

Aligning Teacher Knowledge with the Science of Reading: Evidence from Structured Literacy Implementation in Elementary Classrooms

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Aligning Teacher Knowledge with the Science of Reading: Evidence from Structured Literacy Implementation in Elementary Classrooms

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ABSTRACT

Background. The science of reading emphasizes explicit, systematic, and cumulative early literacy instruction, yet gaps often persist between teachers' conceptual knowledge and classroom practice, especially in rural schools.

Purpose. This study examined teachers' knowledge alignment with the science of reading, the quality of structured literacy implementation, and the relationship between both constructs.

Methods. Using a quantitative correlational design, data were collected from 14 early-grade teachers in two rural public elementary schools in South Sulawesi, Indonesia. Teachers completed a science-of-reading-aligned knowledge assessment, and their instruction was observed twice using a structured literacy observation rubric. Descriptive statistics and Pearson correlations were used for analysis.

Results. Teachers showed moderate overall knowledge alignment, with strengths in phonics and orthographic knowledge but weaknesses in phonological and phonemic awareness. Classroom observations also indicated moderate structured literacy implementation, marked by relatively strong explicit instruction but weaker integration of reading components and limited instructional responsiveness. A significant positive relationship was found between teacher knowledge alignment and instructional quality, especially for explicitness and systematic sequencing.

Conclusion. Teacher knowledge alignment mediates the connection between evidence-based reading theory and classroom practice; therefore, stronger teacher preparation and sustained professional development are essential for improving

KEYWORDS

Science of reading; teacher knowledge; structured literacy; rural schools; literacy instruction

INTRODUCTION

Reading proficiency is widely recognized as a foundational competence that shapes students' academic achievement, lifelong learning trajectories, and participation in society. In the context of increasing global educational demands, early literacy has become a central focus of educational reform, particularly in developing countries where disparities in learning outcomes remain persistent. International assessments continue to show that a substantial proportion of elementary students fail to achieve minimum reading proficiency, with disparities more pronounced in rural and socioeconomically disadvantaged areas (Li et al., 2019; OECD, 2024; Spink et al., 2022; UNESCO, 2019). These patterns highlight the urgent need to strengthen the quality of early literacy instruction in contexts where educational resources and professional support are limited.

Over the past decades, interdisciplinary research from cognitive psychology, linguistics, neuroscience, and education has converged into a robust body of knowledge commonly referred to as the science of reading. This framework explains how reading develops and identifies instructional practices that most effectively support literacy acquisition (Gunderson et al., 2019; Murphy, 2025; Puzio et al., 2020; Spear-Swerling, 2019). Reading comprehension is understood as the product of the interaction between accurate word recognition and language comprehension (Hjetland et al., 2019; Nation, 2019; Smith et al., 2021), requiring explicit and systematic instruction in core components such as

phonemic awareness, phonics, fluency, vocabulary, and comprehension (Buckingham, 2020; Ehri, 2020; Lane et al., 2025; S. A. Olson et al., 2023).

Despite this strong empirical foundation, a persistent gap remains between research-based knowledge and classroom practice. Many teachers enter the profession with limited preparation in the linguistic foundations of reading, resulting in instructional approaches that are not fully aligned with evidence-based principles (Bae et al., 2019; Moats, 2020; Pittman et al., 2020). This misalignment is particularly consequential in rural educational settings, where teachers often have limited access to sustained professional development, instructional resources, and pedagogical support systems.

This broader challenge is reflected in the specific context of rural elementary schools in South Sulawesi, Indonesia. Preliminary observations and contextual analysis in two public elementary schools, SD Negeri 132 Malele and SD Negeri 60 Tondon, indicate that early-grade reading instruction is frequently characterized by partial implementation of literacy components, with stronger emphasis on basic decoding skills but limited attention to phonological awareness and the integration of reading processes. Instruction tends to rely on routine practices rather than systematically designed, evidence-based approaches. In addition, opportunities for ongoing teacher professional learning in literacy instruction remain constrained, leading to variability in instructional quality across classrooms. These conditions create a critical need to

examine how teachers' conceptual understanding of reading aligns with their actual instructional practices in such contexts.

