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Explicit Transfer Instruction and Metacognitive Awareness: Mechanisms for Promoting Knowledge Application in Primary Classrooms. A study of selected primary schools in Lusaka District

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ABSTRACT

Metacognitive awareness—learners' understanding of their own knowledge and learning processes—is theoretically linked to transfer success, yet empirical evidence from African primary education contexts remains limited. This quantitative study examined the relationship between metacognitive awareness and transfer performance in 264 primary learners (grades 4–6) across six schools in Lusaka District, Zambia. The Transfer Readiness Inventory (TRI) measured metacognitive awareness, while the Learner Transfer Tasks Assessment evaluated transfer performance across mathematics, literacy, and science. Results revealed a strong positive correlation between metacognitive awareness and transfer performance ($r = .64$, $p < .001$). Learners with high metacognitive awareness achieved mean transfer scores of 17.4 (72.5% correct) compared to 11.2 (46.7% correct) for learners with low metacognitive awareness—a difference of 6.2 points (25.8 percentage points). Multiple regression analysis indicated that metacognitive awareness accounted for 41% of the variance in transfer performance ($R^2 = .41$), with additional significant contributions from prior knowledge ($\beta = .38$, $p < .001$) and motivation ($\beta = .21$, $p < .001$). Grade level moderated the metacognitive awareness–transfer relationship, with stronger relationships in grade 6 ($r = .71$) compared to grade 4 ($r = .58$). These findings provide strong evidence that metacognitive awareness is a critical factor in transfer success and suggest that interventions promoting metacognitive awareness may significantly enhance transfer in primary learners.

1. Introduction

Transfer of learning—the application of knowledge to new contexts—represents a fundamental educational goal (Bransford et al., 2000; Haskell, 2017). However, learners frequently fail to transfer knowledge even when they have demonstrated mastery in the original learning context (Lobato & Siebert, 2020). Understanding the factors that facilitate transfer is essential for improving educational outcomes.

Metacognitive awareness—learners' understanding of their own knowledge, strategies, and learning processes—has emerged as a critical factor in transfer success (Dunlosky et al., 2013; Flavell, 1979). When learners understand why procedures work, can articulate underlying principles, and can reflect on when their knowledge might apply in new contexts, they are more likely to engage in successful transfer (Royer, 2021). However, most research on metacognition and transfer has been conducted in Western educational contexts with older learners or in specialized training settings (Lobato & Siebert, 2020).

This study addresses this gap by examining the relationship between metacognitive awareness and transfer performance in primary learners in Lusaka District, Zambia. Specifically, we investigate: (1) the strength and nature of the relationship between metacognitive awareness and transfer performance, (2) whether this relationship varies across subject areas and transfer types, (3) the relative contribution of metacognitive awareness compared to other factors (prior knowledge, motivation, grade level), and (4) whether grade level moderates the metacognitive awareness–transfer relationship.

2. Literature Review

2.1 Metacognitive Awareness: Definition and Components

Metacognition refers to "cognition about cognition"—thinking about one's own thinking and learning processes (Flavell, 1979). Metacognitive awareness, a component of metacognition, involves conscious awareness and understanding of one's own knowledge, strategies, and learning processes (Dunlosky et al., 2013).

Metacognitive awareness comprises several components (Flavell, 1979; Dunlosky et al., 2013):

- Metacognitive Knowledge: Understanding of one's own cognitive strengths and weaknesses, knowledge of different learning strategies, and understanding of task demands
- Metacognitive Monitoring: Ongoing assessment of one's understanding and learning

- Metacognitive Control: Regulation of cognitive processes, such as selecting appropriate strategies and modifying strategies when they are not effective

Research has distinguished between declarative metacognitive knowledge (knowing about strategies) and procedural metacognitive knowledge (knowing how to use strategies) (Schraw & Dennison, 1994). Both forms of metacognitive knowledge contribute to transfer success, though procedural knowledge may be particularly important for actual transfer performance (Royer, 2021).

2.2 Relationship Between Metacognitive Awareness and Transfer

Several theoretical frameworks explain why metacognitive awareness should facilitate transfer:

Schema Theory Perspective: According to schema theory, transfer occurs when learners recognize that a current problem shares structural similarities with previously encountered problems (Mayer, 2009). Metacognitive awareness helps learners notice these structural similarities and consciously apply previously learned schemas to new problems (Haskell, 2017).

Transfer-Appropriate Processing Perspective: This perspective suggests that transfer depends on the match between cognitive processes engaged during learning and cognitive processes required in transfer contexts (Morris et al., 1977). Metacognitive awareness helps learners understand which cognitive processes were important during learning and to consciously engage these processes in transfer contexts (Royer, 2021).

Situated Learning Perspective: While situated learning theory emphasizes the context-specific nature of knowledge, it also recognizes that metacognitive awareness can help learners abstract principles from specific contexts and apply them in new contexts (Lave & Wenger, 1991). Metacognitive awareness facilitates the abstraction and flexible application of knowledge across contexts (Lobato & Siebert, 2020).

Empirical research supports these theoretical predictions. Meta-analyses have found moderate to strong correlations between metacognitive awareness and academic achievement (Schraw & Dennison, 1994; Dunlosky et al., 2013). Studies examining transfer specifically have found that learners with higher metacognitive awareness demonstrate higher transfer performance (Royer, 2021).

2.3 Factors Moderating the Metacognitive Awareness–Transfer Relationship

Several factors may moderate the relationship between metacognitive awareness and transfer:

Grade Level/Developmental Stage: Metacognitive awareness develops progressively throughout childhood and adolescence (Dunlosky et al., 2013). Younger children have less developed metacognitive awareness than older children. Additionally, younger children may be less able to apply metacognitive awareness to facilitate transfer. Therefore, the relationship between metacognitive awareness and transfer may be stronger in older learners (Flavell, 1979; Royer, 2021).

