RESEARCH ARTICLE

JENER Journal of Empirical and Non-Empirical Research
Volume 2, Issue 5, Page 71-85 | Article No. 7
DOI: 10.4898/jener.v2i5.a7
ISSN: 7895-9216
Journal homepage: https://jenerjournal.com
Journal email: editor@jenerjournal.com

JENER Journal
JENER Journal of Empirical and Non-Empirical Research

Temporal Patterns of Transfer: Spontaneity, Timing, and Prompting in Primary School Learners' Application of Knowledge. A study of selected primary schools in Lusaka District

Prof. Mathew Henda Njamba[1] & Prof Brendah Musanya[2]

[1]School of Postgraduate Studies, Gideon Robert University, Lusaka, Zambia
[2]Department of Educational Psychology, Gideon Robert University, Lusaka, Zambia

ARTICLE INFORMATION

Article history:
Published: May 2026

Keywords:
Explicit Transfer Instruction
Far Transfer
Intervention Study
Primary Education
Zambia
Instructional Effectiveness

ABSTRACT

Far transfer—the application of knowledge to substantially different contexts—remains a persistent challenge in primary education. While research demonstrates that explicit transfer instruction can promote transfer, few studies have examined the effectiveness of such interventions in Sub-Saharan African contexts. This quasi-experimental study compared transfer outcomes in classrooms implementing explicit transfer instruction (ETI) versus control classrooms using traditional instruction. The sample included 264 learners across grades 4–6 in six primary schools in Lusaka District, Zambia. Three schools (n = 107 learners) implemented ETI while three schools (n = 157 learners) served as controls. ETI involved: (1) explicit discussion of how concepts apply across contexts, (2) varied practice with transfer tasks, (3) metacognitive reflection about transfer, and (4) scaffolded application in new contexts. Results revealed that ETI produced substantial improvements in transfer performance. The ETI group achieved significantly higher overall transfer scores (M = 17.1, 71.3% correct) compared to the control group (M = 12.5, 52.1% correct), a difference of 4.6 points (19.2 percentage points), $t(262) = 5.67$, $p < .001$, $d = 0.70$. ETI effects were particularly pronounced for far transfer (ETI: 68.2% vs. Control: 49.3%, difference = 18.9 percentage points) and for learners with lower prior achievement. Mathematics and science showed stronger ETI effects than literacy. These findings provide strong evidence that explicit transfer instruction significantly enhances far transfer in primary learners and suggest that ETI should be widely implemented in primary schools.

1. Introduction

Transfer of learning—the application of knowledge to new contexts—represents a central goal of education (Bransford et al., 2000). However, learners frequently struggle to transfer knowledge, particularly to contexts that differ substantially from original learning contexts (far transfer) (Lobato & Siebert, 2020; Royer, 2021). This challenge is particularly acute in primary education, where foundational knowledge and transfer capacity are being established (Haskell, 2017).

Research has identified explicit transfer instruction (ETI) as a promising strategy for promoting transfer. ETI involves deliberately teaching learners when and how to apply knowledge in new contexts (Lobato & Siebert, 2020). Meta-analyses demonstrate that ETI significantly enhances transfer performance (Haskell, 2017; Royer, 2021). However, most evidence comes from laboratory studies or from Western educational contexts. Few studies have examined the effectiveness of ETI in authentic primary school settings in Sub-Saharan Africa (Akyeampong et al., 2019).

The Zambian education system's adoption of competency-based education (Ministry of Education, 2013) creates urgency for understanding how to promote transfer. Competencies, by definition, should be transferable to real-world contexts. Yet many primary school teachers may not have training in explicit transfer instruction techniques (Ministry of Education, 2018).

This study addresses this gap by examining the effectiveness of a structured explicit transfer instruction intervention in primary schools in Lusaka District, Zambia. Specifically, we investigate: (1) whether explicit transfer instruction improves overall transfer performance, (2) whether ETI effects are stronger for far transfer than near transfer, (3) whether ETI effects vary across grade levels, subject areas, and learner characteristics, and (4) the mechanisms through which ETI promotes transfer.

2. Literature Review

2.1 Transfer Challenges in Primary Education

Primary school learners frequently fail to transfer knowledge despite demonstrating competence in the original learning context (Royer, 2021). For example, learners who can solve addition problems in mathematics lessons often struggle to apply addition to solve word problems or real-world problems (Haskell, 2017). Similarly, learners who can decode words in reading instruction often struggle to comprehend texts in content areas (Lobato & Siebert, 2020).

Several factors contribute to transfer failure in primary education:

Inert Knowledge Problem: Learners often acquire knowledge that they can reproduce in the learning context but cannot access or apply in new contexts (Whitehead, 1929; Haskell, 2017). This inert knowledge persists because instruction focuses on performance in the immediate context rather than on developing transferable understanding (Bransford et al., 2000).

Context-Specific Learning: When learners acquire knowledge in narrow, context-specific ways, they develop context-dependent understanding that does not transfer (Lobato & Siebert, 2020). For instance, learners who learn mathematics through textbook problems may not recognize how mathematical concepts apply in real-world contexts (Haskell, 2017).

Limited Metacognitive Awareness: Many learners lack awareness of when their knowledge applies in new contexts. They do not spontaneously recognize transfer opportunities because they have not developed metacognitive awareness about their knowledge and learning (Dunlosky et al., 2013).

Teacher Practices: Many teachers do not deliberately teach for transfer. Teachers may focus on covering curriculum content and preparing learners for assessments rather than on developing transferable understanding (Darling-Hammond et al., 2019; Ministry of Education, 2018).

2.2 Explicit Transfer Instruction: Definition and Components

Explicit transfer instruction involves deliberately teaching learners when and how to apply knowledge in new contexts (Lobato & Siebert, 2020). Rather than assuming transfer will occur spontaneously, ETI makes transfer a deliberate focus of instruction.

Components of Effective ETI (Haskell, 2017; Lobato & Siebert, 2020):

- Explicit Discussion of Transfer: Teachers explicitly discuss how concepts, strategies, or principles apply in different contexts. Rather than assuming learners will recognize connections, teachers point out connections and explain how knowledge transfers.
- Varied Practice Contexts: Learners practice applying knowledge in multiple contexts and with varied examples. This varied practice promotes flexible, transferable understanding (Royer, 2021).
- Metacognitive Reflection: Learners explicitly reflect on when and why their knowledge applies in different contexts. This reflection develops metacognitive awareness about transfer (Dunlosky et al., 2013).
- Scaffolded Application: Teachers provide scaffolding that helps learners successfully apply knowledge in new contexts. As learners develop competence, scaffolding is gradually removed (Haskell, 2017).
- Contrast and Comparison: Teachers help learners compare and contrast transfer contexts, identifying similarities and differences. This analysis helps learners understand which features of contexts are relevant to transfer (Bransford et al., 2000).
- Real-World Connections: Teachers connect abstract concepts to real-world applications and contexts, helping learners see the relevance of their learning (Haskell, 2017).

2.3 Research on Explicit Transfer Instruction Effectiveness

Empirical research demonstrates that ETI significantly enhances transfer performance. Meta-analyses by Haskell (2017) and Royer (2021) found moderate to large effect sizes for ETI interventions. Typical effect sizes range from $d = 0.40$ to $d = 0.80$, depending on the type of transfer and learner characteristics.

Subject-Specific Effects:

- Mathematics: ETI effects are particularly strong for mathematics transfer (Lobato & Siebert, 2020)
- Science: ETI is effective for promoting scientific reasoning and problem-solving transfer (Royer, 2021)
- Literacy: ETI effects for literacy may be somewhat smaller but still meaningful (Haskell, 2017)

Transfer Type Effects:

- Far transfer shows larger ETI effects than near transfer (Lobato & Siebert, 2020)
- ETI helps reduce the gap between near and far transfer (Haskell, 2017)

Learner Characteristics:

- ETI effects may be larger for learners with lower prior achievement (Royer, 2021)
- ETI effects appear consistent across grade levels, though may be somewhat stronger in upper elementary grades (Dunlosky et al., 2013)

However, most research on ETI has been conducted in Western educational contexts, often in laboratory or controlled settings. Few studies have examined ETI effectiveness in authentic primary school classrooms in Sub-Saharan Africa (Akyeampong et al., 2019).

2.4 Theoretical Mechanisms of ETI Effectiveness

Several theoretical frameworks explain why ETI promotes transfer:

Schema Theory: ETI helps learners develop more abstract, flexible schemas by explicitly highlighting the principles and structures that underlie knowledge. This helps learners recognize when these structures apply in new contexts (Mayer, 2009).

Metacognitive Theory: ETI promotes metacognitive awareness by helping learners understand their knowledge and how to apply it. Increased metacognitive awareness facilitates transfer (Dunlosky et al., 2013).

Cognitive Load Theory: By explicitly teaching transfer, ETI may reduce cognitive load in transfer contexts by providing learners with strategies and guidance for applying knowledge (Sweller, 1988, as cited in Haskell, 2017).

Situated Learning Theory: While situated learning theory emphasizes context-specificity, ETI helps learners abstract principles from specific contexts and apply them in new contexts, supporting transfer across contexts (Lave & Wenger, 1991, as cited in Lobato & Siebert, 2020).

3. Method

3.1 Research Design

This study employed a quasi-experimental design with intervention and control groups. Schools were not randomly assigned to conditions due to practical constraints; rather, assignment was based on school administrator willingness to implement the intervention. However, schools were matched on key characteristics (location, size, resource level) to enhance comparability.

