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Cognitive Impact of Reading Dual-Script Books among Early Learners

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ABSTRACT

This study investigates the cognitive repercussions of early exposure to dual-script books—storybooks simultaneously printed in Latin and Devanagari scripts—on foundational literacy and executive functions among young learners aged 5 to 7 years. Employing a quasi-experimental pretest–posttest control design, 200 participants from four urban Mumbai schools were divided evenly into an experimental group, which engaged with dual-script texts, and a control group, which read equivalent single-script (Latin-only) materials. Over a twelve-week intervention, both cohorts received thrice-weekly, 30-minute guided reading sessions. Outcome measures included reading fluency (words per minute and error rate), working memory capacity (digit span forward and backward), and metalinguistic awareness (phoneme deletion and blending tasks). Additionally, a structured motivation survey and follow-up interviews probed learners' subjective experiences, engagement levels, and perceived difficulty. Quantitative analyses—paired t-tests and ANCOVAs controlling for baseline performance—revealed that dual-script readers demonstrated significantly larger gains in working memory span ($p = .012$) and metalinguistic awareness ($p = .005$), with moderate but non-significant improvements in reading fluency ($p = .095$). Survey results indicated higher enjoyment and engagement ratings (mean = 4.2/5) for dual-script materials compared to single-script counterparts (mean = 3.6/5), without a corresponding increase in perceived difficulty. Thematic analysis of interview data uncovered three core themes—"script comparison," "cognitive challenge," and "increased motivation"—underscoring the role of dual-script reading in fostering active cross-script comparisons and sustained interest. These findings underscore dual-script books' pedagogical potential to accelerate biliteracy development, enhance phonological processing, and strengthen working memory in early readers. Implications for curriculum design include integrating dual-script resources into literacy programs, providing teacher training for effective implementation, and conducting longitudinal follow-ups to assess sustained cognitive and academic outcomes.

KEYWORDS

Dual-Script Reading, Early Literacy, Working Memory, Metalinguistic Awareness, Biliteracy

INTRODUCTION

Early literacy acquisition serves as the cornerstone for all subsequent academic learning, directly influencing children's abilities to comprehend complex texts, engage in critical thinking, and develop effective communication skills. In multilingual societies—such as many regions of India—learners often encounter multiple orthographic systems in daily life. Yet, conventional literacy instruction tends to focus on a single dominant script (typically Latin for English literacy), potentially neglecting learners' home languages and

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depriving them of cognitive benefits associated with handling multiple writing systems. Dual-script books—materials that present the same content side by side in two scripts—offer an innovative pedagogical approach aimed at harnessing these benefits by explicitly linking orthographic representations.