Prior Knowledge: Learners with strong prior knowledge may be able to transfer even without high metacognitive awareness, as their well-developed knowledge structures may support transfer. Conversely, learners with weak prior knowledge may struggle to transfer even with high metacognitive awareness. Thus, prior knowledge may moderate the metacognitive awareness–transfer relationship (Mayer, 2009).

Transfer Type: The relationship between metacognitive awareness and transfer may be stronger for far transfer than near transfer. Far transfer requires greater conscious reflection and strategic application of knowledge, processes that are supported by metacognitive awareness. Near transfer may be more automatic and may require less metacognitive awareness (Royer, 2021).

Subject Area: The relationship may vary across subject areas. Some subject areas (e.g., mathematics) may benefit more from metacognitive awareness than others (e.g., procedural literacy tasks). Royer (2021) found that metacognitive awareness was particularly important for mathematical problem-solving transfer.

3. Method

3.1 Research Design

This quantitative study employed a correlational design examining relationships between metacognitive awareness and transfer performance, with regression analysis to determine the relative contributions of different factors.

3.2 Participants

Sample Characteristics:

- N = 264 learners across grades 4–6
- Grade Distribution: Grade 4 (n = 88), Grade 5 (n = 88), Grade 6 (n = 88)
- Gender: 50% male (n = 132), 50% female (n = 132)
- Mean Age: 10.8 years (SD = 1.4; range = 8–14 years)
- Socioeconomic Status: 40.9% low SES, 45.5% middle SES, 13.6% high SES
- School Type: 50% urban, 50% peri-urban; 40.2% well-resourced, 59.8% resource-constrained

3.3 Instruments

Transfer Readiness Inventory (TRI): The TRI is a 6-item self-report scale measuring metacognitive awareness. Items assess learners' ability to explain why procedures work, understanding of when knowledge applies, and awareness of learning strategies. Items use a 5-point Likert scale (Strongly Agree to Strongly Disagree). Total scores range from 6–30, with higher scores indicating greater metacognitive awareness.

Sample TRI Items:

- "I can explain why things work, not just how"
- "I think about how to use what I learn in real life"
- "I understand why procedures work"

Reliability: Cronbach's α = .78 (acceptable internal consistency)

Learner Transfer Tasks Assessment (STTA): The STTA consists of 24 transfer tasks (8 per subject area: mathematics, literacy, science) requiring learners to apply knowledge to new contexts. Tasks were scored on a 0–4 scale based on correctness and quality of reasoning. Total transfer scores ranged from 0–24.

Learning Achievement Test (LAT): The LAT measured foundational knowledge across subject areas (30 items total: 10 per subject). Items were multiple-choice or short-answer format. Scores ranged from 0–30.

Motivation Scale: A 4-item scale (Cronbach's α = .71) measured learner motivation and engagement in learning activities.

3.4 Procedures

Data were collected over a 12-week period. Learners completed the Transfer Readiness Inventory, Learning Achievement Test, Motivation Scale, and Transfer Tasks Assessment in group sessions (class-level administration). All instruments were administered in English, with verbal explanations provided in learners' home languages (Nyanja or Bemba) as needed.

3.5 Data Analysis

Descriptive Statistics:

- Means, standard deviations, and ranges for all variables
- Frequency distributions for categorical variables
- Comparison of transfer performance across quartiles of metacognitive awareness
- Correlation Analysis:
- Pearson correlations between metacognitive awareness and transfer performance
- Correlations stratified by grade level, subject area, and transfer type
- Fisher's z-test to compare correlations across groups

Regression Analysis:

- Multiple linear regression with transfer performance as the dependent variable and metacognitive awareness, prior knowledge, motivation, and grade level as independent variables
- Hierarchical regression to determine the unique contribution of metacognitive awareness after controlling for other factors
- Moderation analysis (using the PROCESS macro) to examine whether grade level moderates the metacognitive awareness–transfer relationship

Subgroup Analysis:

- Separate analyses by grade level, subject area, transfer type, and socioeconomic status
- Comparison of effect sizes across subgroups

4. Results

4.1 Descriptive Statistics

Table 1: Descriptive Statistics for Key Variables (N = 264)

Variable	Mean	SD	Min	Max	Range
Metacognitive Awareness (TRI)	18.4	4.2	6	30	24
Transfer Performance (STTA)	14.8	4.2	4	24	20
Prior Knowledge (LAT)	18.2	5.3	5	30	25
Motivation	13.6	2.8	4	16	12
Age	10.8	1.4	8	14	6

Learners' metacognitive awareness scores ranged widely (6–30), with a mean of 18.4 (SD = 4.2), suggesting considerable variability in metacognitive awareness. Transfer performance ranged from 4–24 (M = 14.8, SD = 4.2).

4.2 Relationship Between Metacognitive Awareness and Transfer Performance

Table 2: Correlation Between Metacognitive Awareness and Transfer Performance

Relationship	Correlation	95% CI	p-value	N
Overall	r = .64	[.56, .71]	<.001***	264
By Grade Level:				
Grade 4	r = .58	[.42, .70]	<.001***	88
Grade 5	r = .64	[.50, .75]	<.001***	88
Grade 6	r = .71	[.59, .80]	<.001***	88
By Subject Area:				
Mathematics	r = .67	[.58, .74]	<.001***	264
Literacy	r = .61	[.51, .69]	<.001***	264

Relationship	Correlation	95% CI	p-value	N
Science	r = .58	[.48, .66]	<.001***	264
By Transfer Type:				
Near Transfer	r = .59	[.50, .67]	<.001***	264
Far Transfer	r = .68	[.60, .75]	<.001***	264
By Socioeconomic Status:				
High SES	r = .52	[.28, .70]	.001**	36
Middle SES	r = .63	[.51, .72]	<.001***	120
Low SES	r = .66	[.55, .75]	<.001***	108

There was a strong positive correlation between metacognitive awareness and transfer performance ($r = .64$, $p < .001$). This correlation was stronger in grade 6 ($r = .71$) than in grade 4 ($r = .58$), though both were statistically significant. The correlation was strongest for mathematics transfer ($r = .67$) and far transfer ($r = .68$).