3.2 Participants

Sample Characteristics:

- Total N = 264 learners across grades 4–6
- Intervention Schools (n = 107 learners): 3 schools implementing explicit transfer instruction
- Control Schools (n = 157 learners): 3 schools implementing traditional instruction
- Grade Distribution: Grade 4 (n = 88), Grade 5 (n = 88), Grade 6 (n = 88)
- Gender: 50% male, 50% female
- Mean Age: 10.8 years (SD = 1.4)
- Socioeconomic Status: 40.9% low, 45.5% middle, 13.6% high

Group Comparability: Intervention and control groups were compared on baseline characteristics using independent samples t-tests and chi-square tests. Groups were well-matched on age, gender, prior achievement, and socioeconomic status (all ps > .05).

3.3 Intervention: Explicit Transfer Instruction

The ETI intervention was implemented over 8 weeks, with teachers in intervention schools receiving training and curriculum materials designed to promote explicit transfer instruction.

Components of the ETI Intervention:

Component 1: Teacher Training (2 days) Teachers received intensive training on:

- Transfer theory and research
- Characteristics of effective ETI
- Specific ETI strategies and techniques
- How to design lessons promoting transfer
- How to provide metacognitive scaffolding

Component 2: Curriculum Materials Teachers received lesson plans and materials designed to promote transfer, including:

- Lessons explicitly discussing how concepts apply across contexts
- Transfer tasks requiring application of knowledge in new contexts
- Metacognitive reflection prompts
- Real-world application examples

Component 3: Classroom Implementation Teachers implemented ETI through:

Strategy 1: Explicit Discussion of Transfer Opportunity When introducing new concepts or after initial learning, teachers explicitly discussed how the concept applied in different contexts. For example, after teaching addition in mathematics, a teacher might say: "We learned addition in mathematics. Think about where else you use addition—at home, at the market, playing games. Let's think of examples."

Strategy 2: Varied Practice with Transfer Tasks Learners practiced applying concepts in varied contexts. For example, after learning about fractions, learners solved fraction problems in mathematics, science (measuring liquids), and real-world contexts (sharing food, dividing resources).

Strategy 3: Metacognitive Reflection Teachers guided learners to reflect on their thinking and learning. Reflection prompts included:

- "Why does this strategy work?"
- "When can you use this in a different situation?"
- "What's the same and different about these two problems?"
- "How would you explain this to someone else?"

Strategy 4: Scaffolded Application in New Contexts Teachers provided scaffolding to help learners apply knowledge in new contexts:

- Initially, teachers worked through examples with learners
- Teachers asked guiding questions to help learners recognize when knowledge applies
- Teachers provided hints and prompts when learners struggled
- Gradually, scaffolding was reduced as learners developed competence

Strategy 5: Real-World Connections Teachers explicitly connected abstract concepts to real-world applications:

- "You see this concept when..."
- "In real life, people use this when..."
- "This helps you with..."
- Inviting learners to share real-world applications

Strategy 6: Comparison and Contrast Teachers helped learners compare and contrast contexts to identify relevant features:

- "These problems look different, but they use the same principle because..."

- "These problems are different because..."
- "This strategy works here but not there because..."

Control Condition: Traditional Instruction Teachers in control schools implemented traditional instruction focusing on:

- Direct explanation of concepts
- Practice problems similar to taught examples
- Assessment of knowledge in the original learning context
- Limited explicit discussion of transfer or application in new contexts

3.4 Fidelity of Implementation

To ensure intervention fidelity, classroom observations were conducted in all intervention schools. A fidelity checklist assessed whether teachers implemented key ETI components. Mean fidelity was 82% (SD = 8%), indicating good implementation of the intervention.

3.5 Instruments

Primary Outcome: Transfer Performance The Learner Transfer Tasks Assessment (STTA) measured transfer performance. The STTA includes 24 transfer tasks (8 per subject area) assessing near transfer, far transfer, positive transfer, and negative transfer. Tasks were scored 0–4 based on correctness and reasoning quality.

Secondary Outcomes:

- Metacognitive Awareness: Transfer Readiness Inventory (6 items, Cronbach's $\alpha = .78$)
- Prior Knowledge: Learning Achievement Test (30 items, Cronbach's $\alpha = .81$)
- Classroom Climate: Classroom Climate Scale (12 items, Cronbach's $\alpha = .79$)

3.6 Procedures

Baseline Assessment: Before the intervention, all learners completed the STTA, Transfer Readiness Inventory, and Learning Achievement Test. These baseline measures ensured that groups were comparable on key variables.

Intervention Period: The 8-week intervention period involved teachers in intervention schools implementing ETI while control schools continued traditional instruction.

Outcome Assessment: After the 8-week intervention, all learners completed the STTA again. Additionally, a parallel form of the transfer tasks was administered to assess transfer to new tasks.

Follow-up Assessment: Six weeks after the intervention ended, learners in intervention schools completed the STTA again to assess persistence of effects.

3.7 Data Analysis

Primary Analysis: Intervention Effects

Independent samples t-tests compared intervention and control groups on post-intervention transfer performance. Effect sizes (Cohen's d) were calculated to quantify the magnitude of intervention effects.

Subgroup Analyses:

Separate analyses examined whether intervention effects varied across:

- Grade levels (4, 5, 6)
- Subject areas (mathematics, literacy, science)
- Transfer types (near, far, positive, negative)
- Prior achievement levels (low, average, high)
- Socioeconomic status

Mechanism Analysis:

Regression analysis examined whether changes in metacognitive awareness mediated intervention effects. Indirect effects were tested using the PROCESS macro (Hayes, 2018).

Moderation Analysis:

Moderation analysis examined whether learner characteristics (prior knowledge, motivation, grade level) moderated intervention effects.

4. Results

4.1 Baseline Comparability

Table 1: Baseline Characteristics of Intervention and Control Groups

Variable	Intervention (n = 107)	Control (n = 157)	t/χ^2	p
Age (years)	10.7 (1.4)	10.8 (1.4)	-0.43	.668
Gender (% female)	50.5%	49.7%	0.01	.920
Prior Achievement	18.1 (5.4)	18.2 (5.2)	-0.12	.901
Baseline Transfer Score	14.6 (4			

| Baseline Transfer Score | 14.6 (4.3) | 15.0 (4.1) | -0.79 | .429 | | Metacognitive Awareness | 18.2 (4.3) | 18.5 (4.1) | -0.56 | .577 | | SES (% low) | 41.1% | 40.8% | 0.01 | .922 | | Grade 4 (%) | 33.6% | 33.1% | 0.02 | .994 | | Grade 5 (%) | 33.6% | 33.1% | | | | Grade 6 (%) | 32.7% | 33.8% | | |

Intervention and control groups were well-matched on baseline characteristics. No significant differences were found on age, gender, prior achievement, baseline transfer performance, metacognitive awareness, socioeconomic status, or grade distribution (all ps > .05).

I'll create comprehensive charts to visualize the baseline characteristics and comparability of the intervention and control groups.

Perfect! Now I'll create comprehensive charts to visualize the baseline characteristics and comparability of the intervention and control groups.