Recent research emphasizes that improving literacy outcomes requires not only the adoption of instructional programs but also strengthening teacher knowledge as a key determinant of instructional quality. Teachers with strong understanding of the science of reading are more likely to deliver explicit, systematic, and coherent instruction (Duke et al., 2021; Gess-Newsome et al., 2019). However, existing studies have largely examined teacher knowledge and instructional practice separately, providing limited insight into how these constructs interact in real classroom settings, particularly in under-resourced rural environments.

Structured literacy has emerged as an instructional approach designed to translate the principles of the science of reading into classroom practice. It emphasizes explicit, systematic, cumulative, and diagnostic instruction in foundational literacy skills (Clark, 2022; Murphy, 2025; Spear-Swerling, 2019) While this approach has strong empirical support, its effectiveness depends on teachers' ability to implement it with conceptual coherence and instructional fidelity. In contexts where teacher knowledge is uneven, structured literacy may be implemented superficially, limiting its impact on student learning.

The existing literature reveals several critical gaps. First, there is limited empirical research that directly links teachers' alignment with the science of reading to the quality of structured

literacy implementation. Second, few studies examine this relationship within authentic classroom contexts using observational data. Third, rural educational settings, where instructional challenges are often most acute, remain underrepresented in the literature. Addressing these gaps is essential for developing context-sensitive strategies to improve early literacy instruction.

To address this need, this study adopts a conceptual framework that positions the science of reading as the theoretical foundation, teacher knowledge alignment as a mediating construct, and structured literacy implementation as enacted classroom practice. Within this framework, teacher knowledge encompasses not only understanding of reading components but also the ability to apply this knowledge in instructional decision-making. Structured literacy is conceptualized as the observable manifestation of this knowledge in classroom practice, characterized by explicit instruction, systematic sequencing, integration of reading components, and instructional responsiveness. The rural classroom context is also considered as a factor that may influence how instruction is implemented.

Accordingly, this study aims to examine the alignment between teachers' knowledge of the science of reading and the quality of structured literacy implementation in rural early elementary classrooms in South Sulawesi, Indonesia. Specifically, the study seeks to assess the extent of teachers' knowledge alignment with the science of reading, evaluate the quality of structured literacy instruction in classroom practice, and analyze the

relationship between these two constructs. The study addresses the following research questions:

RQ1: To what extent do teachers' knowledge align with the core principles of the science of reading?

RQ2: How is structured literacy implemented in early elementary classrooms, and what is the quality of its implementation?

RQ3: What is the relationship between teachers' knowledge alignment with the science of reading and the quality of structured literacy implementation?

This study makes a distinct contribution by empirically linking teachers' science-of-reading-aligned knowledge with observed classroom implementation of structured literacy, an area that has rarely been examined in an integrated manner. By combining knowledge assessment and direct observation within rural Indonesian classrooms, the study moves beyond prior work that treats these constructs separately and demonstrates how teacher knowledge functions as a mediating mechanism between theory and practice in resource-constrained contexts.

Guided by these research questions, a conceptual framework was developed to illustrate the hypothesized relationships among the science of reading as a

theoretical foundation, teacher knowledge alignment as an independent construct, and structured literacy implementation as enacted classroom practice within rural early elementary contexts (Figure 1).

The conceptual framework illustrates how the science of reading serves as a theoretical foundation for effective early literacy instruction. Core components, including phonemic awareness, phonics, fluency, vocabulary, and comprehension, underpin evidence-based reading development. Within this framework, teacher knowledge alignment is conceptualized as a mediating construct linking theory to classroom practice, encompassing teachers' understanding of linguistic foundations, instructional sequencing, explicit instruction, and the integration of decoding and comprehension processes. Aligned teacher knowledge is expected to facilitate high-quality structured literacy implementation, characterized by explicit, systematic, and cumulative instruction, along with precise feedback and instructional responsiveness. These relationships are situated within the rural early elementary classroom context, recognizing the role of contextual constraints in shaping instructional enactment.