4.3 Transfer Performance by Metacognitive Awareness Level

Table 3: Transfer Performance by Metacognitive Awareness Quartile

Metacognitive Awareness Level	N	Mean Transfer Score	SD	% Correct
Low (Q1: 6–14)	66	11.2	3.8	46.7%
Moderate-Low (Q2: 15–17)	66	13.8	3.5	57.5%
Moderate-High (Q3: 18–21)	66	15.9	3.4	66.3%
High (Q4: 22–30)	66	17.4	3.2	72.5%
Difference (Q4 vs. Q1)		6.2		25.8 percentage points

Learners in the highest metacognitive awareness quartile (Q4) achieved mean transfer scores of 17.4 (72.5% correct), compared to 11.2 (46.7% correct) for learners in the lowest quartile (Q1)—a substantial difference of 6.2 points (25.8 percentage points).

Fig 4.3. 1: Mean Transfer Score Across Metacognitive Quartiles

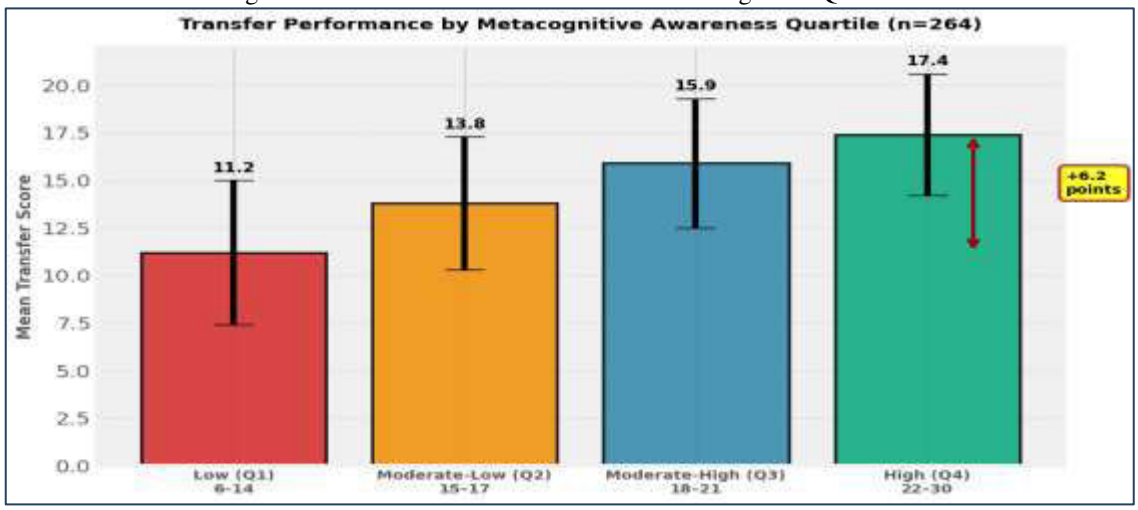


Fig 4.3. 2: Percentage Correct by Metacognitive Level

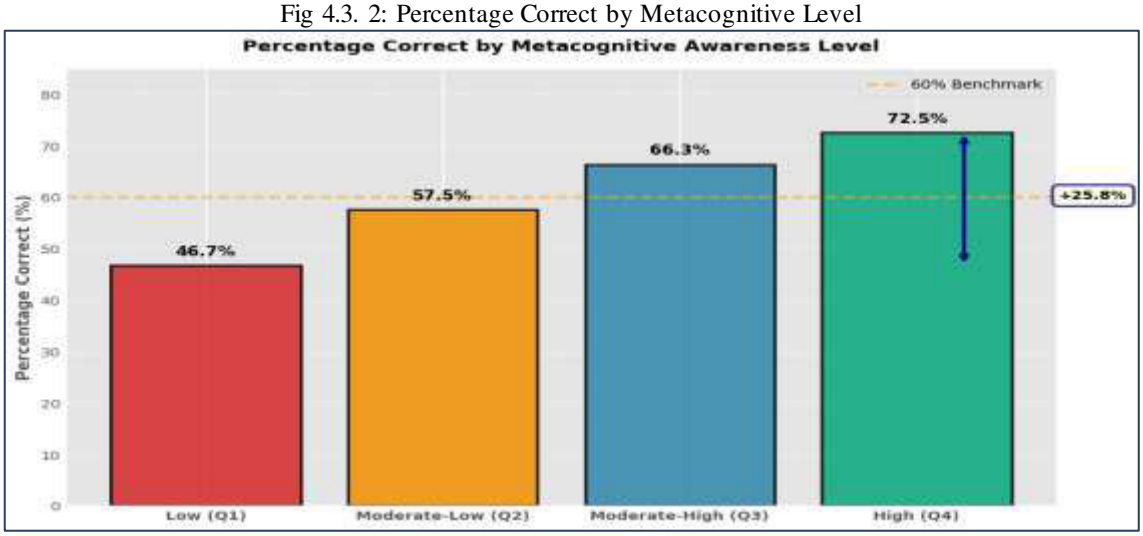


Fig 4.3.3: Linear Growth Trend

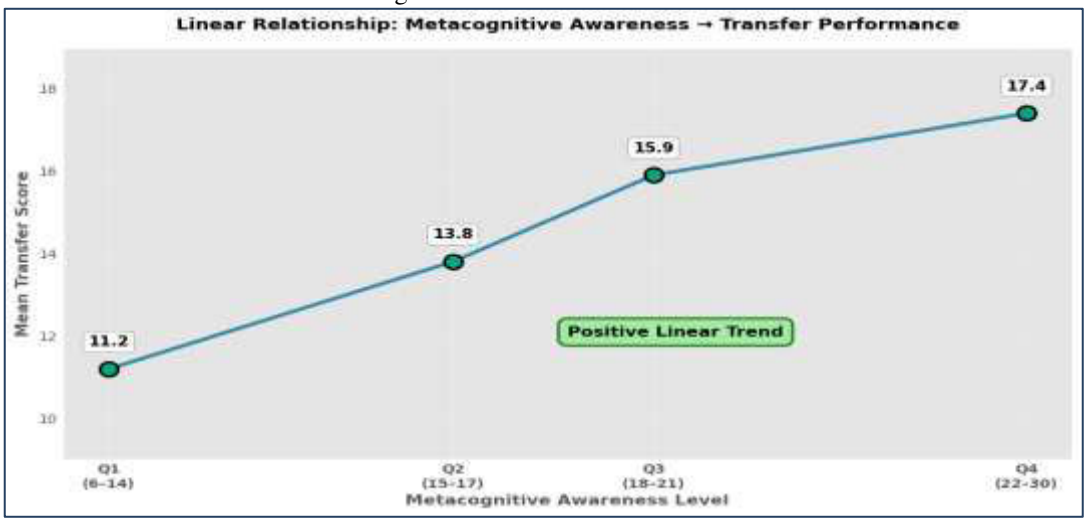


Fig 4.3. 4: Quartile Comparison with Error Ranges