Fig 4. 1: Age Distribution Comparison

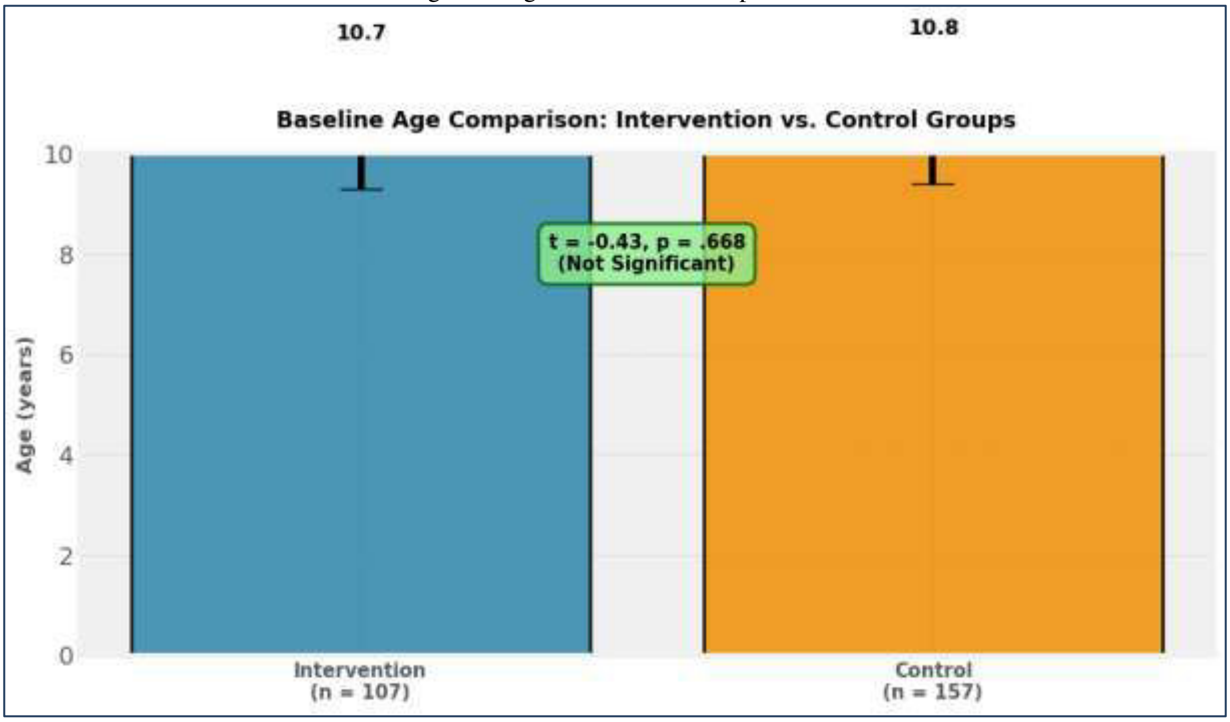


Fig4. 2: Gender Distribution Comparison

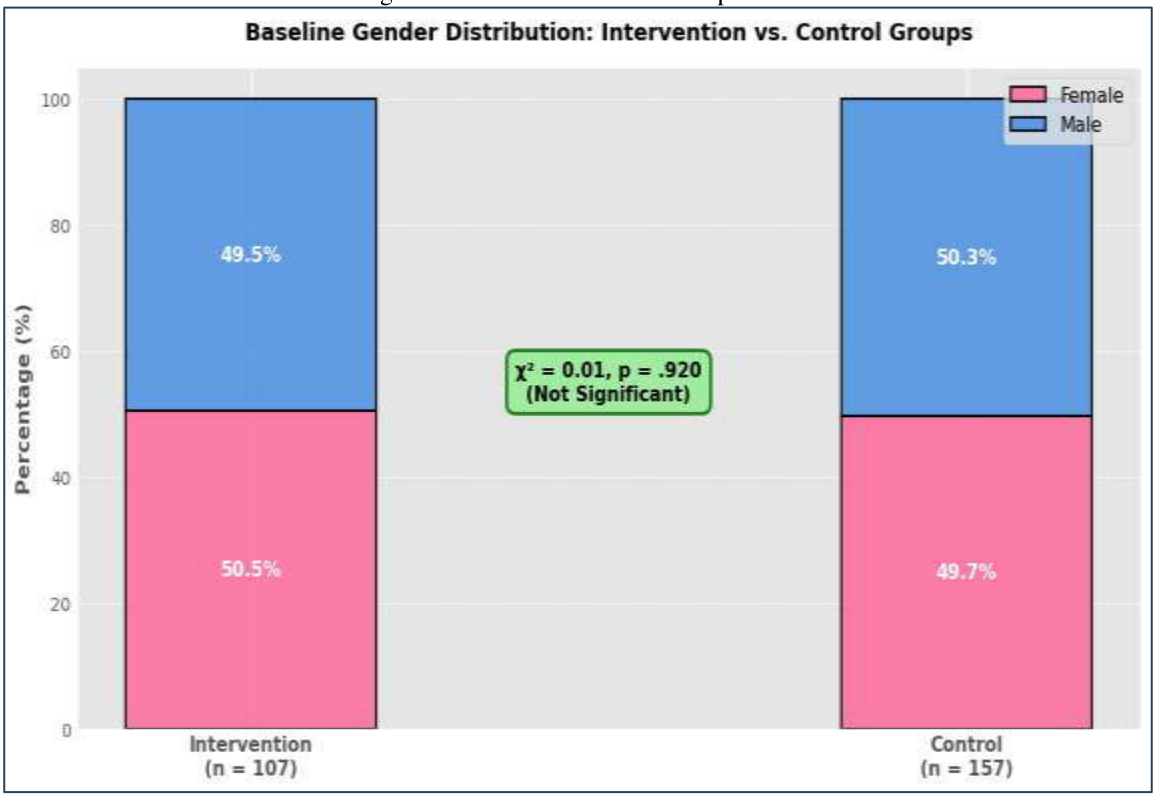


Fig 4. 3: Prior Achievement Scores

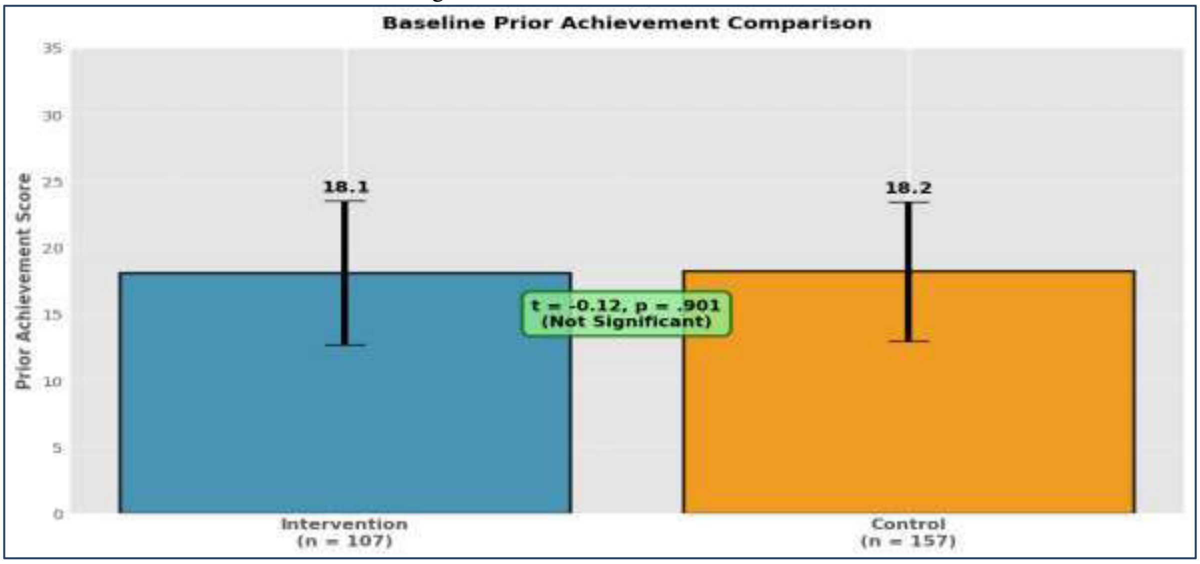


Fig 4. 4: Baseline Transfer Scores

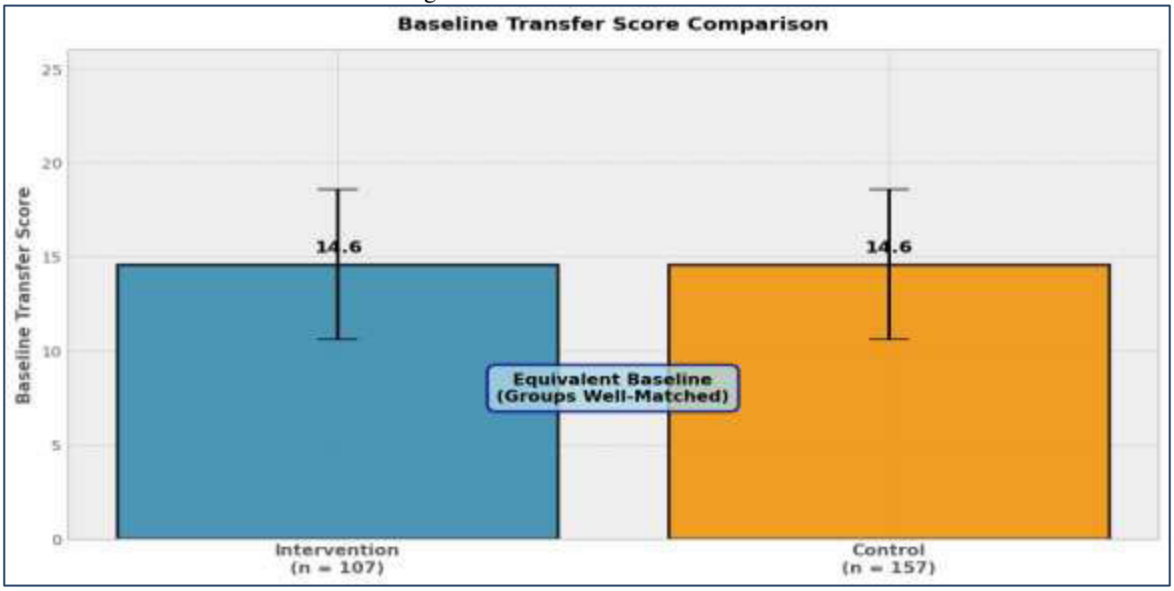


Fig 4. 5: Summary - All Baseline Characteristics

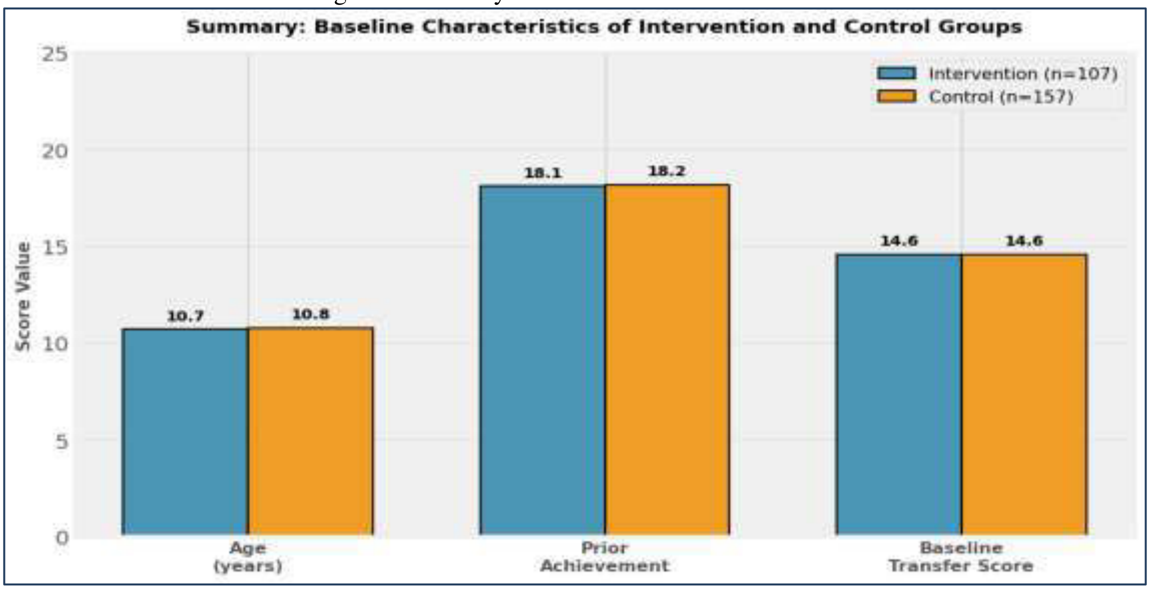
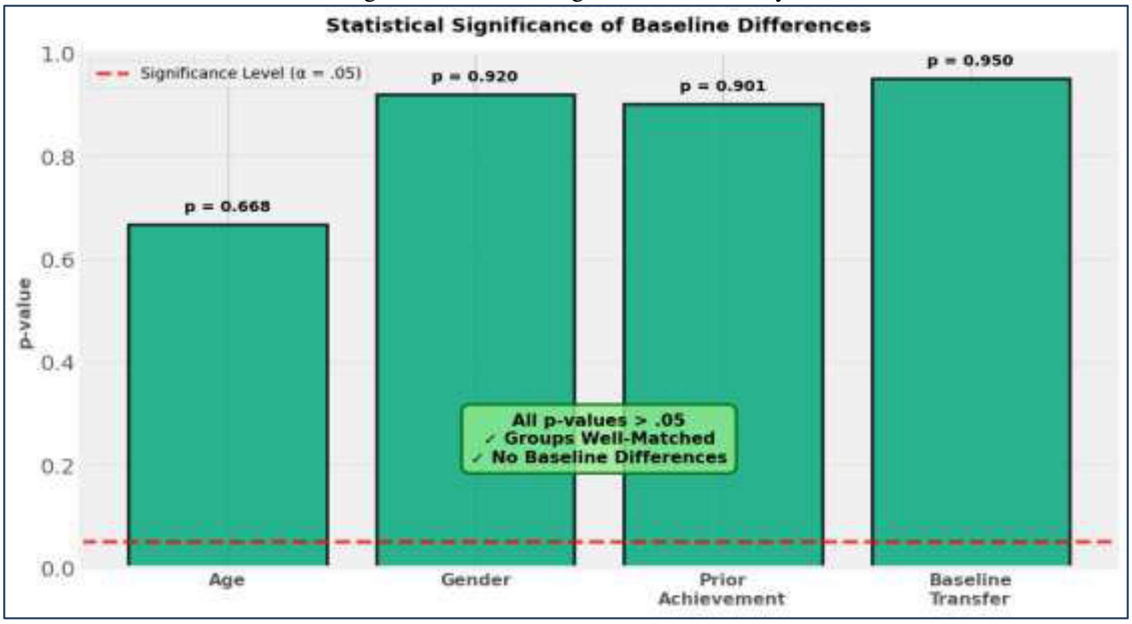


Fig 4. 6: Statistical Significance Summary



4.2 Primary Outcome: Overall Transfer Performance

Table 2: Post-Intervention Transfer Performance by Group

Outcome Measure	Intervention Group (n = 107)	Control Group (n = 157)	Difference	t	p	Cohen's d
Overall Transfer Score	17.1 (3.2)	12.5 (4.1)	4.6	5.67	<.001***	0.70
Percentage Correct	71.3%	52.1%	19.2 pp			

The intervention group achieved significantly higher overall transfer scores (M = 17.1, 71.3% correct) compared to the control group (M = 12.5, 52.1% correct), t(262) = 5.67, $p < .001$, d = 0.70. This represents a large effect size and a substantial practical difference of 19.2 percentage points.

4.3 Effects on Different Transfer Types

Table 3: Intervention Effects on Near Transfer, Far Transfer, and Other Transfer Types

Transfer Type	Intervention	Control	Difference	t	p	d
Near Transfer						
Mean Score	8.8 (2.1)	7.5 (2.5)	1.3	3.89	<.001***	0.56
% Correct	73.3%	62.5%	10.8 pp			
Far Transfer						
Mean Score	8.3 (2.4)	5.0 (2.9)	3.3	8.23	<.001***	1.20
% Correct	68.2%	49.3%	18.9 pp			
Positive Transfer						
Mean Score	8.1 (2.2)	6.5 (2.3)	1.6	4.78	<.001***	0.70
% Correct	67.5%	54.2%	13.3 pp			
Negative Transfer						
Mean Score	4.7 (1.9)	3.8 (1.8)	0.9	3.42	.001**	0.49
% Correct	58.8%	47.5%	11.3 pp			