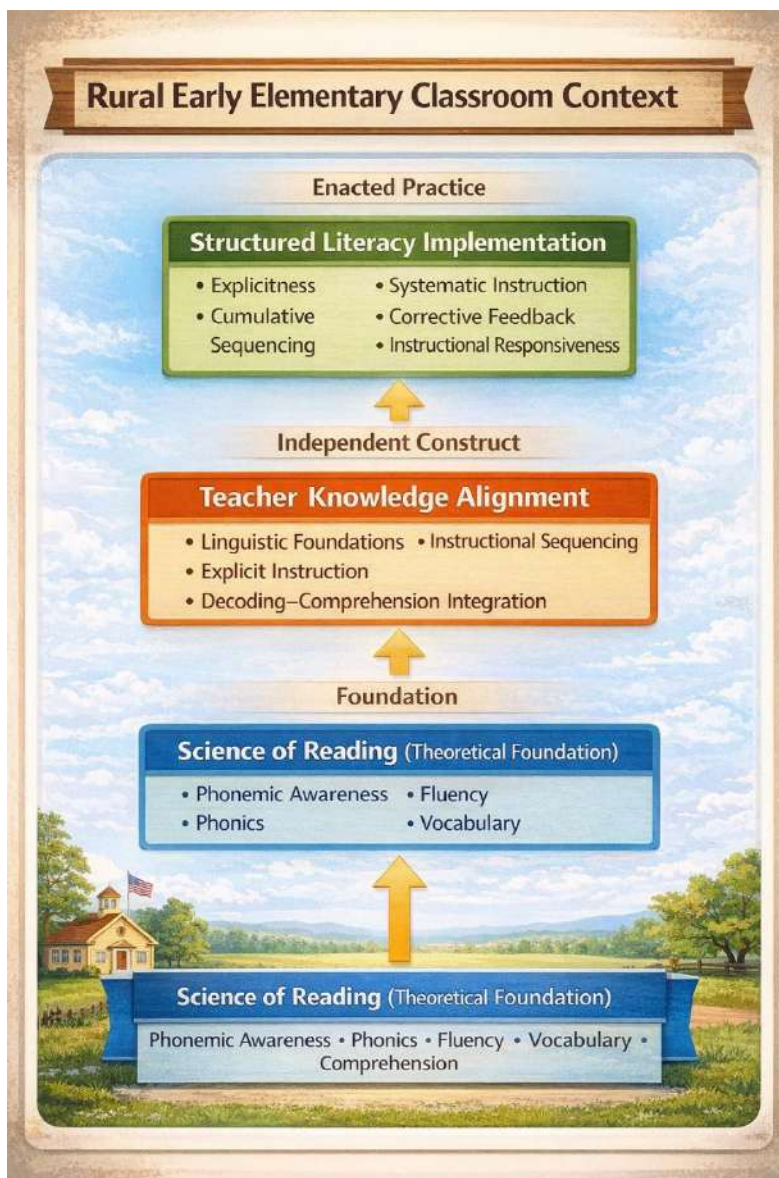


Figure 1. Conceptual Framework of Teacher Knowledge Alignment and Structured Literacy Implementation Based on the Science of Reading

Importantly, this framework also guided the analytical design of the study. It informed the selection of teacher knowledge alignment as the independent variable and structured literacy implementation as the outcome variable, as well as the specific dimensions assessed within each construct. The framework further guided the development of instruments, including the knowledge assessment aligned with science of reading components and the

observation rubric reflecting key features of structured literacy. In addition, it provided the basis for interpreting the relationship between variables, particularly in examining how variations in teacher knowledge alignment are associated with differences in instructional quality across classrooms.

METHOD

Research Design

This study employed a quantitative, non-experimental correlational research design to examine the alignment between teachers' knowledge of the science of reading and the quality of structured literacy implementation in early elementary classrooms. This design was selected to allow for systematic measurement of teacher knowledge, classroom instructional practices, and the relationships between these variables within authentic educational settings.

Research Context and Participants

This study was conducted in two rural public elementary schools, SD Negeri 132 Malele and SD Negeri 60 Tondon, located in South Sulawesi, Indonesia. These schools were purposefully selected because they represent typical rural educational contexts characterized by limited access to sustained professional development and instructional resources, particularly in early literacy instruction. Participants consisted of 14 early-grade elementary teachers teaching Grades 1 through 3, who were responsible for delivering foundational reading instruction during a critical period of literacy development. Grades 1 to 3 were selected because they represent the formative stage in which students acquire and consolidate essential reading skills, including phonemic awareness, phonics, fluency, vocabulary, and early reading comprehension. Instructional quality at this level plays a decisive role in shaping students' long-term literacy trajectories.

Of the participating teachers, nine were from SD Negeri 132 Malele and five were from SD Negeri 60 Tondon.