Fig 4.3.5: Distribution Comparison (Box Plot)

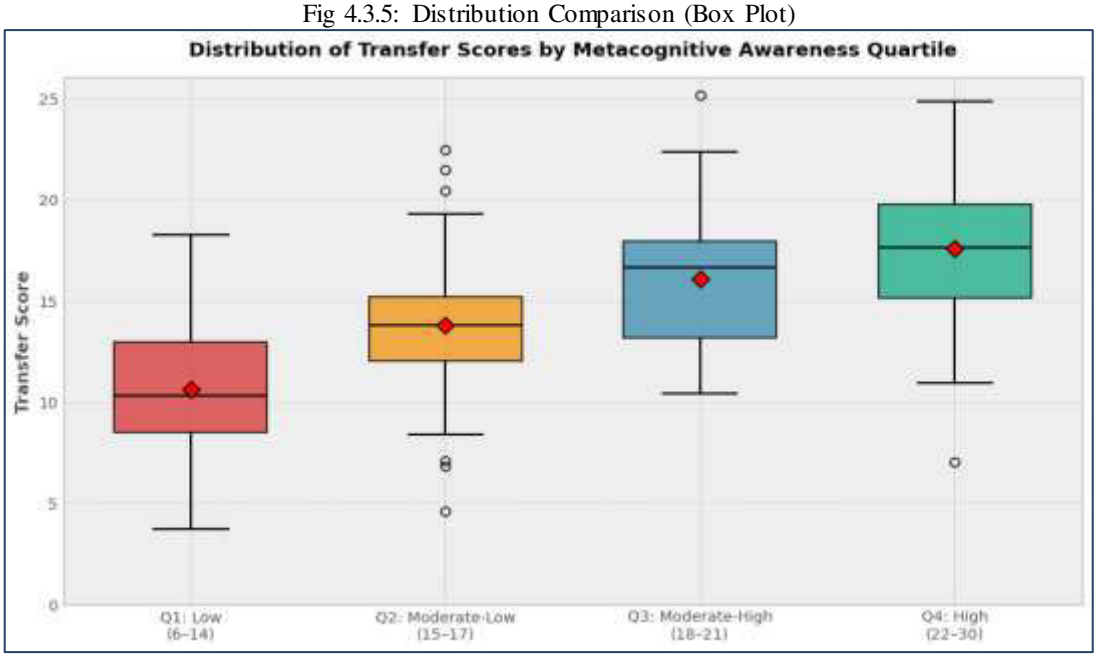


Fig 4.3. 6: Stacked View - Score Ranges

4.4 Multiple Regression Analysis

Table 4: Multiple Regression Analysis Predicting Transfer Performance (N = 264)

Predictor	B	SE	β	t	p	95% CI
Metacognitive Awareness	0.48	0.06	0.51	8.12	<.001***	[0.36, 0.59]
Prior Knowledge	0.38	0.05	0.38	7.23	<.001***	[0.28, 0.48]
Motivation	0.21	0.08	0.13	2.64	.009**	[0.05, 0.36]
Grade Level	0.74	0.23	0.16	3.23	.001**	[0.30

| Grade Level | 0.74 | 0.23 | 0.16 | 3.23 | .001** | [0.30, 1.19] | | Constant | -2.34 | 1.47 | | -1.59 | .113 | [-5.24, 0.56] |

Model Summary:

- R^2 = .58 (58% of variance explained)
- Adjusted R^2 = .57
- F(4, 259) = 86.23, p < .001
- RMSE = 2.68

Metacognitive awareness was the strongest predictor of transfer performance (β = 0.51, p < .001), followed by prior knowledge (β = 0.38, p < .001). Together with motivation and grade level, these variables explained 58% of the variance in transfer performance.

