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WHEN THINKING FAILS: MISCONCEPTIONS AND THE ROLE OF COGNITIVE DISSONANCE IN MATHEMATICS TEACHER EDUCATION

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Abstract. Misconceptions in mathematics persist as a problem in teacher education, often rooted in unresolved cognitive conflicts. This study aims to explore how cognitive dissonance contributes to the formation and persistence of mathematical misconceptions in a prospective mathematics teacher. Conducted at a private university in Malang, Indonesia, this research employs a qualitative case study design with one participant, purposefully selected based on prior conceptual errors. Data were collected through task-based assessments and semi-structured interviews, and were then analyzed thematically. The findings show that the participant exhibited stable misconceptions in key mathematical areas, particularly when encountering information that challenged prior beliefs. Rather than adjusting or restructuring incorrect knowledge, the participant displayed psychological resistance through justification, minimization, and selective attention to confirming evidence. These mechanisms serve to reduce internal discomfort (dissonance) without engaging in conceptual change. As a result, the erroneous mental model is maintained despite exposure to correct information. This highlights the critical role of cognitive dissonance in reinforcing misconceptions through defensive cognitive strategies.

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INTRODUCTION

Mathematics education plays a crucial role in developing students' critical thinking and problem-solving skills (Al-Husban, 2020; Catarino & Vasco, 2021; Chan, 2022; Gacovska-Barandovska et al., 2020; Hafni et al., 2019; Rauscher & Badenhorst, 2021; Vachova et al., 2023; Yıldız-Feyzioğlu & Kıran, 2022; Yulianto et al., 2024). However, various studies indicate that mathematical misconceptions remain a significant challenge, especially among prospective mathematics teachers. These misconceptions can hinder the correct understanding of mathematical concepts and adversely affect the quality of future teaching practices (Moosapoor, 2023; Rahaju et al., 2023; Zhang et al., 2024). Moreover, previous research has suggested that misconceptions are not only due to a lack of knowledge but also to unresolved cognitive conflicts, known as cognitive dissonance (Harmon-Jones & Mills, 2019).

Several studies have examined mathematical misconceptions from different perspectives, including psychological factors and effective instructional strategies to address them (Ancheta & Subia, 2020; Aygör & Ozdag, 2012; Clement, 2020). However, there is still a limited understanding of how cognitive dissonance explicitly influences the persistence of misconceptions among prospective mathematics teachers. Most existing research focuses primarily on identifying misconceptions without deeply exploring the psychological mechanisms that maintain them. This gap underscores the need for research examining the role of cognitive dissonance in sustaining these misconceptions.

Addressing this research gap is essential to provide a more holistic understanding of the cognitive processes underlying mathematical misconceptions. One domain where misconceptions frequently emerge and persist is algebra, a foundational subject in mathematics education that underpins higher-level concepts such as functions, equations, and abstract reasoning. Algebra is particularly important because it acts as a bridge between arithmetic and advanced mathematics, and misconceptions formed in this area can significantly hinder students' long-term mathematical development (Faradiba et al., 2024; Tiew et al., 2023). For prospective mathematics teachers, a robust understanding of algebra is critical not only for their own competence but also for ensuring accurate and practical instruction for future students. Yet, studies have shown that even teacher candidates often struggle with basic algebraic concepts, misapply rules, or retain intuitive but incorrect beliefs from prior learning experiences.

The findings of this study are expected to inform the development of more effective teaching strategies that help prospective mathematics teachers resolve their cognitive conflicts and improve their conceptual understanding. Therefore, this study aims to examine the role of cognitive dissonance in the formation and persistence of algebraic misconceptions in a prospective mathematics teacher at a private university in Malang. By focusing on algebra, this research not only highlights a high-stakes area in mathematics learning but also sheds light on the psychological mechanisms, specifically cognitive dissonance and psychological resistance, that influence conceptual stability or change. The main research question guiding this study is: How does cognitive dissonance contribute to the formation and persistence of algebraic misconceptions in a prospective mathematics teacher?