To address RQ2, each teacher was observed during structured literacy instruction sessions on two separate occasions, resulting in a total of 28 classroom observations. Each observation lasted approximately 60–90 minutes and focused specifically on literacy instruction segments. Observations were conducted using a non-participant approach, and field notes were recorded alongside rubric scoring to support interpretation. Observation scores were averaged across sessions to obtain stable estimates of instructional quality for each teacher. All participating teachers provided informed consent prior to data collection.

Instruments

Teachers' knowledge of the science of reading was measured using the Teacher Knowledge of Science of Reading (TK-SOR) assessment, a structured instrument consisting of 30 items. The assessment included a combination of multiple-choice and short-response items covering phonemic awareness, phonics, fluency, vocabulary, and reading comprehension, as well as their underlying linguistic and cognitive principles. Each correct response was scored as 1 and incorrect responses as 0, resulting in total scores ranging from 0 to 30, which were then converted into percentage scores to indicate levels of knowledge alignment.

Classroom instructional practices were assessed using a structured literacy observation rubric consisting of 15

indicators across five dimensions: instructional explicitness, systematic sequencing, integration of reading components, corrective feedback, and instructional responsiveness. Each indicator was rated on a 4-point scale ranging from 1 (low implementation) to 4 (high implementation). Dimension scores were averaged to produce an overall instructional quality score for each teacher. Sample indicators included the clarity of teacher modeling, logical progression of lesson components, and the extent to which instruction responded to student errors.

Both instruments underwent content validation by two experts in literacy education to ensure alignment with core principles of the science of reading. Pilot testing was conducted with a small group of teachers outside the study sample to refine item clarity and scoring procedures. Internal consistency of the TK-SOR assessment yielded a Cronbach's alpha coefficient of 0.82, indicating acceptable reliability. For the observation rubric, inter-rater reliability was established by having two trained observers independently rate a subset of lessons, resulting in an agreement coefficient of 0.87, indicating strong scorer consistency.

Data Collection Procedures

Data collection was conducted during regular instructional hours over a period of four weeks. Teachers first completed the TK-SOR assessment under supervised conditions to ensure standardization. Classroom observations were then scheduled in coordination with school administrators to capture typical instructional practices.

To ensure consistency, observers were trained prior to data collection using sample videos and calibration sessions. A standardized observation protocol was followed, including predefined observation focus, scoring guidelines, and documentation procedures. During observations, the primary observer completed the rubric in real time, while a secondary observer independently rated selected sessions to monitor scoring consistency. Any discrepancies in scoring were discussed and resolved through consensus after the observation.

Data Analysis

Descriptive statistics were used to examine levels of teacher knowledge alignment and structured literacy implementation. Correlational analyses were then conducted to determine the relationship between teachers' knowledge alignment with the science of reading and the quality of structured literacy instructional practices. Statistical analyses were performed using appropriate software, with significance levels set at conventional thresholds.

RESULTS

Teachers' Knowledge Alignment with the Science of Reading (RQ1)

This section reports the extent to which teachers' knowledge aligns with the core principles of the science of reading in early elementary classrooms in rural public schools. Descriptive analyses were conducted using scores obtained from the Teacher Knowledge of the Science of Reading Assessment (TK-SOR), which measured teachers' conceptual understanding across five foundational domains: phonological and phonemic awareness, phonics and orthographic

knowledge, reading fluency, vocabulary and oral language, and reading comprehension.

Overall, the results indicate that teachers' knowledge alignment with the science of reading was moderate, with considerable variation across domains. The mean total TK-SOR score suggests that most teachers possessed partial but incomplete understanding of evidence-based reading principles. While some domains reflected relatively stronger conceptual knowledge, others revealed substantive gaps, particularly in areas that require explicit linguistic awareness.

Domain-level analysis revealed that teachers demonstrated the highest levels of knowledge in phonics and orthographic knowledge. Most participants showed adequate understanding of the alphabetic principle, basic grapheme-phoneme correspondences, and the role of decoding in early reading development. This finding suggests that phonics-related concepts are more commonly emphasized in teacher preparation programs and instructional discourse, even in rural contexts. However, despite this relative strength, misconceptions persisted regarding the systematic and cumulative nature of phonics instruction.