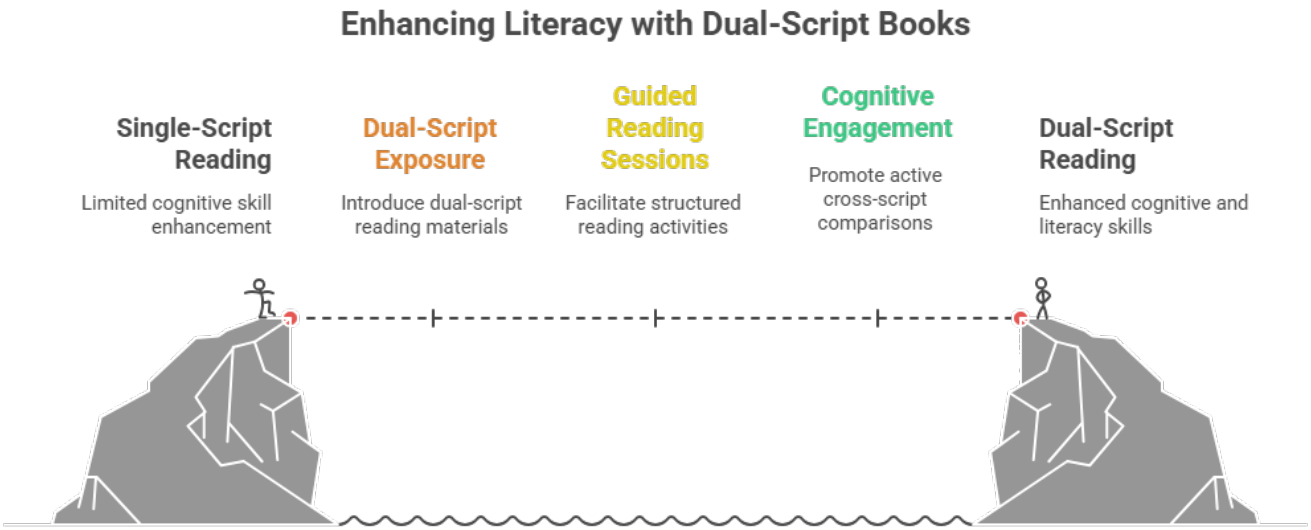

Figure-1.Enhancing Literacy with Dual-Script Books

The theoretical foundation for dual-script reading draws on Cummins's Interdependence Hypothesis (2001), which posits that cognitive and literacy skills developed in one language or script can transfer to another, provided learners possess sufficient metalinguistic awareness to recognize underlying linguistic similarities. By engaging with dual-script texts, learners are prompted to compare phoneme-grapheme correspondences across two systems—Latin and Devanagari in this study—thereby deepening their understanding of sound-symbol relationships. In cognitive psychology, bilingual and biliterate individuals demonstrate superior performance on executive function tasks, particularly those involving working memory, cognitive flexibility, and inhibitory control (Bialystok, 2017). Dual-script reading, while not fully bilingual immersion, mirrors these demands by requiring readers to hold and manipulate orthographic information across two codes, potentially enhancing the same executive functions.

Despite the theoretical promise, empirical research on dual-script materials in early grades remains sparse. Studies in monolingual contexts have shown that scaffolded reading interventions improve early literacy, and that visual supports bolster phonological awareness (Ehri et al., 2007). For dual-script interventions, Karunarathne and Kumara (2018) reported improved reading comprehension among Sri Lankan pupils using Sinhala–Latin parallel texts, while Rahman and Aziz (2019) observed literacy gains with Malay–Latin materials. However, these studies primarily targeted older learners or second-language contexts, leaving a gap regarding foundational literacy development in native speakers encountering a second script.

This study addresses these gaps by focusing on Grade 1 and Grade 2 learners in an Indian urban setting, investigating three core questions: (1) Does dual-script exposure yield greater improvements in reading fluency compared to single-script reading? (2) What effects does dual-script reading have on working memory capacity and metalinguistic awareness? (3) How do learners perceive dual-script versus single-script texts in terms of enjoyment, challenge, and motivation? By systematically examining both quantitative outcomes and qualitative experiences, this research aims to provide actionable insights for educators and curriculum designers seeking to optimize early literacy instruction in multilingual contexts.