RESEARCH METHODS

This study employs a qualitative case study design to explore the cognitive dissonance a prospective mathematics teacher experiences regarding mathematical misconceptions. The research was conducted at a private university in Malang during the 2024 academic year. The subject was purposively selected based on prior identification of conceptual errors in mathematics coursework. One participant was selected for in-depth investigation, representing the population of prospective mathematics teachers who struggle with persistent misconceptions. Data collection involved task-based assessments designed to elicit misconceptions and semi-structured interviews to explore cognitive and emotional responses related to conflicting knowledge. These instruments allowed for an in-depth understanding of the participant's thought processes, reasoning patterns, and justification strategies (Creswell & Guetterman, 2019).

The task was designed to identify and elicit the participant's mathematical misconceptions, particularly in the domain of algebra (Figure 1). The tasks were designed to represent common conceptual errors in symbolic manipulation, such as misapplication of the distributive property, incorrect simplification of algebraic expressions, and misuse of negative signs. These tasks aimed to provoke intuitive but flawed reasoning, thereby triggering cognitive dissonance when participants encountered contradictions between their prior knowledge and formal mathematical principles. The structure and objectives of each task component are shown in Table 1. Although a total of seven tasks were prepared, the participant was given the flexibility to decide how many tasks to complete during the session. This approach was adopted to maintain the participant's emotional stability throughout the assessment process. Ultimately, the participant chose to work on two tasks, which were sufficient to reveal significant misconceptions and cognitive-emotional responses for in-depth analysis.

Table 1. Task Blueprint for Algebraic Misconception Assessment

Aspect	Indicator	Item Format	Purpose
Algebraic understanding	Errors in symbolic operations	Simplification and symbolic manipulation	To identify conceptual misunderstandings in basic algebra
	Misapplication of distributive property	Distributive problems with negative numbers	To trigger dissonance by confronting intuitive but incorrect strategies
	Incorrect simplification of algebraic expressions	Combining like terms, variable substitution	To uncover misconceptions and inconsistencies in structural manipulation
	Misuse of negative signs	Mixed-sign operations	To expose intuitive errors and provoke cognitive conflict

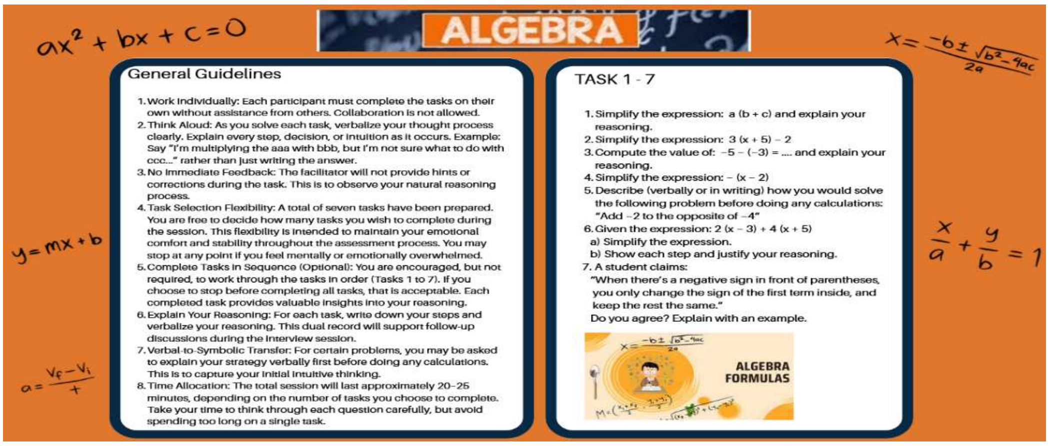

Figure 1. Instructions and Tasks for Identifying Algebraic Misconceptions

The semi-structured interview was designed to explore participants' cognitive and emotional responses to the mathematical tasks, with a specific focus on identifying signs of cognitive dissonance, psychological resistance, and the potential for conceptual change. The interview questions were designed to probe how the participant justified their incorrect answers, whether they experienced discomfort upon recognizing inconsistencies, and how they processed corrective feedback. By analyzing these responses, the study aimed to reveal internal conflicts and defense mechanisms that may sustain mathematical misconceptions. The detailed structure of the interview components and their respective purposes is shown in Table 2.