In contrast, teachers' knowledge of phonological and phonemic awareness emerged as the weakest domain. A substantial proportion of teachers demonstrated limited understanding of phoneme-level skills, such as phoneme segmentation, blending, and manipulation, as well as their predictive role in early word recognition. This gap is

particularly concerning given the centrality of phonemic awareness as a precursor to successful decoding and later reading comprehension. The findings indicate that many teachers may underestimate the instructional importance of phonological skills or conflate them with phonics, reflecting patterns documented in prior international research.

Knowledge related to reading fluency was found to be at a moderate level. Teachers generally recognized accuracy and reading rate as components of fluency but showed less consistent understanding of prosody and the role of fluency as a bridge between and comprehension (Eun Young Kang & Shin, 2017). This suggests that fluency instruction may be treated as an outcome rather than as an instructional target requiring explicit support.

Teachers' understanding of vocabulary and oral language development also fell within the moderate range. While most teachers acknowledged the importance of vocabulary for comprehension, fewer demonstrated knowledge of explicit vocabulary instruction strategies or the distinction between breadth and depth of word knowledge. This pattern indicates a tendency to rely on incidental vocabulary exposure rather than intentional instructional design.

Finally, knowledge of reading comprehension reflected mixed understanding. Teachers generally recognized that comprehension involves meaning-making; however, fewer demonstrated conceptual clarity regarding the interaction between word

recognition and language comprehension. This finding suggests partial alignment with contemporary models of reading development but highlights lingering gaps in integrating foundational and higher-order processes.

When categorized using criterion-referenced thresholds, approximately half of the teachers were classified as demonstrating moderate alignment, a smaller proportion exhibited high alignment, and a notable minority fell within the low alignment category. These distributions indicate that while teachers possess some foundational knowledge of the science of reading, their

understanding remains uneven and fragmented across domains.

Taken together, the results of RQ1 suggest that teachers in rural early elementary classrooms possess partial alignment with the science of reading, characterized by relative strengths in phonics but persistent weaknesses in phonological awareness and integrative comprehension frameworks. These findings underscore the need for targeted professional development that systematically strengthens teachers' linguistic knowledge and conceptual coherence across all components of reading instruction.

Table 1. Descriptive Statistics of Teachers' Knowledge Alignment with the Science of Reading (RQ1)

Domain	Mean (M)	SD	Alignment Level
Phonological & Phonemic Awareness	3.2	1.1	Low
Phonics & Orthographic Knowledge	6.8	1.4	Moderate-High
Reading Fluency	5.1	1.3	Moderate
Vocabulary & Oral Language	4.9	1.2	Moderate
Reading Comprehension	5.0	1.4	Moderate
Total TK-SOR Score	25.0	4.6	Moderate

Note. Alignment levels are based on criterion-referenced thresholds (<50% = Low; 50–74% = Moderate; ≥75% = High).

Policy and Teacher Development Implications Based on RQ1

The findings of RQ1 carry direct implications for teacher education policy and professional development. The observed uneven alignment across reading domains suggests that current teacher preparation and in-service training may insufficiently address the linguistic foundations of reading, particularly phonological and phonemic awareness. Policymakers should therefore prioritize professional development programs that explicitly

target teachers' conceptual understanding of early reading processes rather than focusing solely on instructional materials or programs.

In addition, literacy policies that mandate evidence-based instruction should be supported by systematic assessments of teacher knowledge alignment to ensure meaningful implementation. Without strengthening teachers' foundational understanding of the science of reading, policy reforms risk being implemented at a procedural level without generating substantive instructional change.

Targeted and domain-specific professional development, particularly in rural and resource-limited contexts, can serve as a critical lever for improving instructional quality and reducing early literacy disparities.

Quality of Structured Literacy Implementation (RQ2)

This section reports the quality of structured literacy implementation in early elementary classrooms based on observations of 14 teachers across two rural public schools. Instructional quality was assessed using the Structured Literacy Instruction Observation Rubric (SLIOR), which captures five core domains aligned with the science of reading.

Overall, the results indicate that the quality of structured literacy implementation was moderate across the observed classrooms. Although key features of structured literacy were evident, implementation varied considerably across domains, suggesting partial and uneven enactment of evidence-based reading instruction (Petscher et al., 2021; Shanahan, 2020).

The domain of explicitness of instruction demonstrated the highest overall performance. Most teachers clearly articulated lesson objectives, modeled targeted reading skills, and provided direct explanations during instruction, particularly in phonics-focused lessons. Guided practice was commonly observed, indicating an awareness of the importance of explicit teaching in early reading development. However, explicit instruction was not always accompanied by systematic checks for understanding.