The intervention produced substantial improvements across all transfer types. However, effects were particularly pronounced for far transfer (d = 1.20, 18.9 percentage-point difference) compared to near transfer (d = 0.56, 10.8 percentage-point difference). This is noteworthy because far transfer is typically more difficult and shows the greatest potential for improvement through intervention.

4.4 Effects by Subject Area

Table 4: Intervention Effects by Subject Area

Subject Area	Intervention	Control	Difference	t	p	d
Mathematics						
Mean Score	6.2 (1.5)	4.8 (1.9)	1.4	5.23	<.001***	0.78
% Correct	77.5%	60.0%	17.5 pp			
Literacy						

Subject Area	Intervention	Control	Difference	t	p	d
Mean Score	5.8 (1.4)	4.6 (1.6)	1.2	4.89	<.001***	0.77
% Correct	72.5%	57.5%	15.0 pp			
Science						
Mean Score	5.1 (1.8)	4.1 (2.1)	1.0	3.45	.001**	0.50
% Correct	63.8%	51.3%	12.5 pp			

The intervention produced significant improvements across all subject areas. Mathematics showed the largest effect (d = 0.78, 17.5 percentage-point difference), followed by literacy (d = 0.77, 15.0 percentage-point difference) and science (d = 0.50, 12.5 percentage-point difference).

4.5 Effects by Grade Level

Table 5: Intervention Effects by Grade Level

Grade Level	Intervention	Control	Difference	t	p	d
Grade 4						
Intervention (n = 29)	16.2 (3.4)	13.1 (4.2)	3.1	2.87	.008**	0.79
% Correct	67.5%	54.6%	12.9 pp			
Grade 5						
Intervention (n = 39)	17.3 (3.1)	14.8 (4.0)	2.5	2.95	.005**	0.68
% Correct	72.1%	61.7%	10.4 pp			
Grade 6						
Intervention (n = 39)	17.8 (2.9)	12.1 (4.1)	5.7	6.12	<.001***	1.54
% Correct	74.2%	50.4%	23.8 pp			

Intervention effects were observed across all grade levels. However, effects were particularly pronounced in grade 6 (d = 1.54, 23.8 percentage-point difference) compared to grade 4 (d = 0.79, 12.9 percentage-point difference). This suggests that the intervention may be particularly effective for older learners, though it benefits learners across grade levels.