Table 2. Semi-Structured Interview Blueprint

Aspect	Indicator	Sample Questions	Purpose
Cognitive dissonance	Discomfort when realizing the answer conflicts with formal concept	"What did you feel when you realized your answer was incorrect?"	To reveal internal psychological conflict experienced by the participant
Conceptual change	Openness to revising understanding after explanation	"Has your understanding of the concept changed after the explanation?"	To examine potential for conceptual change
Psychological resistance	Justification, denial, or rationalization of incorrect answer	"Why do you still believe your original answer is correct?"	To identify resistance mechanisms preventing conceptual change
Selective attention	Preference for information confirming prior beliefs	"Do you trust your previous method more than the new explanation?"	To detect confirmation bias and cognitive filtering behavior

The analysis of interview transcripts and field notes deepened understanding of participants' cognitive processes and behavioral responses during the task engagement and interview sessions. This instrument focused on identifying observable indicators of cognitive dissonance, such as expressions of confusion or frustration, as well as verbal strategies reflecting psychological resistance, like justification or topic avoidance. Additionally, reflective statements were analyzed to assess the participant's potential for conceptual change, while repeated patterns across contexts helped evaluate the consistency of misconceptions. The specific aspects, indicators, and observational purposes of this instrument are shown in Table 3.

The data analysis employed a grounded theory approach, with three coding stages: open coding, axial coding, and selective coding (Table 4). In the open coding phase, data were broken down into discrete parts to identify initial codes that emerged directly from the participants' responses in task-based assessments, interview transcripts, and field notes. These codes reflected specific instances of mathematical errors, emotional reactions, and cognitive behaviors. Examples of open codes include MISC-DIST (misapplication of distributive property), CD-EMO-DISCOMFORT (emotional discomfort signaling dissonance), and PR-JUSTIFY (rationalization of incorrect responses).

Table 3. Interview Transcript & Field Notes Blueprint

Aspect	Indicator	Data Source	Purpose of Observation
Expression of dissonance	Signs of confusion, frustration, or hesitation	Transcript excerpts & non-verbal cues	To observe emotional responses associated with cognitive dissonance
Resistance strategies	Defensive language, topic shifting, justification	Interview transcripts	To identify verbal manifestations of psychological resistance
Reflective thinking	Attempts to reinterpret or revise prior concept	Reflective statements during interviews	To detect moments of conceptual reflection and restructuring
Conceptual consistency	Repeated errors or reasoning across different contexts	Cross-analysis between tasks and interviews	To examine the stability and depth of misconceptions in varied problem contexts

In the axial coding phase, these open codes were organized into broader conceptual categories based on their relationships, particularly causal, strategic, and consequential ones. For instance, codes such as PR-JUSTIFY, PR-SELECTIVE, and PR-MINIMIZE were grouped under psychological resistance, while CD-EMO-DISCOMFORT and CD-AVOIDANCE were clustered under cognitive dissonance. These categories provided a deeper understanding of the mechanisms by which the participant coped with conflicting information, often leading to the reinforcement rather than the resolution of misconceptions.

The final stage, selective coding, identified a core category that integrates and explains the central phenomenon observed across the data: "The persistence of mathematical misconceptions is sustained by cognitive dissonance and psychological resistance." All other themes and codes were interpreted as components that interacted to contribute to this central insight. The process revealed that although opportunities for conceptual change existed, they were frequently blocked by internal conflict and defensive reasoning strategies, thereby maintaining erroneous beliefs over time.

Table 4. Coding Summary

Coding Phase	Category / Code	Description	Source
Open Coding	MISC-DIST	Misapplication of the distributive property	Task-based assessment
	MISC-NEG	Incorrect use of negative signs	Task-based assessment
	CD-EMO-DISCOMFORT	Emotional discomfort indicating cognitive conflict	Interview
	PR-JUSTIFY	Justification of incorrect answer	Interview
	OBS-NONVERBAL-CD	Non-verbal signs of confusion or hesitation	Field notes
	CC-REFLECTIVE	Attempt to reconstruct understanding	Interview transcript
Axial Coding	Cognitive Dissonance	Cluster of emotional and cognitive conflict indicators	From multiple open codes
	Psychological Resistance	Defense mechanisms against conceptual change	PR-JUSTIFY, PR-MINIMIZE, PR-SELECTIVE
	Mathematical Misconception	Conceptual errors shown across contexts	MISC-* codes
	Conceptual Change (Potential)	Participant's openness to change or reflection	CC-* codes
Selective Coding	Core Category	Misconceptions are sustained by dissonance and resistance	Integration of all axial categories