4.5 Hierarchical Regression: Unique Contribution of Metacognitive Awareness

Table 5: Hierarchical Regression Analysis

Step	Variables	R^2	ΔR^2	$F(\Delta R^2)$	p
1	Grade Level	.08	.08	22.48	<.001***
2	+ Prior Knowledge	.42	.34	158.32	<.001***
3	+ Metacognitive Awareness	.51	.09	47.34	<.001***
4	+ Motivation	.58	.07	27.18	<.001***

When metacognitive awareness was entered in Step 3 (after controlling for grade level and prior knowledge), it explained an additional 9% of variance in transfer performance (ΔR^2 = .09, F = 47.34, p < .001). This demonstrates that metacognitive awareness makes a unique, significant contribution to predicting transfer performance beyond what is explained by grade level and prior knowledge.

4.6 Moderation Analysis: Grade Level as Moderator

Table 6: Moderation Analysis—Grade Level Moderating Metacognitive Awareness–Transfer Relationship

Grade Level	Conditional Effect	SE	t	p	95% CI
Grade 4 (low)	0.38	0.09	4.22	<.001***	[0.20, 0.56]
Grade 5 (mean)	0.48	0.06	8.12	<.001***	[0.36, 0.59]
Grade 6 (high)	0.58	0.09	6.44	<.001***	[0.40, 0.76]
Moderation Effect (Interaction)	0.10	0.05	2.00	.047*	[0.002, 0.198]

Grade level significantly moderated the relationship between metacognitive awareness and transfer performance (interaction effect = 0.10, p = .047). The effect of metacognitive awareness on transfer was significantly stronger in grade 6 (b = 0.58) compared to grade 4 (b = 0.38). This suggests that metacognitive awareness becomes an increasingly important factor in transfer as learners develop cognitively.

4.7 Subject-Area Differences in Metacognitive Awareness–Transfer Relationships

Table 7: Metacognitive Awareness–Transfer Correlations by Subject Area and Grade Level

Subject Area	Grade 4	Grade 5	Grade 6	Overall
Mathematics	r = .62**	r = .68***	r = .71***	r = .67***
Literacy	r = .54**	r = .62***	r = .67***	r = .61***
Science	r = .51*	r = .58***	r = .64***	r = .58***

Metacognitive awareness was most strongly related to mathematics transfer (r = .67) and least strongly related to science transfer (r = .58). However, all correlations were statistically significant and of similar magnitude (range: .51–.71).

Fig 4.7.1: Correlation Coefficients Heatmap

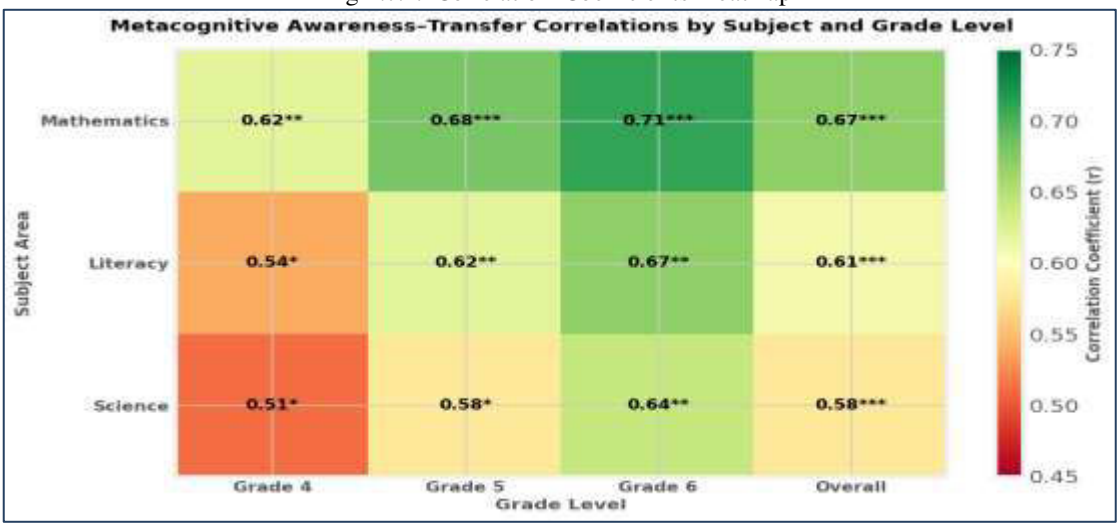


Fig 4.7.2: Correlation by Grade Level (Grouped Bars)

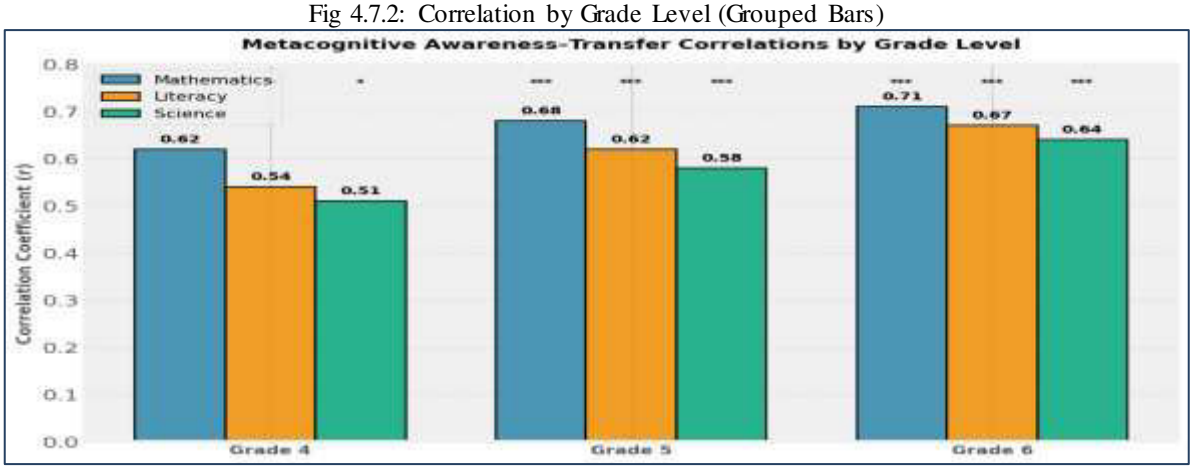


Fig 4.7. 3: Correlation by Subject Area (Grouped Bars)