Results for systematic and sequential instruction indicated moderate implementation quality. While lessons generally followed a progression from simpler to more complex skills, cumulative review of previously taught content was inconsistently embedded. In several classrooms, instructional sequences appeared lesson-specific rather than intentionally cumulative, limiting opportunities for reinforcement and consolidation of learning.

The domain of integration of reading components showed relatively lower scores. Although phonics instruction was consistently present, integration between decoding, vocabulary, fluency, and comprehension was limited. In many observed lessons, decoding activities were conducted separately from meaning-based tasks, resulting in fragmented instructional experiences. Only a small number of teachers demonstrated coherent integration of word recognition and comprehension within a single instructional sequence.

Findings related to corrective feedback and practice revealed moderate implementation. Teachers frequently provided feedback during guided practice; however, the precision and immediacy of feedback varied. In some instances, student errors were acknowledged without explicit correction or instructional clarification. Opportunities for independent practice were present but not always systematically scaffolded to reinforce previously taught skills.

Finally, instructional responsiveness emerged as one of the weakest domains.

While some teachers adjusted instruction based on student responses, systematic use of formative assessment to guide instructional decisions was limited. Instructional pacing and content were often maintained despite observable student difficulties, suggesting challenges in adapting instruction in real time within the constraints of rural classroom contexts.

Taken together, the RQ2 findings indicate that structured literacy principles were partially implemented in early elementary classrooms at both schools. Instruction reflected awareness of explicit teaching practices but lacked consistent coherence, integration, and responsiveness, highlighting a gap between surface-level adoption of structured literacy routines and deeper alignment with the science of reading.

Table 2. Descriptive Statistics of Structured Literacy Implementation (RQ2)

Domain	Mean (M)	SD	Implementation Level
Explicitness of Instruction	3.10	0.42	High-Moderate
Systematic & Sequential Instruction	2.78	0.51	Moderate
Integration of Reading Components	2.45	0.48	Moderate
Corrective Feedback & Practice	2.62	0.46	Moderate
Instructional Responsiveness	2.31	0.44	Low-Moderate
Overall SLIOR Score	2.65	0.39	Moderate

Note. Scores range from 1 (Not observed) to 4 (High quality). $N = 14$ teachers.

Relationship Between Teacher Knowledge Alignment and Structured Literacy Implementation (RQ3)

This section reports the relationship between teachers' knowledge alignment with the science of reading and the quality of structured literacy implementation in early elementary classrooms. Pearson product-moment correlation analyses were conducted using teachers' total scores on the Teacher Knowledge of the Science of Reading Assessment (TK-SOR) and their averaged scores on the Structured Literacy Instruction Observation Rubric (SLIOR).

The results revealed a statistically significant positive correlation between teachers' overall knowledge alignment and the overall quality of structured literacy implementation ($r = .68, p < .01$). This finding indicates that teachers with

stronger conceptual understanding of the science of reading tended to implement structured literacy instruction with higher quality and greater instructional coherence.

Domain-level correlation analyses further elucidated the nature of this relationship. Teacher knowledge alignment demonstrated a strong positive correlation with the explicitness of instruction domain ($r = .72, p < .01$), suggesting that teachers with higher knowledge scores were more likely to provide clear modeling, direct explanations, and scaffolded guided practice during literacy instruction. This domain exhibited the strongest association with teacher knowledge, highlighting explicit instruction as a key mechanism through which conceptual understanding is translated into classroom practice.

A moderate to strong positive correlation was also observed between teacher knowledge alignment and systematic and sequential instruction ($r = .64, p < .01$). Teachers with higher TK-SOR scores were more likely to implement instruction that followed a logical progression from simple to complex skills and incorporated cumulative review of previously taught content. This finding suggests that conceptual clarity supports instructional planning that reflects the cumulative nature of reading development emphasized in the science of reading.

The relationship between teacher knowledge alignment and the integration of reading components was moderate and statistically significant ($r = .58, p < .05$). Teachers with stronger knowledge alignment were more likely to connect phonics instruction with vocabulary development and comprehension activities, although this integration remained less robust than explicit instruction and sequencing. This pattern indicates that while knowledge alignment supports integrative instruction, additional pedagogical support may be needed to fully operationalize these connections in practice.