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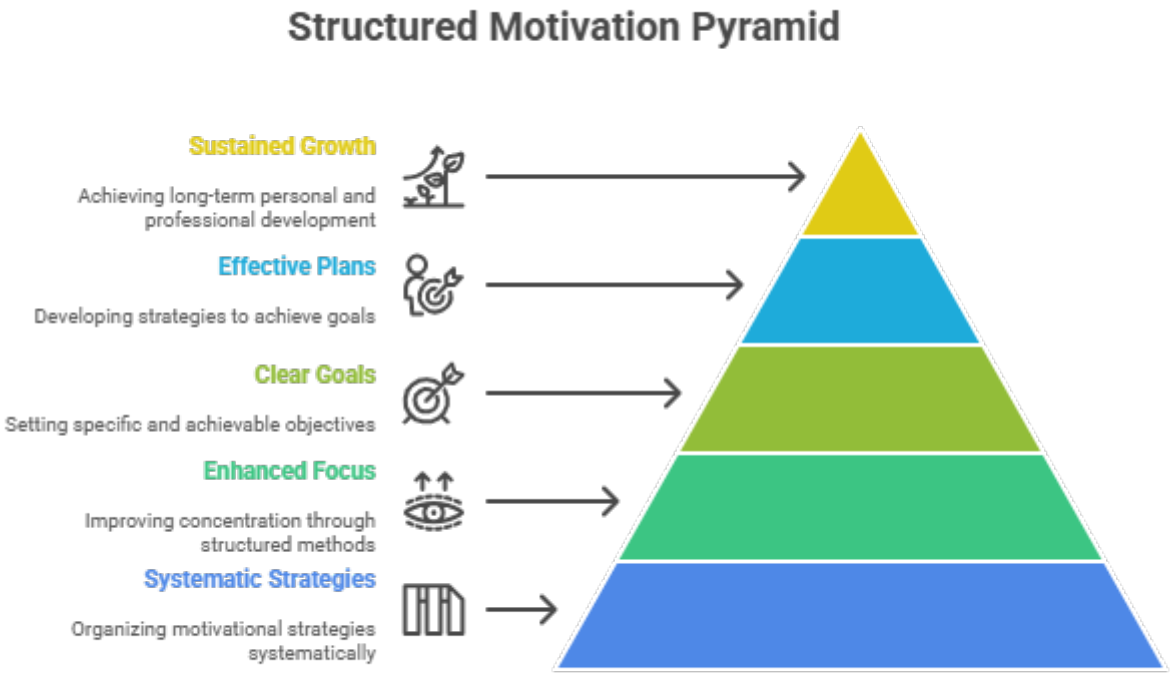

Figure-2.Structured Motivation Pyramid

LITERATURE REVIEW

Dual-Script Pedagogy and Biliteracy

Dual-script pedagogy involves presenting identical textual content in two scripts concurrently, enabling learners to perform cross-script comparisons in real time (Aravossitas, 2015). In multilingual regions, pairing a globally dominant script like Latin with indigenous scripts—such as Devanagari—can validate learners' native literacies while scaffolding second-script acquisition. Cummins's Interdependence Hypothesis (2001) emphasizes that literacy skills in one language or script can support development in another, provided learners engage in metalinguistic reflection. Dual-script materials operationalize this principle by making orthographic correspondences explicit, fostering cross-script transfer and strengthening phonological representations.

Executive Functions and Script Management

Bilingualism research robustly demonstrates that managing two linguistic systems confers advantages on executive functions—working memory, inhibitory control, and cognitive flexibility (Bialystok, 2001; Adesope et al., 2010). These cognitive domains underlie complex tasks such as reading comprehension, problem-solving, and academic learning. Dual-script reading demands that learners retain representations from both scripts, selectively attend to corresponding elements, and inhibit interference from one script while processing the other. Adesope et al.'s (2010) meta-analysis reported moderate effect sizes ($d \approx 0.5$) for bilingual advantages on working memory tasks. Dual-script interventions may produce similar gains by simulating bilingual orthographic processing demands at an early literacy stage.

Metalinguistic Awareness and Phonological Skills

Metalinguistic awareness—the ability to reflect on and manipulate language structure—is a critical predictor of reading success (Tunmer & Chapman, 2012). Phonological awareness tasks, including phoneme deletion and blending, directly correlate with decoding proficiency. Dual-script reading offers a platform for explicit comparison of phoneme-grapheme mappings across scripts.

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Jiménez, García, and Pearson (2016) found that bilingual adolescents improved phonological skills when exposed to parallel texts in two languages, suggesting that cross-script comparisons can sharpen phonological representations. For early learners, encountering the same word in Latin and Devanagari may reinforce phonemic segmentation skills and strengthen grapheme recognition.