RESULTS AND DISCUSSION

The analysis of data from the task, semi-structured interviews, and the researcher's field notes revealed several key findings regarding participants' mathematical misconceptions and the cognitive-emotional processes underlying them. The results are organized thematically according to the axial codes: Mathematical Misconceptions, Cognitive Dissonance, Psychological Resistance, and Potential for Conceptual Change.

1. Persistent Mathematical Misconceptions

Table 1 revealed stable misconceptions in fundamental algebraic operations, such as the distributive property (MISC-DIST) and handling of negative values (MISC-NEG). The participant consistently expanded expressions like a (b + c) incorrectly as ab + c and often failed to apply the sign rules properly when performing algebraic subtraction. These misconceptions were not momentary errors but persistent patterns across tasks. *"I always thought you could just multiply the first term and leave the rest... it is what I have always done."* (Interview transcript). This statement indicates the presence of a procedural script, a repeated cognitive routine that has become automatic but is conceptually flawed. Rather than reflecting a misunderstanding due to a recent error or temporary confusion, this reveals a systematic misconception reinforced over time, possibly through prior uncorrected practice or instructional gaps. This misconception is also evident in the participant's written work, as shown in Figure 2.

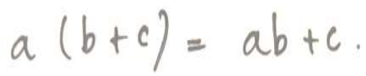

Figure 2. Participant's written response showing a distributive property misconception

Another consistent error emerged when subtracting negative numbers, particularly in expressions such as −5 − (−3), where the participant concluded the result was −8. This mistake, labeled MISC-NEG, shows a lack of conceptual understanding of the operation's directionality and sign rules. The participant explained: "Subtracting a negative just makes the number smaller, doesn't it? Because negative means less." This verbalization illustrates semantic interference: the participant draws on an intuitive but incorrect understanding of negativity as "getting smaller," without fully integrating the mathematical logic of double negatives. These kinds of beliefs are often reinforced through everyday language, making them especially resistant to change. In solving this problem, the participant used a number line, interpreting movement to the right as addition and to the left as subtraction. Starting at −5, the participant moved three steps to the left (because of the subtraction), arriving at −8. This misconception is visually evident in the participant's number line representation, as shown in Figure 3.

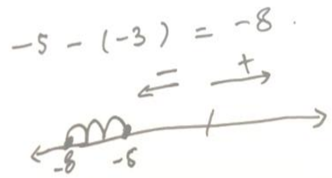

Figure 3. Participant's number line showing a misconception with negative subtraction

Moreover, the consistency of these misconceptions across different formats (symbolic expressions, word problems, and contextual tasks) suggests that they are not context-dependent but rather reflect a core cognitive schema. This schema appears immune to traditional corrective instruction unless cognitive conflict is explicitly triggered and sustained.

From the field notes, the participant was observed expressing confidence in incorrect answers and hesitating only when prompted with conflicting evidence. This confidence, despite incorrect reasoning, is an important indicator that the misconception has become internalized and normalized, perceived as a "truth" within the learner's conceptual system.

Overall, this extended analysis suggests that the participants' misconceptions are not isolated or accidental but structurally embedded in their mathematical thinking. As such, addressing them requires more than just error correction; it necessitates disrupting entrenched mental models through carefully designed cognitive conflict, reflective questioning, and metacognitive scaffolding. This aligns with theoretical perspectives that view conceptual change not as information replacement but as a reorganization of prior knowledge structures. A structured summary of these findings, participant responses, and interpretations of their cognitive implications, can be seen in Table 5.