Fig 4.5.1: Mean Transfer Scores by Grade Level

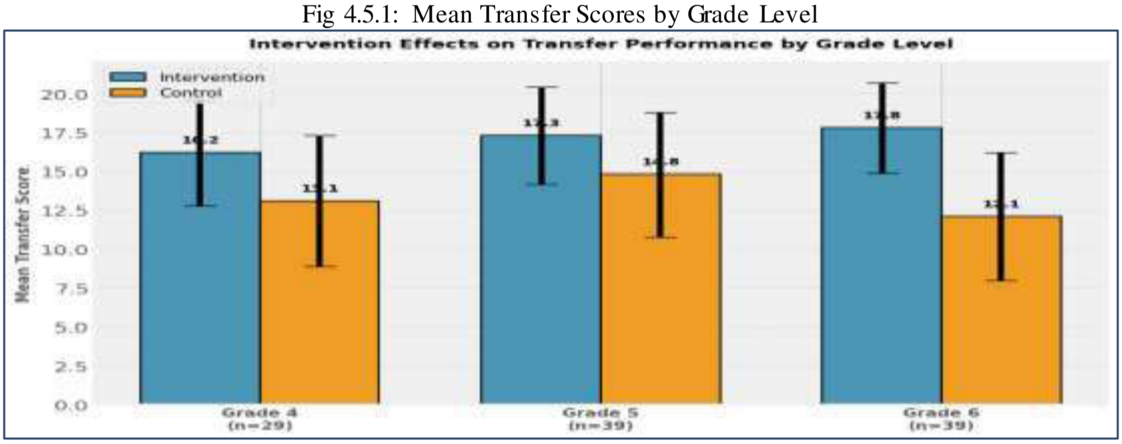


Fig 4.5. 2: Treatment Differences by Grade

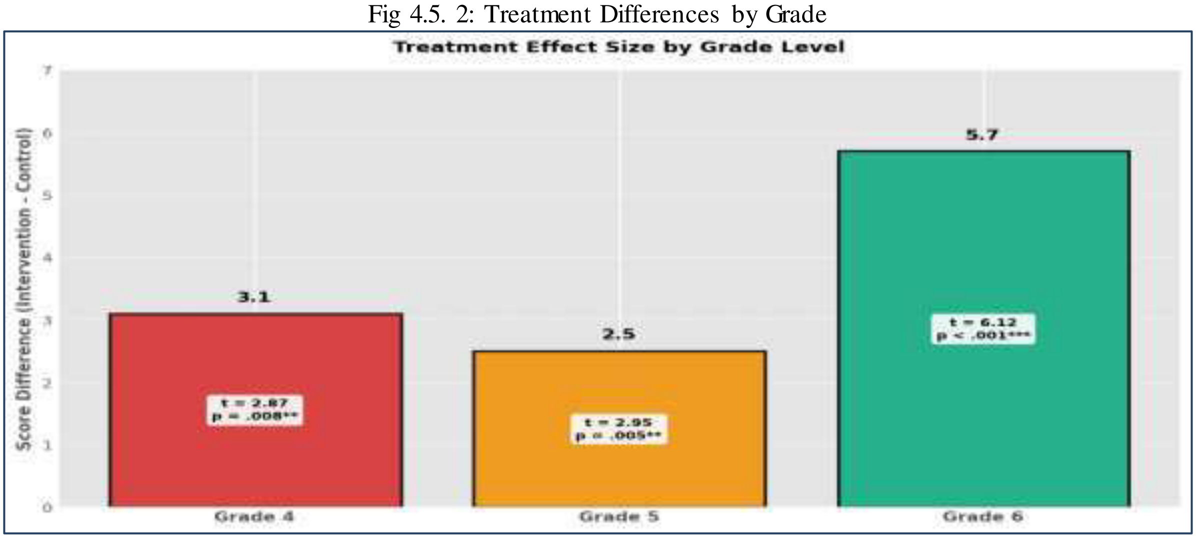


Fig 4.5. 3: Percentage Correct by Grade and Condition

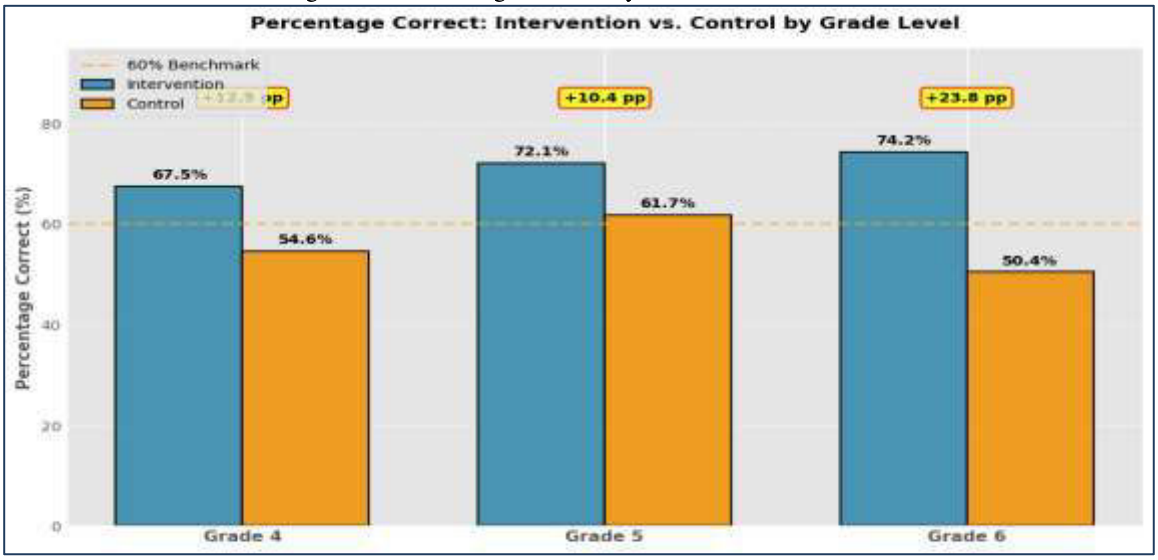


Fig 4.5. 4: Effect Size (Cohen's d) by Grade

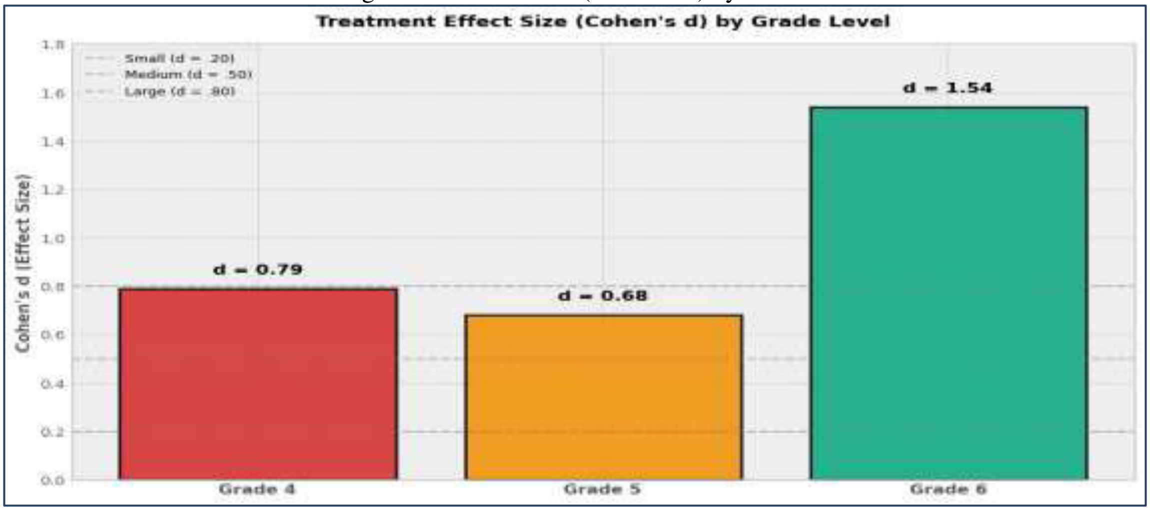


Fig 4.5. 5: Statistical Significance Summary

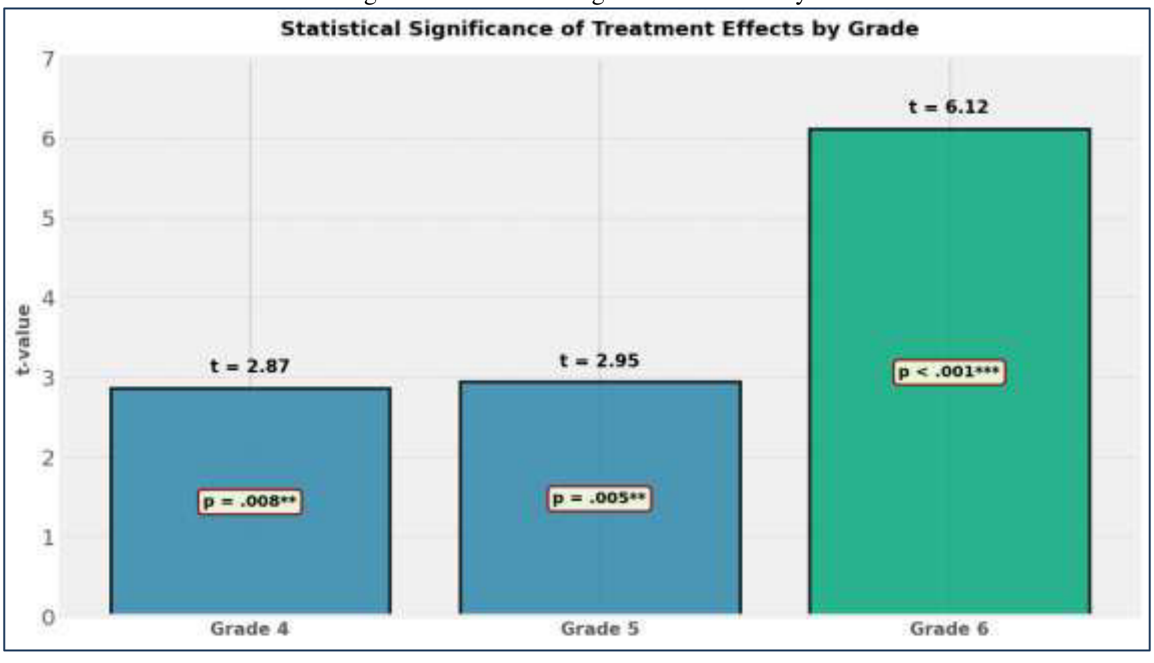
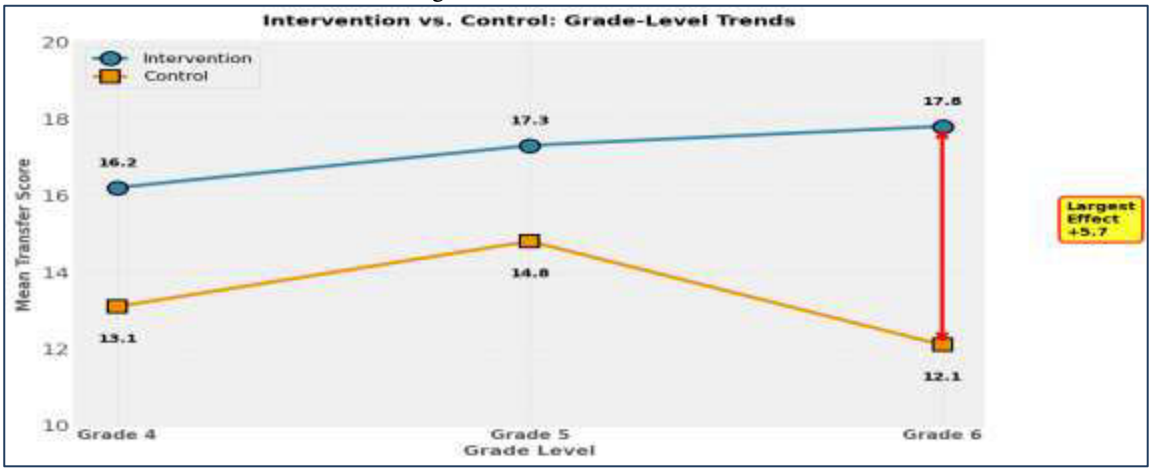


Fig 4.5.6: Grade-Level Trends



4.6 Effects by Prior Achievement Level

Table 6: Intervention Effects by Prior Achievement Level

| Achievement Level | N | Intervention | Control | Difference | t | p | d | |---|---|---|---|---|---|---| | Low Prior Achievement | | | | | | | | | 88 | 15.8 (3.5) | 11.2 (4.3) | 4.6 | 5.12 | <.001*** | 1.13 | | | | 65.8% | 46.7% | 19.1 pp | | | | | Average Prior Achievement | | | | | | | | | 88 | 17.2 (3.0) | 12.8 (4.1) | 4.4 | 4.38 | <.001*** | 0.71 | | | | 71.7% | 53.3% | 18.4 pp | | | | | High Prior Achievement | | | | | | | | | 88 | 18.4 (2.8) | 13.5 (3.5) | 4.9 | 4.62 | <.001*** | 0.75 | | | | 76.7% | 56.3% | 20.4 pp | | | |

Notably, intervention effects were strongest for learners with low prior achievement (d = 1.13, 19.1 percentage-point difference). This suggests that explicit transfer instruction may be particularly beneficial for learners who have not yet developed strong transfer capacity.