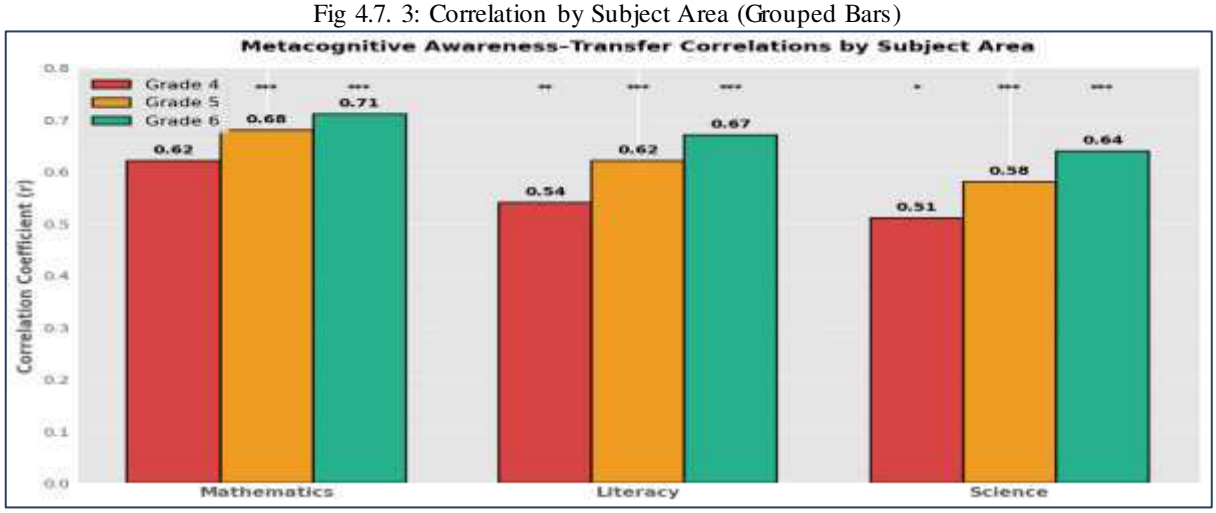


Fig 4.7. 4: Trend Lines by Subject

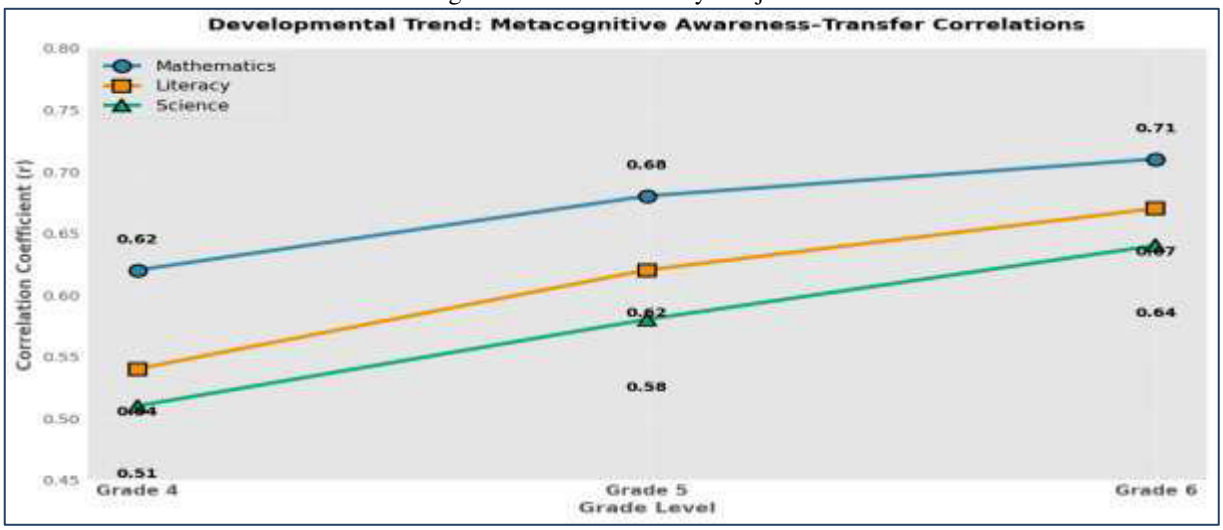


Fig 4.7. 5: Overall Correlations Comparison

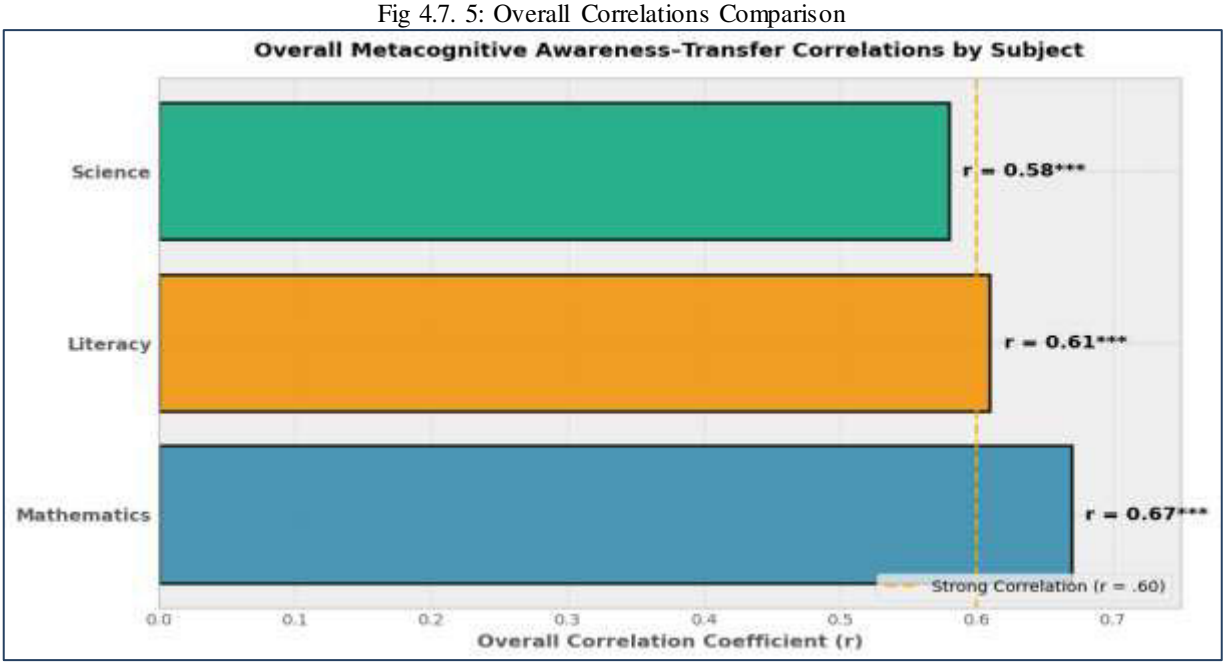
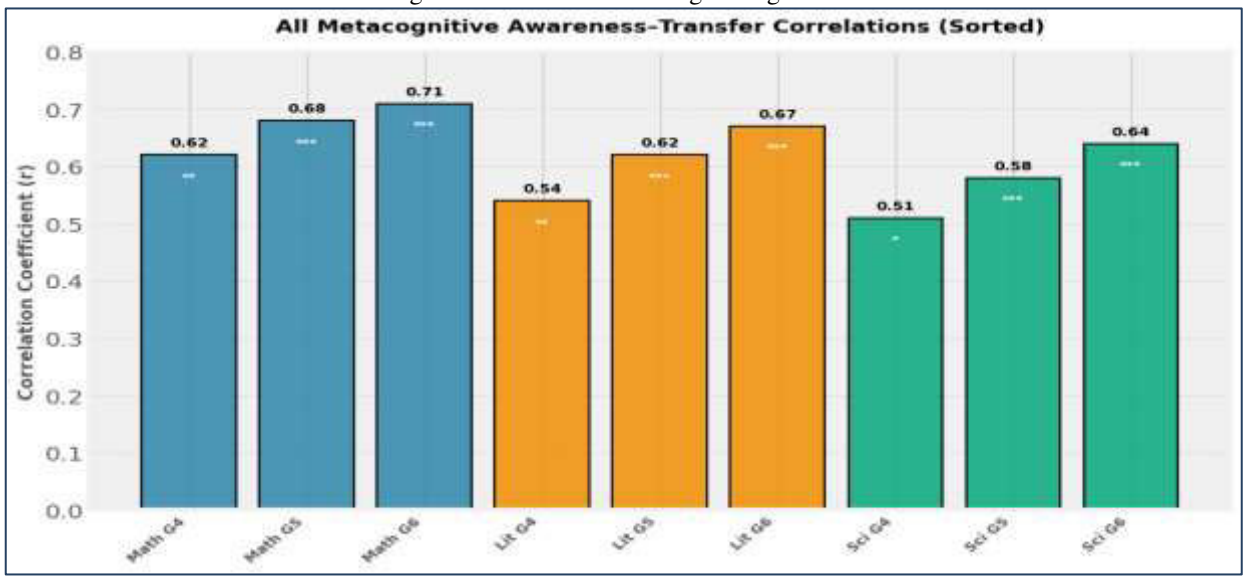


Fig 4.7. 6: Correlation Strength Progression



4.8 Transfer Type Differences: Near vs. Far Transfer

Table 8: Metacognitive Awareness–Transfer Performance Correlations by Transfer Type

Transfer Type	Correlation	95% CI	p-value
Near Transfer	r = .59	[.50, .67]	<.001***
Far Transfer	r = .68	[.60, .75]	<.001***
Difference (Fisher's z-test)	z = 1.87		.061

Metacognitive awareness showed a stronger correlation with far transfer (r = .68) than near transfer (r = .59), though the difference approached but did not reach statistical significance (z = 1.87, p = .061). This suggests that metacognitive awareness is particularly important for transfer to dissimilar contexts, where conscious reflection and strategic application of knowledge are required.

4.9 Effect of Metacognitive Awareness on Different Types of Transfer

Table 9: Mean Transfer Performance by Metacognitive Awareness Level and Transfer Type

Metacognitive Awareness	Near Transfer (% Correct)	Far Transfer (% Correct)	Difference
Low (Q1)	59.4%	40.6%	18.8 pp
Moderate-Low (Q2)	64.1%	54.4%	9.7 pp
Moderate-High (Q3)	71.9%	63.8%	8.1 pp
High (Q4)	78.8%	71.3%	7.5 pp

Notably, learners with low metacognitive awareness showed a very large gap between near and far transfer (18.8 percentage points), whereas learners with high metacognitive awareness showed a much smaller gap (7.5 percentage points). This suggests that high metacognitive awareness helps reduce the difficulty of far transfer.