Table 5. Summary of Persistent Mathematical Misconceptions

Code	Type of Misconception	Task	Participant's Response	Interpretation
MISC-DIST	Misuse of Distributive Property	$a(b+c) = ab + c$	"I always thought you could just multiply the first term and leave the rest."	Procedural misconception; lacks structural understanding of distribution over addition.
MISC-NEG	Misunderstanding of Negative Number Operations	$-5 - (-3) = -8$	"Subtracting a negative just makes the number smaller, doesn't it?"	Conceptual misunderstanding; confuses everyday semantics with mathematical rules.
CONFIDENCE	High confidence in incorrect procedures		Multiple algebra tasks	Confident tone and quick answers despite errors
SEMANTIC-INT	Everyday language interference in mathematical logic		"Negative means less"	Semantic interference leads to resistance to formal mathematical interpretation.

2. Cognitive Dissonance When Confronted with Conflicting Information

When correct solutions were introduced during the interview sessions (Table 2), the participant exhibited visible signs of discomfort and confusion—coded as CD-EMO-DISCOMFORT and OBS-NONVERBAL-CD. Rather than immediately reconciling the error, the participant hesitated, avoided eye contact, and often deflected the issue. *"I feel like I've seen it done that way, but it just doesn't make sense to me. I'm not wrong, am I?"*. Exemplifies not only confusion but also an emotional appeal for reassurance, rather than conceptual reconciliation. This behavior aligns with Festinger's theory of cognitive dissonance (Harmon-Jones & Mills, 2019), which posits that individuals experience psychological discomfort when confronted with information that contradicts their current cognitive schema. Instead of integrating accurate information, the participant exhibited subtle avoidance and began rationalizing the discrepancy, demonstrating cognitive resistance to change. This reveals a crucial barrier in mathematics education: the resistance is not just a misunderstanding of content, but an emotional and psychological negotiation to preserve one's self-consistency. These findings underscore that effective instructional interventions must address not only content clarity but also learners' emotional readiness to confront dissonant information. A summary of the participant's dissonance-related behaviors and interpretations is presented in Table 6.

Table 6. Summary of Cognitive Dissonance Responses and Behavioral Indicators

Code	Observed Behavior	Illustrative Quote	Interpretation
CD-EMO-DISCOMFORT	Expressed anxiety, verbal doubt, and emotional uncertainty	"It just doesn't make sense to me. I'm not wrong, am I?"	Emotional discomfort resulting from conflicting knowledge and self-belief.
OBS-NONVERBAL-CD	Avoided eye contact, hesitated before responding, visible tension	"Nonverbal behaviors during interview segments"	Nonverbal indicators of internal conflict and uncertainty during dissonance.
DIS-JUSTIFY	Justified misconceptions using vague reasoning	"I've seen it done that way before, maybe it depends on the method.	Defense mechanism to reduce psychological discomfort without revising belief.
DIS-DEFLECT	Shifted focus away from error; changed subject or gave vague reply	"Maybe the question is tricky, or I just didn't read it right."	Avoidance strategy to protect self-concept and delay cognitive restructuring.

3. Psychological Resistance Preventing Conceptual Change

Instead of engaging in self-correction, the participant demonstrated resistance mechanisms such as justification (PR-JUSTIFY), minimization (PR-MINIMIZE), and selective attention to confirmatory evidence (PR-SELECTIVE). These were identified in both the participant's verbal explanations and reflective responses (Table 3). *"Maybe it is just a trick question. In most cases, the way I do it still works."* This remark exemplifies two resistance mechanisms: minimizing the importance of the contradiction and justifying the continued use of incorrect reasoning. These behaviors not only reflect emotional self-preservation but also reveal a deeper inertia against conceptual change, as the learner avoids the cognitive effort required to revise faulty schema. The resistance, therefore, is not rooted solely in misunderstanding but in the perceived psychological cost of acknowledging error. As such, the participant's learning process is hindered by a desire to preserve cognitive comfort rather than pursue epistemic accuracy. A summary of the resistance mechanisms and their expressions can be seen in Table 7.