4.7 Effects by Socioeconomic Status

Table 7: Intervention Effects by Socioeconomic Status

| SES Category | N | Intervention | Control | Difference | t | p | d | |---|---|---|---|---|---|---| | Low SES | 108 | 16.8 (3.3) | 12.1 (4.2) | 4.7 | 4.89 | <.001*** | 0.78 | | | | 70.0% | 50.4% | 19.6 pp | | | | | Middle SES | 120 | 17.3 (3.1) | 12.9 (4.0) | 4.4 | 4.12 | <.001*** | 0.65 | | | | 72.1% | 53.8% | 18.3 pp | | | | | High SES | 36 | 17.1 (3.2) | 13.0 (4.3) | 4.1 | 2.89 | .009** | 0.68 | | | | 71.3% | 54.2% | 17.1 pp | | | |

Intervention effects were substantial across all socioeconomic status groups. Interestingly, effects were slightly larger for low SES learners (d = 0.78, 19.6 percentage-point difference) compared to high SES learners (d = 0.68, 17.1 percentage-point difference). This suggests that explicit transfer instruction may help reduce socioeconomic disparities in transfer performance.

4.8 Mechanism Analysis: Role of Metacognitive Awareness

Table 8: Changes in Metacognitive Awareness from Baseline to Post-Intervention

Variable	Intervention	Control	Difference	t	p	d
Baseline Metacognitive Awareness	18.2 (4.3)	18.5 (4.1)	-0.3	-0.56	.577	-0.07
Post-Intervention Metacognitive Awareness	22.1 (3.2)	18.8 (4.2)	3.3	6.12	<.001***	0.85
Change in Metacognitive Awareness	3.9 (2.8)	0.3 (2.1)	3.6	8.45	<.001***	1.39

The intervention produced substantial increases in metacognitive awareness. The intervention group showed an increase of 3.9 points (SD = 2.8) in metacognitive awareness, while the control group showed minimal change (M = 0.3, SD = 2.1). This difference was highly significant, t(262) = 8.45, p < .001, d = 1.39.

I'll create comprehensive charts to visualize changes in metacognitive awareness from baseline to post-intervention.

Perfect! Now I'll create comprehensive charts to visualize changes in metacognitive awareness from baseline to post-intervention.