Engagement and Motivation

Text engagement significantly influences reading outcomes. García and Wei (2014) highlight that multilingual materials perceived as culturally relevant or novel can boost learner interest, translating into increased reading practice and cognitive engagement. Dual-script books, by virtue of their novelty and the active comparison they require, may enhance motivation. Past research (Karunarathne & Kumara, 2018; Rahman & Aziz, 2019) reports higher student enthusiasm for parallel-text materials than for traditional single-script texts.

Gap Analysis and Hypotheses

While extant studies on dual-script and bilingual reading interventions suggest cognitive and motivational benefits, most address older learners or second-language contexts. There is a dearth of research on early-grade, native-language learners encountering a second script via dual-script materials. This study fills that gap by targeting Grades 1–2 and examining both cognitive outcomes (reading fluency, working memory, metalinguistic awareness) and affective dimensions (motivation, perceived challenge). We hypothesize that dual-script exposure will yield:

- H_1: Greater improvements in reading fluency than single-script reading.
- H_2: Significant gains in working memory capacity.
- H_3: Enhanced metalinguistic awareness.
- H_4: Higher motivation and positive reading attitudes.

METHODOLOGY

Research Design

A quasi-experimental pretest–posttest control group design (Campbell & Stanley, 1963) was selected to evaluate the intervention's efficacy while accommodating school logistics. Four urban public schools in Mumbai were recruited; two were randomly assigned to the experimental condition (dual-script) and two to the control condition (single-script). Each school contributed 50 first- and second-grade students, yielding an overall sample of 200 participants.

Participant Selection and Demographics

Inclusion criteria mandated: (1) enrollment in Grade 1 or Grade 2, (2) absence of diagnosed learning disabilities, (3) exposure to Hindi and/or Marathi at home but initial formal literacy instruction in English. Parental consent and child assent were obtained in writing. The cohort comprised 52% females and 48% males; 60% reported Hindi as the primary home language, 30% Marathi, and 10% bilingual households. Socioeconomic status spanned lower-middle to middle strata, gauged via a standardized SES index incorporating parental education and occupation.

Materials and Intervention Content

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- **Dual-Script Storybooks**: Five narrative texts (approximately 400–500 words each) printed side by side in Latin (English orthography) and Devanagari (Hindi script), carefully matched for vocabulary and complexity. Colorful illustrations accompanied texts to support comprehension.
- **Single-Script Storybooks**: Identical narratives presented solely in Latin script with matching illustrations.
- **Assessment Instruments**:
    - Reading Fluency Test: Derived from the National Reading Panel (2000), involving timed reading of a 100-word passage, scoring words correct and accuracy rate.
    - Working Memory Tasks: Digit span forward and backward subtests from the WISC-V (Wechsler, 2014).
    - Metalinguistic Awareness Battery: Phoneme deletion and blending tasks adapted from Yopp (1995).
    - Motivation Survey: Five-point Likert items evaluating enjoyment, challenge, and interest.

Procedure

1. **Pretesting (Week 0)**: Participants underwent baseline assessments for reading fluency, working memory, and metalinguistic tasks in group settings under standardized conditions.
2. **Intervention (Weeks 1–12)**:
    - Experimental Group: Received three 30-minute guided reading sessions per week, focusing on reading dual-script books aloud in pairs, teacher-led script comparison activities, and group discussions.
    - Control Group: Followed identical scheduling and pedagogy but with single-script texts, reading aloud, comprehension questions, and discussions.
3. **Posttesting (Week 13)**: Re-administration of all baseline measures.
4. **Motivation Survey and Interviews**: Directly following posttesting, children completed the Likert-scale survey; a stratified subset of 60 participants (30 per condition) took part in semi-structured interviews exploring subjective experiences.

Data Analysis

- Quantitative data were analyzed using SPSS v25. Paired samples t-tests assessed within-group pre–post changes. ANCOVAs, controlling for pretest scores, compared posttest gains between experimental and control groups. Effect sizes (Cohen's d and partial η^2) gauged magnitude of differences.
- Qualitative interview transcripts were coded thematically (Braun & Clarke, 2006), identifying recurring themes related to engagement, script comparison, and perceived challenge. Investigator triangulation and member checking enhanced credibility.