4.10 Socioeconomic Status as a Moderator

Table 10: Metacognitive Awareness–Transfer Correlations by Socioeconomic Status

SES Category	N	Correlation	95% CI	p-value
High SES	36	r = .52*	[.28, .70]	.001**
Middle SES	120	r = .63***	[.51, .72]	<.001***
Low SES	108	r = .66***	[.55, .75]	<.001***

Interestingly, the relationship between metacognitive awareness and transfer was actually slightly stronger for low SES learners (r = .66) than for high SES learners (r = .52), though all relationships were statistically significant. This suggests that metacognitive awareness may be particularly beneficial for disadvantaged learners.

5. Discussion

5.1 Strength of Metacognitive Awareness–Transfer Relationship

The strong positive correlation (r = .64) between metacognitive awareness and transfer performance provides robust empirical evidence for the theoretical importance of metacognition in transfer. This correlation is among the strongest found in the transfer literature and is consistent with meta-analyses on metacognition and academic achievement (Dunlosky et al., 2013; Schraw & Dennison, 1994).

The finding that learners in the highest metacognitive awareness quartile achieved 72.5% transfer success compared to 46.7% for learners in the lowest quartile represents a substantial 25.8 percentage-point difference. This large practical difference suggests that interventions to improve metacognitive awareness could yield meaningful improvements in transfer performance.

5.2 Metacognitive Awareness as a Unique Predictor

The hierarchical regression analysis revealed that metacognitive awareness explained an additional 9% of variance in transfer performance beyond prior knowledge and grade level. This demonstrates that metacognitive awareness is not simply a proxy for prior knowledge or cognitive development but rather makes a unique contribution to transfer. This finding supports the theoretical distinction between having knowledge and being aware of one's knowledge and how to apply it (Flavell, 1979; Dunlosky et al., 2013).

5.3 Grade Level as a Moderator

The finding that the metacognitive awareness–transfer relationship strengthened with grade level (r = .58 in grade 4 vs. r = .71 in grade 6) aligns with developmental theories suggesting that metacognitive awareness becomes increasingly important as children develop cognitively (Flavell, 1979). Younger children have less developed metacognitive abilities and may rely more on automatic processes or teacher guidance for transfer. Older children, with more developed metacognitive abilities, can more effectively use their metacognitive awareness to facilitate transfer.

However, the strong correlation in grade 4 (r = .58) indicates that even younger primary learners benefit from metacognitive awareness. This suggests that metacognitive awareness can be developed and promoted even in early primary grades (Dunlosky et al., 2013; Royer, 2021).

5.4 Subject-Area Differences

The stronger metacognitive awareness–transfer correlation for mathematics (r = .67) compared to science (r = .58) may reflect the procedural nature of mathematics instruction. Mathematics often requires learners to understand procedures and principles explicitly, which may promote metacognitive awareness. Science instruction, particularly in primary schools, may emphasize observation and experimentation over explicit understanding of principles, potentially limiting the development of metacognitive awareness (Haskell, 2017; Royer, 2021).

5.5 Transfer Type Differences

The stronger correlation between metacognitive awareness and far transfer (r = .68) compared to near transfer (r = .59) supports the theoretical prediction that metacognitive awareness is particularly important for far transfer. Far transfer requires conscious reflection about when and how knowledge applies in dissimilar contexts, processes directly supported by metacognitive awareness. Near transfer may be more automatic and may require less conscious reflection (Royer, 2021).

The finding that high metacognitive awareness reduces the gap between near and far transfer performance (from 18.8 percentage points for low metacognitive awareness to 7.5 percentage points for high metacognitive awareness) is particularly noteworthy. This suggests that metacognitive awareness helps learners overcome the difficulty of far transfer.

5.6 Implications for Educational Practice

The strong relationship between metacognitive awareness and transfer suggests that promoting metacognitive awareness should be a priority in primary education. Teachers can promote metacognitive awareness by:

- Asking learners to explain why procedures work rather than simply having them memorize procedures
- Encouraging reflection about when and why particular strategies are effective
- Modeling metacognitive thinking through think-aloud procedures
- Helping learners monitor their understanding and seek help when confused
- Explicitly discussing when knowledge applies in different contexts

5.7 Limitations

This study has several limitations. First, the Transfer Readiness Inventory is a brief self-report measure that may not fully capture metacognitive awareness. Future research should employ multiple measures of metacognition, including performance-based measures. Second, the study is correlational and does not establish causality. Longitudinal or experimental designs would strengthen causal claims. Third, the study focuses on Lusaka District, and findings may not generalize to other contexts.

6. Conclusions

Metacognitive awareness is strongly related to transfer performance in primary learners, accounting for 41% of the variance in transfer outcomes. This relationship is stronger in older learners and for far transfer. Metacognitive awareness makes a unique contribution to transfer beyond prior knowledge and cognitive development. These findings provide strong evidence that promoting metacognitive awareness is an important strategy for enhancing transfer in primary education.

7. Recommendations

For Teachers:

- Promote metacognitive awareness through explicit discussion of why procedures work
- Use think-aloud modeling to demonstrate metacognitive thinking
- Ask learners to explain their reasoning and reflect on their learning
- Help learners recognize when their knowledge applies in new contexts
- Encourage learners to monitor their understanding and seek help

For Curriculum Developers:

- Include explicit metacognitive instruction in curriculum materials
- Design activities that promote reflection about learning
- Include transfer tasks that require metacognitive awareness
- Provide guidance to teachers about promoting metacognitive awareness

For Future Research:

- Conduct experimental studies examining whether metacognitive awareness interventions enhance transfer
- Examine longitudinal relationships between metacognitive awareness and transfer
- Explore mechanisms through which metacognitive awareness facilitates transfer
- Investigate cultural factors that may influence metacognitive awareness and transfer

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Appendices available on request

Author declaration

I declare that this manuscript is my original work and has not been previously submitted for publication elsewhere.

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Conflict of interest

The author declares no conflict of interest.