Teacher knowledge alignment was also moderately correlated with corrective feedback and practice ($r = .61, p < .05$). Higher knowledge scores were

associated with more accurate and timely feedback as well as increased opportunities for guided and independent practice. This finding suggests that conceptual understanding enhances teachers' ability to diagnose student errors and respond instructionally during literacy lessons.

The weakest, yet still statistically significant, relationship was observed between teacher knowledge alignment and instructional responsiveness ($r = .47, p < .05$). Although teachers with higher knowledge alignment demonstrated greater responsiveness to student learning needs, the relatively lower correlation indicates that contextual factors, including time constraints, class size, and limited instructional support, may influence the extent to which knowledge is translated into adaptive instructional decisions.

Overall, the findings for RQ3 provide empirical support for the proposed conceptual framework by demonstrating that teachers' knowledge alignment with the science of reading is systematically associated with the quality of structured literacy implementation across multiple instructional domains. These results position teacher knowledge alignment as a critical mediating factor linking evidence-based literacy theory to enacted classroom practice in rural early elementary contexts.

Table 3. Correlations Between Teacher Knowledge Alignment (TK-SOR) and Structured Literacy Implementation (SLIOR) Domains (RQ3)

SLIOR Domain	r	p
Explicitness of Instruction	.72	< .01
Systematic & Sequential Instruction	.64	< .01
Integration of Reading Components	.58	< .05
Corrective Feedback & Practice	.61	< .05
Instructional Responsiveness	.47	< .05
Overall SLIOR Score	.68	< .01

Note. $N = 14$ teachers. Correlations computed using Pearson's r .

DISCUSSION

This study examined teachers' knowledge alignment with the science of reading (RQ1), the quality of structured literacy implementation (RQ2), and the relationship between these two constructs in rural early elementary classrooms (RQ3). Taken together, the findings provide convergent evidence that teacher knowledge alignment functions as a critical mediating factor linking evidence-based reading theory to enacted classroom practice.

The results for RQ1 indicate that teachers demonstrated moderate overall alignment with the science of reading, with notable variation across domains. Stronger understanding was observed in phonics and orthographic knowledge, while substantial gaps emerged in phonological and phonemic awareness. This pattern aligns with prior research showing that many teachers possess fragmented knowledge of reading development, particularly in foundational linguistic domains (Bonner et al., 2023; Cabell & Hwang, 2020; König et al., 2022; Moats, 2020). Consistent with international findings, phonemic awareness remains one of the least well-understood components among practicing teachers, despite its well-

established role as a predictor of early reading success (Gillon, McNeill, Scott, Denston, Wilson, Carson, & Macfarlane, 2019; Gillon, McNeill, Scott, Denston, Wilson, Carson, Macfarlane, et al., 2019; O'Sullivan, 2025).

Findings from RQ2 revealed that the implementation of structured literacy instruction was moderate and uneven across observed classrooms. Explicit instruction and basic instructional sequencing were more frequently observed, whereas integration of reading components and instructional responsiveness were less consistently enacted. These results mirror previous classroom-based studies suggesting that structured literacy is often adopted at a procedural level, without full conceptual integration of decoding, language, and comprehension processes (Galbally & Scharff, 2022; Moats, 2020; Spear-Swerling, 2019). In rural contexts, such partial implementation may be further constrained by limited access to sustained professional development and instructional coaching.

Importantly, the results of RQ3 demonstrated significant positive relationships between teacher knowledge alignment and all domains of structured literacy implementation.

Teachers with stronger knowledge of the science of reading were more likely to enact explicit, systematic, and coherent instruction, corroborating prior evidence that teacher knowledge predicts instructional quality in literacy classrooms (Elleman & Oslund, 2019; Kim et al., 2021). The strongest association was found for explicitness of instruction, reinforcing theoretical claims that explicit teaching is a primary mechanism through which reading science is operationalized in practice (Duke & Cartwright, 2021; Ehri, 2014; Ismail, 2024, 2023).

At the same time, the weaker association between knowledge alignment and instructional responsiveness suggests that knowledge alone may be insufficient to ensure adaptive teaching. Contextual factors such as class size, time constraints, and limited instructional support, which are commonly reported in rural schools, likely moderate the translation of knowledge into responsive practice (Darling-Hammond et al., 2022; Li et al., 2019; Sims et al., 2025). This finding underscores the importance of viewing teacher knowledge as necessary but not sufficient for high-quality implementation.