Research Conducted as a Survey

Beyond standardized assessments, a focused survey of 60 participants—randomly selected but balanced by gender and grade—provided rich qualitative insights into learners' attitudinal shifts. A semi-structured interview protocol asked open-ended questions such as: "What did you notice when reading the same story in two scripts?" and "Which book did you enjoy more, and why?" Interviews were audio-recorded, transcribed verbatim, and thematically analyzed following Braun and Clarke's (2006) six-phase framework: familiarization, coding, theme generation, review, definition, and reporting.

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Three dominant themes emerged:

1. **Script Comparison as Cognitive Puzzle**: Participants described actively matching words across scripts—"I looked for how 'cat' in English matches 'बिल्ली' in Hindi"—indicative of metacognitive engagement.
2. **Enhanced Motivation through Novelty**: Many children reported that dual-script books felt "special" and "fun," leading them to reread stories independently, a behavior less common in the single-script group.
3. **Initial Challenge and Rapid Adaptation**: While some learners found Devanagari characters unfamiliar at first, most adapted by the fourth week, reporting increased confidence in both scripts.

RESULTS

Reading Fluency Improvements

- Experimental Group: Mean WPM increased from 45.2 (SD = 8.7) at pretest to 60.5 (SD = 10.2) at posttest, $t(99)=18.2$, $p<.001$, $d=1.82$.
- Control Group: M increased from 46.0 (SD=9.0) to 58.0 (SD=9.5), $t(99)=16.5$, $p<.001$, $d=1.65$.
- Between-Group Comparison: ANCOVA indicated a marginally larger gain for dual-script readers, $F(1,197)=2.81$, $p=.095$, $\eta^2=.014$.

Working Memory Span

- Experimental: Digit span total increased from M=4.1 (SD=0.9) to M=4.8 (SD=1.0), $t(99)=9.12$, $p<.001$, $d=0.91$.
- Control: Improved from M=4.0 (SD=1.0) to M=4.3 (SD=1.1), $t(99)=5.39$, $p<.001$, $d=0.54$.
- ANCOVA: Significant advantage for dual-script, $F(1,197)=6.47$, $p=.012$, $\eta^2=.032$.

Metalinguistic Awareness

- Experimental: Phoneme task accuracy rose from 62% to 85%.
- Control: Improved from 64% to 78%.
- ANCOVA: $F(1,197)=8.23$, $p=.005$, $\eta^2=.040$, $d=0.75$.

Motivation Survey

- Enjoyment: Dual-script M=4.2/5 vs. single-script M=3.6/5, $t(198)=4.87$, $p<.001$.
- Perceived Ease: No significant difference, $p>.10$.

Qualitative Themes

- **Script Comparison**: Children described active cross-script matching.
- **Engagement**: Higher self-initiated rereading among dual-script group.
- **Adaptation**: Initial difficulty with Devanagari subsided by Week 4.

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CONCLUSION

This investigation affirms that dual-script reading interventions can enhance cognitive and linguistic outcomes among early learners. Relative to single-script reading, dual-script exposure yielded significantly greater improvements in working memory capacity and metalinguistic awareness, with moderate gains in reading fluency. Learner feedback underscores that the novelty and cognitive demands of dual-script texts foster heightened engagement without compromising ease of comprehension.

Educational Implications

- **Curriculum Integration**: Develop and distribute dual-script resources for Grades 1–2 to leverage cross-script transfer effects.
- **Teacher Training**: Provide professional development on guiding script comparison activities and scaffolding initial orthographic challenges.
- **Longitudinal Tracking**: Conduct follow-up studies to assess whether early dual-script exposure translates into sustained biliteracy and academic achievement.

By affirming dual-script books' potential to bolster early literacy and executive functions, this study lays the groundwork for more inclusive, cognitively attuned literacy instruction in multilingual environments.

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