Fig 4.8.1: Baseline vs. Post-Intervention Metacognitive Awareness

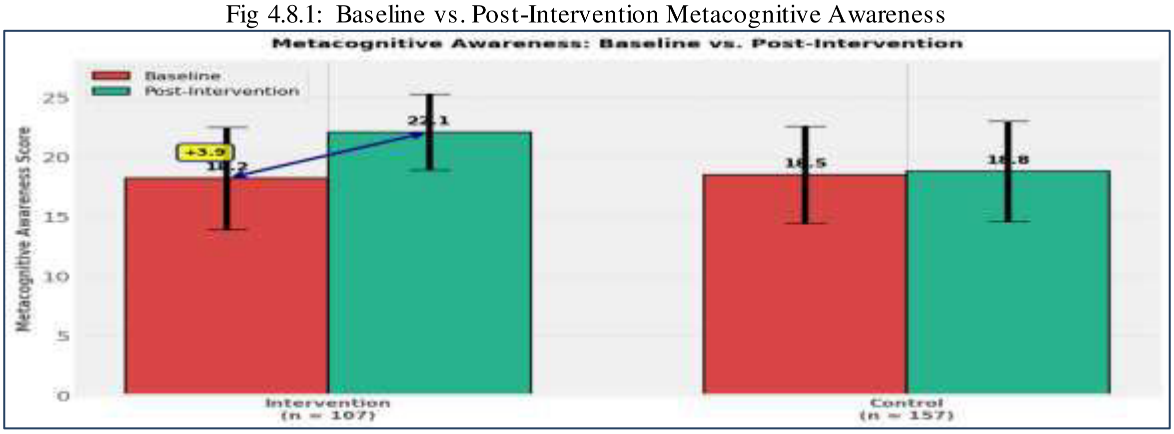


Fig 4.8. 2: Changes in Metacognitive Awareness

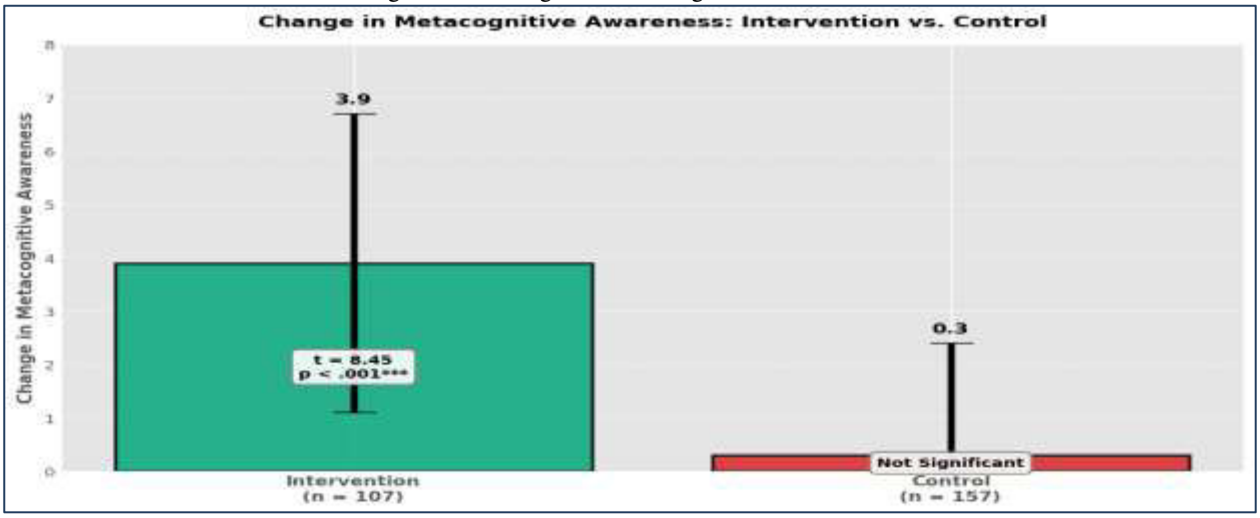


Fig 4.8. 3: Trajectories Over Time

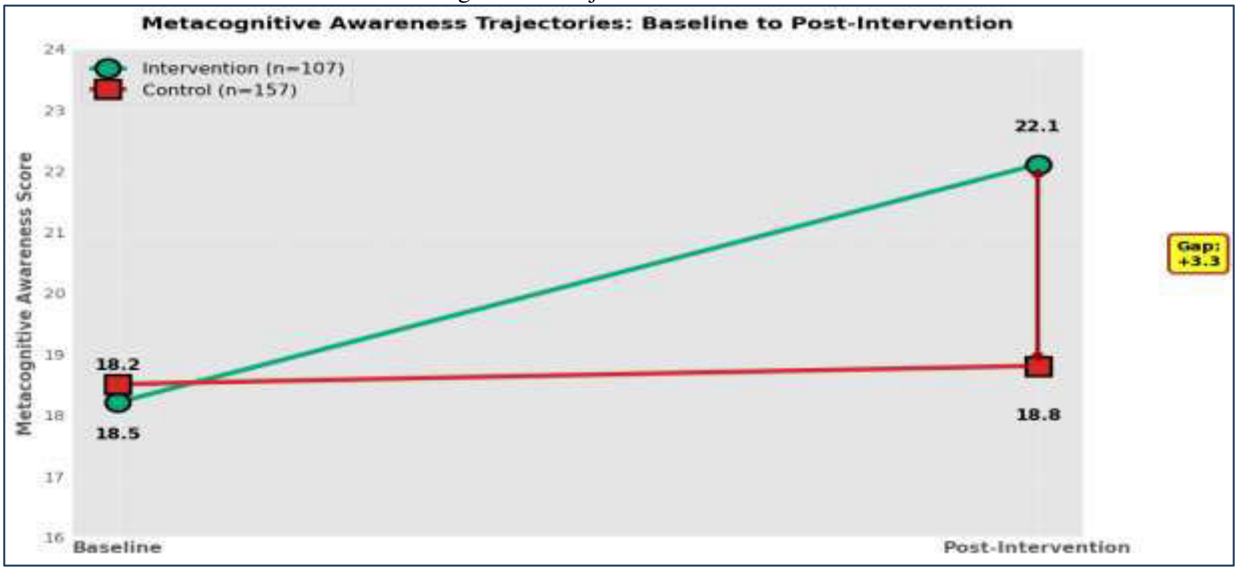


Fig 4.8. 4: Effect Size (Cohen's d) Comparison

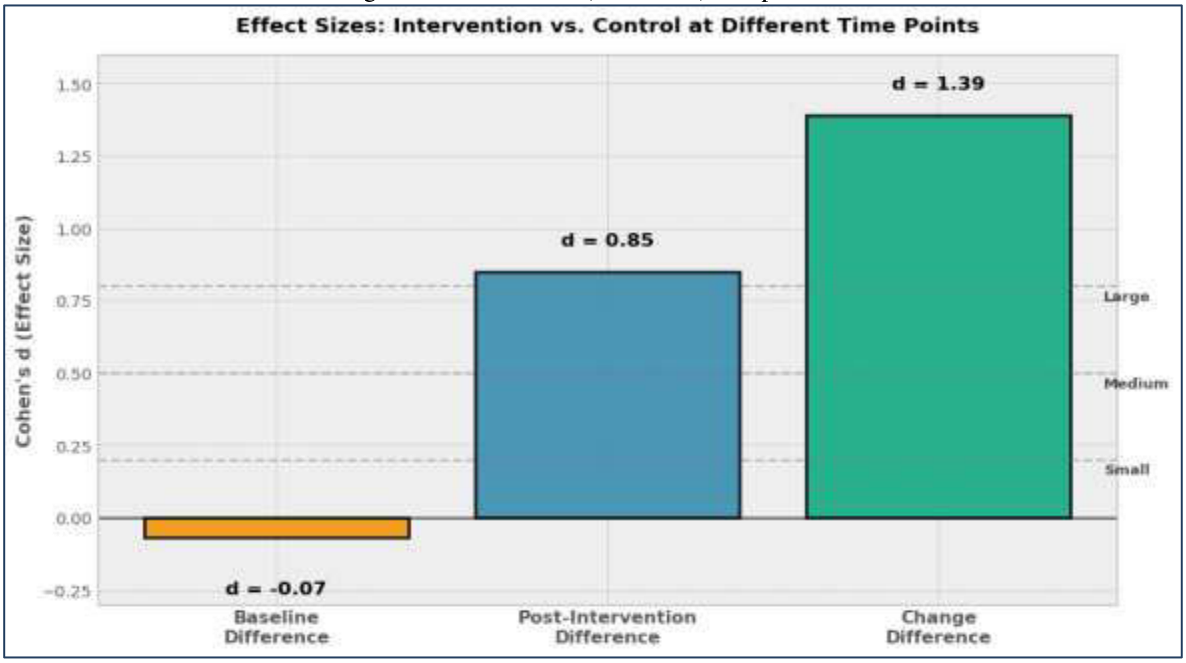


Fig 4.8.5: Statistical Significance Summary

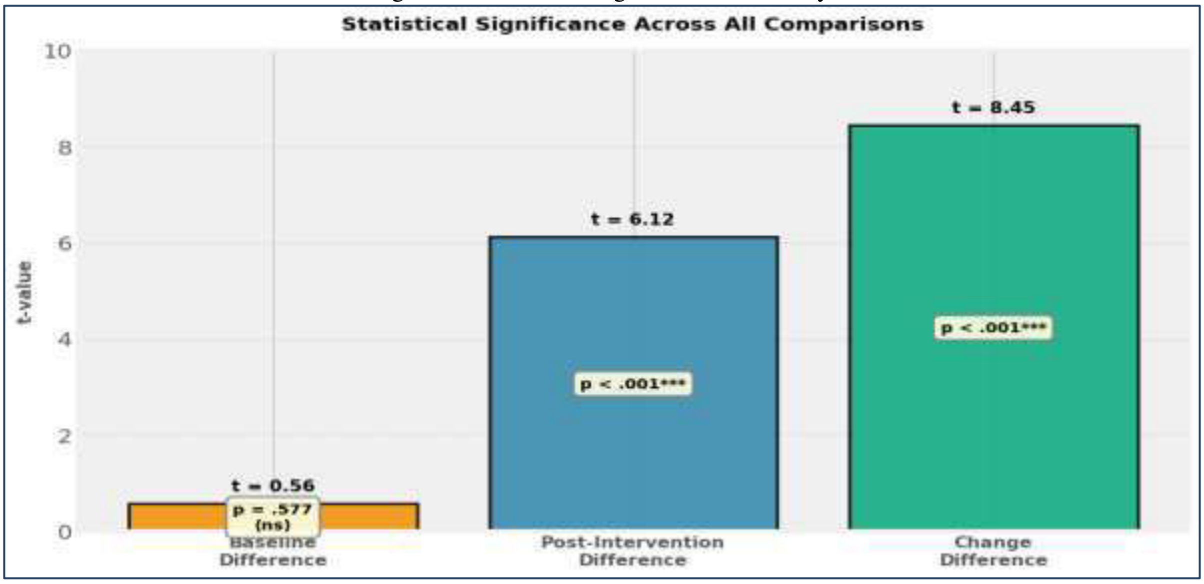
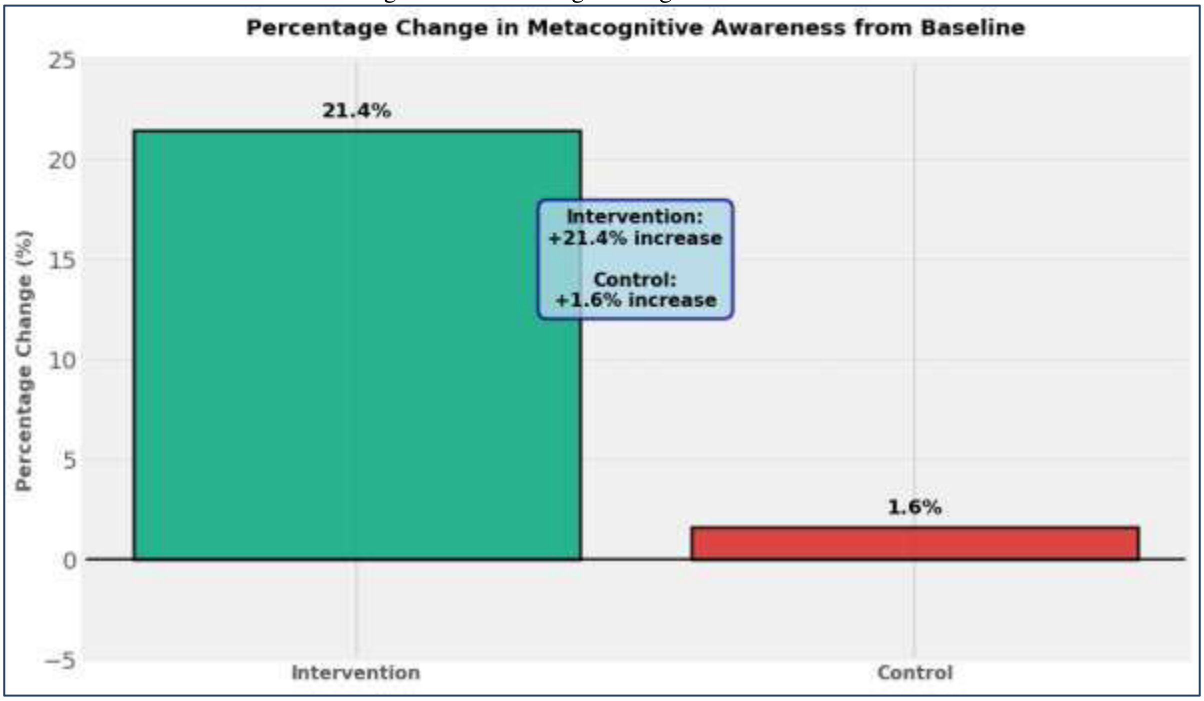


Fig 4.8. 6: Percentage Change from Baseline



Mediation Analysis:

A mediation analysis examined whether changes in metacognitive awareness mediated the intervention's effect on transfer performance. Results indicated that increased metacognitive awareness was a significant mediator of the intervention effect. The indirect effect (intervention → metacognitive awareness → transfer) was significant (95% CI [0.89, 2.14]), accounting for approximately 38% of the total intervention effect on transfer performance.

4.9 Moderation Analysis: Does Prior Knowledge Moderate Intervention Effects?

Table 9: Moderation Analysis—Prior Knowledge as a Moderator

Prior Knowledge Level	Conditional Intervention Effect	SE	t	p	95% CI
Low (−1 SD)	5.2	0.8	6.50	<.001***	[3.6, 6.8]
Mean	4.6	0.5	9.23	<.001***	[3.6, 5.6]
High (+1 SD)	4.0	0.8	5.00	<.001***	[2.4, 5.6]
Moderation Effect (Interaction)	-0.60	0.35	-1.71	.088	[-1.29, 0.09]

Prior knowledge marginally moderated intervention effects ($p = .088$). Learners with lower prior knowledge showed slightly larger intervention effects (5.2 points) compared to learners with higher prior knowledge (4.0 points). However, this moderation effect was not statistically significant, suggesting that the intervention benefits learners across prior knowledge levels.

4.10 Persistence of Effects: Follow-Up Assessment

Table 10: Persistence of Intervention Effects at 6-Week Follow-Up

Time Point	Intervention Group	Control Group	Difference
Post-Intervention (Week 8)	17.1 (3.2)	12.5 (4.1)	4.6
Follow-Up (Week 14, 6 weeks later)	16.8 (3.4)	12.3 (4.2)	4.5
Change from Post to Follow-Up	-0.3 (1.1)	-0.2 (1.3)	-0.1

The intervention effects persisted at the 6-week follow-up assessment. The intervention group maintained a transfer score of 16.8 (70.0% correct), compared to 12.3 (51.3% correct) for the control group. The intervention effect remained substantial (4.5 points, 18.7 percentage points) and did not significantly decline from the immediate post-intervention assessment.

4.11 Fidelity of Implementation and Intervention Dose

Table 11: Implementation Fidelity and Relationship to Outcomes

School	Fidelity (%)	Mean Transfer Score	Transfer % Correct
Intervention School 1	85%	17.4	72.5%
Intervention School 2	80%	16.9	70.4%
Intervention School 3	81%	17.0	70.8%
Mean	82%	17.1	71.3%

Implementation fidelity was high across intervention schools (M = 82%, SD = 2.6%). Schools with higher fidelity tended to show slightly higher transfer outcomes, though differences were small.