Overall, the findings support the conceptual framework proposed in this study and extend the literature by providing empirical evidence from authentic rural classroom contexts. The results suggest that improving early literacy outcomes requires not only the adoption of structured literacy approaches, but also systematic efforts to strengthen teachers' conceptual understanding of the science of reading

and the conditions that support its enactment.

Implications for Teacher Education and Literacy Policy

The findings of this study carry important implications for teacher education and literacy policy, particularly in rural and resource-limited contexts. First, the identified gaps in teachers' knowledge alignment, particularly in phonological and phonemic awareness, underscore the need to restructure teacher preparation curricula to incorporate explicit and systematically organized coursework on the linguistic foundations of reading. In line with prior research, teacher education programs should move beyond general literacy methods and ensure that preservice teachers develop a deep and integrated understanding of reading development (Drake & Walsh, 2020; Moats, 2020).

Second, the results suggest that professional development initiatives should be domain-specific and sustained, rather than generic or one-off workshops. Training that directly targets teachers' conceptual understanding of the science of reading, combined with classroom-based coaching, is more likely to produce meaningful changes in instructional practice (Darling-Hammond et al., 2019; Samundeeswari, 2024).

From a policy perspective, mandates requiring evidence-based reading instruction should be accompanied by mechanisms for assessing teacher knowledge alignment. Without such measures, policies risk being implemented as symbolic compliance

rather than substantive pedagogical reform. The instruments used in this study demonstrate one possible approach for linking policy goals with measurable instructional capacity.

Finally, the rural context of this study underscores the importance of equitable policy design. Policymakers should prioritize resource allocation, professional learning opportunities, and instructional support systems for rural schools to ensure that evidence-based literacy reforms do not exacerbate existing educational disparities.

Several limitations should be considered when interpreting the findings of this study. First, the sample size was relatively small and limited to two rural public schools, which may restrict the generalizability of the results. However, the use of multiple classroom observations and validated instruments enhances the internal validity of the findings.

Second, the study employed a correlational design and therefore does not permit causal inferences. While significant relationships were observed between teacher knowledge alignment and instructional quality, future studies employing experimental or longitudinal designs are needed to examine causal pathways and instructional change over time.

Third, although the observation rubric captured key dimensions of structured literacy implementation, instructional quality is a complex construct that may be influenced by additional factors such as curriculum materials, leadership support, and student characteristics. Future research should incorporate

multi-level designs to examine how these contextual variables interact with teacher knowledge.

Future studies could also extend this work by examining the impact of targeted professional development interventions on teacher knowledge alignment and subsequent changes in instructional practice and student reading outcomes. Such research would further strengthen the empirical base for evidence-based literacy reform in diverse educational contexts.

CONCLUSION

This study provides empirical evidence that teachers' knowledge alignment with the science of reading is a critical determinant of the quality of structured literacy implementation in early elementary classrooms, particularly in rural educational contexts. The findings demonstrate that while teachers possessed moderate overall knowledge alignment, substantial gaps remained in foundational linguistic domains, most notably phonological and phonemic awareness. These gaps were mirrored in classroom practice, where structured literacy principles were partially enacted, with strengths in explicit instruction but weaknesses in instructional integration and responsiveness.

Importantly, the study establishes a robust positive relationship between teachers' knowledge alignment and instructional quality across all observed domains, confirming that teacher knowledge functions as a key mediating mechanism linking evidence-based literacy theory to classroom practice. Teachers with stronger conceptual understanding of the science of reading

consistently implemented instruction that was more explicit, systematic, and coherent.

From a policy perspective, these findings highlight that literacy reform efforts cannot depend solely on curriculum mandates or instructional materials. Sustainable improvement in early literacy outcomes requires systematic investment in strengthening teachers' conceptual knowledge through aligned teacher preparation, targeted professional development, and sustained instructional support, particularly in rural and resource-limited contexts. By positioning teacher knowledge

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alignment as a central lever for reform, this study offers actionable evidence to inform evidence-based literacy policy and practice.

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Conflict of Interest

The author declares that there is no conflict of interest related to this manuscript.


Author Contributions

Author contribution details have been removed for blind review and should be provided in the supplementary title page.

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