Table 7. Summary of Psychological Resistance Mechanisms Preventing Conceptual Change

Code	Observed Behavior	Illustrative Quote	Interpretation
PR-JUSTIFY	Rationalizing errors as methodical variation or legitimate alternatives	"In most cases, the way I do it still works."	Justification is used to maintain prior belief and avoid reconceptualization.
PR-MINIMIZE	Downplaying the relevance or significance of mistakes	"Maybe it's just a trick question."	Cognitive minimization to reduce the need for mental effort and self-correction.
PR-SELECTIVE	Focusing only on confirming examples while dismissing counterexamples.	"This is just one exception, but usually my answer is accepted."	Confirmation bias limits exposure to disconfirming evidence.

4. Limited but Observable Signs of Conceptual Change

Although psychological resistance remained the dominant response, subtle moments of conceptual openness emerged during the interviews, suggesting the participant's potential for meaningful change when appropriately supported. These moments, coded as CC-REFLECTIVE, involved expressions of uncertainty, pauses in reasoning, and genuine self-questioning. One participant's comment captured this shift: *"Wait... maybe I'm thinking of this wrong. Is it because the sign is outside the bracket?"*—indicating a moment of cognitive reflection rather than automatic defense. Another revealing quote was, *"Now that you explain it, I see where I mixed it up… I guess I never really understood why it works that way."* This admission reveals a crack in the cognitive armor, suggesting a realization that the prior understanding was procedural rather than conceptual. Though brief, such reflective moments offer critical leverage points for instructional intervention. They suggest that conceptual change is possible, mainly when dissonance is addressed with scaffolding rather than confrontation. A summary of these findings is shown in Table 8.

Table 8. Summary of Limited but Observable Signs of Conceptual Change

Code	Observed Behavior	Illustrative Quote	Interpretation
CC-REFLECTIVE	Engaging in self-questioning and re-evaluating own reasoning	"Wait... maybe I'm thinking of this wrong. Is it because the sign is outside the bracket?"	Reflective cognition indicates momentary openness to conceptual change.
CC-REFLECTIVE	Admitting lack of full conceptual understanding	"Now that you explain it, I see where I mixed it up… I guess I never really understood why it works that way."	Suggests a shift from procedural to conceptual awareness.
CD-INTELLECTUAL	Expressing intellectual doubt without emotional defensiveness	"I hadn't thought about that. That could be why it doesn't work."	Emergent awareness of conflict between prior belief and new concept.
OBS-VERBAL-PAUSE	Pausing or hesitating during explanations	Silence or trailing off mid-sentence	Non-verbal cue suggesting internal conflict and reconsideration.

This study provides a comprehensive insight into how cognitive dissonance influences the formation and persistence of algebraic misconceptions in a prospective mathematics teacher. Algebra is a critical mathematical domain that demands a solid conceptual foundation to enable learners to handle abstract symbols and operations confidently (Chimoni et al., 2023; Chimoni & Pitta-Pantazi, 2017; Mathaba et al., 2024). The task-based assessment (Table 1) revealed that the participant consistently held misconceptions about fundamental algebraic operations, including the distributive property and the manipulation of negative numbers. These persistent errors are particularly problematic because they reflect entrenched mental models that conflict with formal algebraic rules (Burigana & Vicovaro, 2020; Fific et al., 2010; Moreton et al., 2017; Tondorf & Prediger, 2022; VanLehn et al., 2020), thereby negatively impacting future teaching quality.

When confronted with correct solutions during interviews (Table 2), the participant showed clear signs of cognitive dissonance, including emotional discomfort (CD-EMO-DISCOMFORT) and nonverbal avoidance (OBS-NONVERBAL-CD). This confirms Festinger's theory that cognitive dissonance arises from the psychological tension created by conflicting knowledge (Harmon-Jones & Mills, 2019). The participant's hesitation and justifications, such as "I'm not wrong, am I?", illustrate the emotional struggle inherent when established algebraic misconceptions are challenged. This emotional discomfort serves as a psychological barrier to accepting new, correct information and is closely linked to the persistence of errors.