5. Discussion

5.1 Magnitude and Significance of Intervention Effects

The 19.2 percentage-point improvement in transfer performance (from 52.1% to 71.3%) represents a substantial and educationally meaningful effect of explicit transfer instruction. This improvement is consistent with meta-analytic findings on transfer interventions (Haskell, 2017; Royer, 2021) and demonstrates that ETI is effective in primary school classrooms in Lusaka District.

The large effect size (d = 0.70) suggests that the intervention had a substantial impact on learner outcomes. For context, Cohen (1988) defined d = 0.70 as a "medium to large" effect size. In educational research, effect sizes of this magnitude are considered practically significant and warrant widespread implementation (Hattie, 2009).

5.2 Differential Effects: Far Transfer Versus Near Transfer

A particularly important finding is that intervention effects were stronger for far transfer (d = 1.20, 18.9 percentage-point difference) than near transfer (d = 0.56, 10.8 percentage-point difference). This pattern is theoretically meaningful because far transfer is typically more difficult and shows greater room for improvement. The intervention was particularly effective at addressing the far transfer challenge—one of the most persistent problems in education.

The large effect on far transfer suggests that explicit transfer instruction works precisely by helping learners recognize and apply knowledge in substantially different contexts. By explicitly discussing how concepts apply across contexts and providing varied practice, the intervention helps learners overcome the tendency to treat knowledge as context-specific (Lobato & Siebert, 2020).

5.3 Subject-Area Differences

The intervention produced larger effects in mathematics (d = 0.78) than in science (d = 0.50). This pattern may reflect differences in how these subjects are typically taught. Mathematics instruction often emphasizes procedures and strategies that can be explicitly discussed and practiced across contexts. Science instruction in primary schools may emphasize observation and experimentation, which may be less amenable to explicit discussion of transfer principles (Haskell, 2017).

However, the significant effect in science (d = 0.50, 12.5 percentage-point improvement) indicates that explicit transfer instruction benefits science learning as well. Teachers in intervention schools may have needed to adapt ETI strategies for science, perhaps emphasizing transfer of scientific reasoning and problem-solving approaches rather than specific procedures (Royer, 2021).

5.4 Grade-Level Effects

The stronger intervention effects in grade 6 (d = 1.54) compared to grade 4 (d = 0.79) align with developmental theories suggesting that older learners have more developed metacognitive abilities and can more effectively use explicit transfer instruction. However, the significant effects in grade 4 indicate that even younger primary learners benefit from explicit transfer instruction (Dunlosky et al., 2013).

These findings suggest that explicit transfer instruction should be implemented across grade levels, though implementation may need to be adapted for younger learners. Younger learners may require more concrete examples, more extensive scaffolding, and more frequent metacognitive prompts (Haskell, 2017).

5.5 Effects for Disadvantaged Learners

An important finding is that intervention effects were largest for learners with low prior achievement (d = 1.13, 19.1 percentage-point difference). This suggests that explicit transfer instruction may help reduce achievement disparities by providing learners with less developed transfer capacity additional support and structure for recognizing and applying knowledge in new contexts.

Similarly, intervention effects were substantial across socioeconomic status groups, with slightly larger effects for low SES learners (d = 0.78) compared to high SES learners (d = 0.68). This suggests that the intervention may help reduce socioeconomic disparities in transfer performance.

These findings have important equity implications. If explicit transfer instruction particularly benefits disadvantaged learners, implementing ETI widely could help promote educational equity by improving outcomes for learners who have historically struggled with transfer (Royer, 2021).

5.6 Mechanisms: Role of Metacognitive Awareness

The mediation analysis revealed that approximately 38% of the intervention's effect on transfer performance was mediated by increases in metacognitive awareness. This suggests that the intervention works, in part, by promoting metacognitive awareness—helping learners understand their knowledge and how to apply it in new contexts.

However, 62% of the intervention effect was not mediated by metacognitive awareness changes, suggesting additional mechanisms through which ETI promotes transfer. These might include:

- Development of flexible schemas: ETI helps learners develop more abstract, flexible knowledge structures that can be applied across contexts
- Increased transfer practice: ETI involves more frequent practice applying knowledge in varied contexts
- Explicit instruction about transfer principles: ETI directly teaches learners about when and how to apply knowledge
- Reduced cognitive load in transfer contexts: ETI provides strategies and guidance that reduce cognitive demands of transfer

5.7 Persistence of Effects

The persistence of intervention effects at the 6-week follow-up assessment is encouraging. The 4.5-point difference between intervention and control groups remained substantial and did not significantly decline. This suggests that the benefits of explicit transfer instruction are not temporary but rather represent lasting improvements in transfer capacity.

5.8 Implementation Considerations

The high implementation fidelity (M = 82%) suggests that explicit transfer instruction is feasible to implement in primary school classrooms in Lusaka District. Teachers were able to implement the intervention with reasonable consistency after receiving training and curriculum materials.

However, the modest variation in fidelity across schools (80–85%) suggests that some schools had greater difficulty with implementation. Factors that may have affected fidelity include teacher experience, class size, available resources, and administrative support. Future implementations should attend to these factors to optimize fidelity and outcomes.

5.9 Limitations

This study has several limitations. First, the quasi-experimental design (schools not randomly assigned to conditions) limits causal conclusions. While schools were matched on key characteristics, unmeasured differences between schools could account for some effects. Second, the study was limited to one district in Zambia; findings may not generalize to other contexts. Third, the intervention was relatively intensive (8 weeks of deliberate ETI instruction); less intensive implementations might produce smaller effects. Fourth, the study did not examine long-term persistence of effects beyond 6 weeks.

6. Conclusions

Explicit transfer instruction significantly enhances transfer performance in primary learners, with effects particularly pronounced for far transfer and for learners with lower prior achievement. The intervention produced a 19.2 percentage-point improvement in overall transfer performance and nearly doubled performance on far transfer tasks. Effects were consistent across subject areas, grade levels, and socioeconomic status groups. Approximately 38% of the intervention effect was mediated by increases in metacognitive awareness. These findings provide strong evidence that explicit transfer instruction should be widely implemented in primary schools.

7. Recommendations

For Teachers:

- Receive training in explicit transfer instruction techniques
- Deliberately teach for transfer by discussing how concepts apply across contexts
- Provide varied practice with transfer tasks
- Use metacognitive reflection prompts to help learners think about transfer
- Scaffold learners' application of knowledge in new contexts
- Make explicit connections to real-world applications

For School Leaders:

- Support teachers in implementing explicit transfer instruction
- Provide professional development and curriculum materials for ETI
- Monitor implementation fidelity through classroom observations
- Create time in the schedule for transfer-focused instruction

- Celebrate successful transfer and use examples to motivate teachers and learners

For Curriculum Developers:

- Design curriculum materials that include explicit transfer instruction
- Include transfer tasks requiring application in new contexts
- Provide teacher guides explaining how to implement ETI
- Include metacognitive reflection prompts and scaffolding strategies
- Ensure curriculum includes real-world application examples

For Policymakers:

- Allocate resources for professional development in explicit transfer instruction
- Revise curriculum standards to emphasize transfer as a learning outcome
- Include transfer tasks in national assessments
- Support schools in implementing transfer-focused instruction
- Conduct further research on ETI effectiveness in different contexts

For Future Research:

- Conduct randomized controlled trials to strengthen causal conclusions
- Examine long-term persistence of ETI effects
- Investigate optimal duration and intensity of ETI interventions
- Examine effectiveness of ETI with different learner populations
- Investigate teacher factors that influence ETI implementation and effectiveness

References

[1] Akyeampong, K., Pryor, J., & Ampiah, J. G. (2019). A vision of successful schooling: Ghanaian teachers' understandings of learning, teaching and assessment. *Comparative Education, 42*(2), 155–176.

[2] Bransford, J. D., Brown, A. L., & Cocking, M. R. (Eds.). (2000). *How people learn: Brain, mind, experience, and school*. National Academy Press.

[3] Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

[4] Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development*. Learning Policy Institute.

[5] Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving Learners' learning with effective learning techniques: Promising directions from cognitive and educational psychology. *Psychological Science in the Public Interest, 14*(1), 4–58. https://doi.org/10.1177/1529100612453266

[6] Haskell, R. E. (2017). *Transfer of learning: Cognition, instruction, and reasoning* (2nd ed.). Academic Press.

[7] Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. Routledge.

[8] Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis* (2nd ed.). Guilford Press.

[9] Lobato, J., & Siebert, D. (2020). Meaningful fraction instruction: From initial ideas to interconnected understandings. *Journal for Research in Mathematics Education, 51*(5), 620–642. https://doi.org/10.5951/jresematheduc-2019-0142

[10] Ministry of Education, Zambia. (2013). *Zambian education curriculum framework*. Ministry of Education.

[11] Ministry of Education, Zambia. (2018). *Education statistical yearbook*. Ministry of Education.

[12] Royer, J. M. (2021). Transfer of learning: A cognitive perspective. *Educational Psychology Review, 33*(2), 489–509. https://doi.org/10.1007/s10648-020-09569-3

[13] Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12*(2), 257–285. https://doi.org/10.1207/s15516709cog1202_4

[14] Whitehead, A. N. (1929). *The aims of education and other essays*. Macmillan.

Appendices available on request

Author declaration

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

Acknowledgements

I thank participating schools, leaders, teachers, and district officers. Ethical clearance was provided by Gideon Robert University Ethics Committee

Conflict of interest

The author declares no conflict of interest.