$) demonstrated higher absolutist scores than urban teachers ($M = 17.51$, $SD = 2.84$), suggesting that teachers in rural contexts are more likely to view mathematics as fixed and objective than teachers in urban areas. In contrast, no statistically significant difference was found in fallibilist belief items ($p = .771 > .05$). Both urban ($M = 20.53$, $SD = 2.44$) and rural teachers ($M = 20.63$, $SD = 2.44$) showed similar levels of agreement with fallibilist views, indicating a shared tendency to perceive mathematics as dynamic and evolving across contexts.

Rasch model analysis

The Rasch model analysis further revealed the distribution of teachers' beliefs, highlighting prevailing patterns in their orientations.

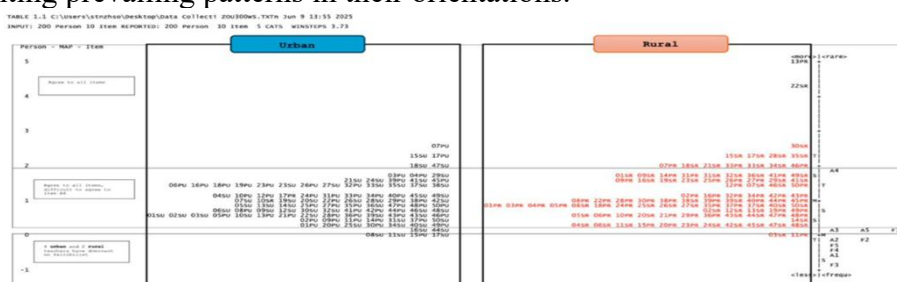


Figure 2 Wright Map of Teachers' Beliefs (Urban vs. Rural Contexts)

The Wright map (Figure 2) represents the distribution of in-service teachers' beliefs about the nature of mathematics (person measure) in relation to the degree of agreement in endorsing belief statements (item measure) across urban and rural contexts. Higher values on the vertical logit scale, which measures belief strength, indicate stronger agreement. The map displays the beliefs of teachers in rural (red) and urban (blue) areas. Rural teachers were somewhat more concentrated between 0 and 2 logits, suggesting slightly stronger overall endorsement of belief statements than urban teachers, who clustered around 1.0 to 1.5 logits. A different group of six participants—four from urban (08SU, 11SU, 15PU, 17SU) and two from rural contexts (03SR, 11PR)—clustered around -1.0 logit, indicating predominantly fallibilist beliefs. Belief items were largely distributed between -0.5 and 2.5 logits, in line with most teacher measures. However, fewer items targeted the extreme ends of the scale, limiting the instrument's ability to distinguish teachers with very strong or very weak beliefs.

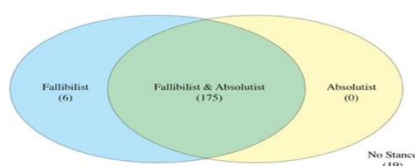


Figure 3: The result of the fallibilist and dual perspective group based on Rasch analysis

Further analysis (Figure 3) indicated that many teachers ($n=175$) held a dual perspective, endorsing both absolutist and fallibilist beliefs, while only a few teachers ($n=6$) showed a clearly dominant fallibilist orientation. This suggests that teachers' beliefs are not strictly dichotomous but are held simultaneously by the same teachers. While contextual differences are evident in absolutist beliefs, fallibilist perspectives appear to be consistently shared across both urban and rural settings.

Discussion and conclusion

This study addressed the research question: *Is there any significant difference in teachers' beliefs about the nature of mathematics held by in-service teachers between urban and rural areas?* The finding indicates that in-service teachers in rural areas were more likely to hold absolutist views of mathematics than their urban counterparts. Rural teachers reported significantly higher mean scores on absolutist belief items, suggesting a stronger tendency to conceptualise mathematics as fixed, objective, and rule-based (Ernest, 1991). This finding aligns with previous studies in Indonesia, which indicate that rural teachers often conceptualise mathematics as static knowledge, even when engaging with problem-solving approaches (e.g., Sari et al., 2019; Siswono et al., 2017). In contrast, no statistically significant difference was found in fallibilist belief items between urban ($M = 20.53$) and rural teachers ($M = 20.63$). This suggests that teachers in both contexts share a comparable tendency to view mathematics as dynamic, evolving, and open to revision. These findings indicate that many teachers hold a dual perspective, simultaneously endorsing both absolutist and fallibilist views.

This coexistence supports the view that teachers' beliefs function as interconnected systems rather than isolated constructs (Green, 1971; Thompson, 1992) and aligns with research highlighting the hybrid, dynamic, and context-dependent nature of beliefs (Philipp, 2007; Skott, 2009). The Rasch analysis in this study further reveals both fallibilist-dominant and dual perspectives, thus highlighting variability in teachers' belief structures. From a sociocultural perspective, these patterns can be linked to the Indonesian educational context, where a long-standing emphasis on high-stakes examinations, procedural fluency, and memorisation may reinforce absolutist

views, particularly in rural settings, despite reforms such as Kurikulum Merdeka that promote inquiry, reasoning, and problem-solving. As Skott (2001) argues, teachers' practices emerge through ongoing negotiation between their personal beliefs and institutional demands.

The findings also suggest that while many teachers endorse elements of fallibilism, such as multiple solution strategies, fewer engage with its broader sociocultural dimensions. This selective engagement suggests that teachers may appropriate procedural aspects of fallibilism without fully embracing its epistemological and sociocultural foundations, highlighting important implications for professional development. While existing fallibilist tendencies provide a foundation for fostering reasoning and conceptual understanding (Beswick, 2012), deeply held beliefs are often resistant to change (Pajares, 1992; Rokeach, 1968). Therefore, professional development initiatives that relate to CME should emphasise sustained reflective practice, enabling teachers to critically examine and reconcile tensions within their belief systems.

In conclusion, this study highlights that in-service teachers' beliefs about the nature of mathematics between rural and urban contexts in Indonesia cannot be adequately understood through rigid dichotomies. The coexistence of both belief types suggests that teachers' belief systems are inherently complex, hybrid and contextually shaped. Importantly, the presence of fallibilist views in both contexts indicates a strong potential for the development of CME in Indonesia, as teachers already exhibit openness to reasoning, multiple solution strategies and the evolving nature of mathematical knowledge. Addressing this complexity requires context-sensitive professional development approaches that move beyond transmission models and instead support sustained reflection and critical engagement. Approaches such as Critical Mathematics Education can help connect mathematics to lived experiences, social issues, and local knowledge, enabling teachers to translate their beliefs into meaningful classroom practices. Such efforts are essential for advancing the goals of *Kurikulum Merdeka* and for fostering more equitable and meaningful mathematics education across diverse Indonesian contexts.

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