Further exploration of participants' responses revealed strong psychological resistance mechanisms (Table 3), including justification, minimization, and selective attention to confirmatory evidence (PR-JUSTIFY, PR-MINIMIZE, PR-SELECTIVE). Instead of critically examining and restructuring their algebraic understanding, the participant minimized the importance of conflicting information by framing it as an exception or trick question. Such resistance aligns with previous findings indicating that learners often protect their existing knowledge frameworks by dismissing contradictory evidence, thereby avoiding the cognitive effort needed for conceptual change (Barzilai & Chinn, 2024; Deng et al., 2019; Elliott et al., 2019; Field et al., 2014; Fific et al., 2010; Liu et al., 2024; Rubenstein-Montano et al., 2001; Shi et al., 2020; Verhagen et al., 2014; Wan et al., 2021; Wu & Jia, 2022). In the context of algebra, this resistance perpetuates misconceptions and limits the learner's ability to develop flexible problem-solving strategies.

However, the data also indicated limited but observable signs of conceptual change (CC-REFLECTIVE), where the participant engaged in self-questioning and tentative re-evaluation of their algebraic thinking. For instance, remarks like "Wait... maybe I'm thinking of this wrong. Is it because the sign is outside the bracket?" suggest moments of cognitive openness. These reflective episodes, though brief, are crucial for conceptual change according to Posner conceptual change theory, which emphasizes that cognitive conflict must be accompanied by motivation and scaffolding to facilitate restructuring of misconceptions (Van Hoof et al., 2017). This highlights the potential for cognitive dissonance to act not only as a source of resistance but also as a catalyst for deeper understanding, provided learners receive appropriate support.

Addressing the research question, cognitive dissonance contributes to the formation and persistence of algebraic misconceptions by triggering psychological discomfort that leads to defensive cognitive strategies rather than productive conceptual change. The participant's stable misconceptions, despite repeated exposure to correct algebraic methods, exemplify how cognitive dissonance fuels resistance mechanisms that maintain faulty knowledge. This interplay between cognition and affect illustrates why misconceptions in algebra are remarkably resilient and difficult to overcome without targeted instructional interventions.

Implications for teacher education are clear: effective algebra instruction must extend beyond procedural training to include strategies that help prospective teachers recognize and manage their cognitive and emotional responses to conflicting information. Techniques such as explicit conceptual explanations, metacognitive reflection, and scaffolded problem-solving can help reduce psychological resistance and promote meaningful conceptual change (Fund & Madjar, 2018; Gidalevich & Kramarski, 2019; Metsämuuronen & Räsänen, 2018; Zheng et al., 2023). By fostering an environment in which cognitive dissonance is constructively addressed, teacher educators can better prepare future mathematics teachers to develop robust, accurate algebraic understanding.

CONCLUSIONS AND SUGGESTIONS

This study reveals that cognitive dissonance plays a pivotal role in the formation and persistence of algebraic misconceptions in a prospective mathematics teacher. The participant's emotional discomfort and psychological resistance when confronted with conflicting information demonstrate how entrenched misconceptions are maintained through defensive cognitive strategies such as justification, minimization, and selective attention. However, limited moments of reflective questioning suggest that conceptual change is possible if supported by appropriate instructional scaffolding. These findings highlight the complex interplay between cognitive conflict and emotional responses in learning algebra, emphasizing the need for teacher education programs to address both aspects to foster meaningful conceptual understanding.

Despite its contributions, this study has several limitations. The research was conducted with a single participant, limiting the generalizability of the findings to a broader population of prospective mathematics teachers. Additionally, the qualitative case study design, while providing rich and in-depth data, relies heavily on subjective interpretation, which may introduce researcher bias. The study focused solely on misconceptions within algebra, so findings may not extend to other areas of mathematics or educational contexts. Lastly, the use of task-based assessments and interviews may not capture all cognitive and emotional processes involved in misconception persistence.

Future research should involve larger and more diverse samples of prospective mathematics teachers to examine whether the identified patterns of cognitive dissonance and psychological resistance are consistent across different individuals and contexts. Longitudinal studies could provide insight into how these processes evolve over time and in response to targeted interventions. Additionally, investigating the effectiveness of specific instructional strategies designed to manage cognitive dissonance and facilitate conceptual change in algebra would be valuable. Finally, expanding the scope to include other mathematical domains or comparing pre-service and in-service teachers could enrich understanding and improve teacher preparation programs

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