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Changes in Science Achievement Following Hands-On Science Activities Among Grade 7 Non-Reader Learners

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Abstract

Background and Aim: Science instruction frequently requires learners to decode scientific vocabulary, read explanations, follow written procedures, and interpret text-based assessment items. These requirements may create additional barriers for Grade 7 learners identified as non-readers. Text-reduced, hands-on activities may provide an alternative access route by allowing learners to encounter scientific phenomena through observation, manipulation, demonstration, oral interaction, and guided experimentation. This study examined changes in Science achievement following a hands-on Science intervention among Grade 7 non-reader learners in a Philippine secondary school.

Materials and Methods: The study employed a quantitative one-group pretest-posttest design. Forty-three Grade 7 learners identified by the participating school as non-readers participated through purposive sampling. The intervention consisted of 20 structured hands-on Science activities incorporating concrete materials, demonstrations, collaborative work, and visual or reduced-text instructions. Science achievement was measured using a 50-item Grade 7 Science Achievement Test administered before and after the intervention. Descriptive statistics were used to summarize achievement scores. A paired-samples t-test was used to examine the difference between pretest and posttest scores, and Cohen's dz was calculated as the standardized paired difference.

Results: The mean Science achievement score increased from 13.47 (SD = 3.65) at pretest to 30.30 (SD = 4.09) at posttest. The reported mean increase was 16.84 points, with a 95% confidence interval of [15.19, 18.49]. A paired-samples t-test indicated a statistically significant difference between pretest and posttest scores, $t(42) = 20.61$, $p < .001$. The standardized within-participant difference was Cohen's $dz = 3.14$.

Conclusion: The available achievement data indicate substantial improvement in Science test scores following the hands-on intervention. However, because the study employed a single-group pretest-posttest design without a comparison group, the observed improvement cannot be attributed exclusively to the intervention. In addition, the intervention combined hands-on activities with visual, oral, collaborative, and teacher-scaffolded strategies. The findings should therefore be interpreted as evidence of improvement following the intervention package rather than definitive causal evidence of intervention effectiveness.

Keywords: Hands-on Science, Grade 7, Non-reader Learners, Text-reduced Instruction, Science Achievement, Inclusive Science Education, Experiential Learning

Introduction

Science education requires learners to observe phenomena, develop explanations, evaluate evidence, and communicate their understanding (National Research Council, 2012). Yet classroom learning also depends on reading scientific vocabulary, instructions, explanations, and assessment questions. These demands can make it difficult for learners with limited decoding skills to demonstrate what they understand about science.

For learners identified by their school as non-readers, difficulty with written materials may limit access to a lesson even when they can engage with the scientific phenomenon itself. Research involving Philippine junior high school science teachers has documented challenges in teaching students described as non-decoders (Buagas & Cabrera, 2025). An accessible approach should therefore provide ways to encounter and explain scientific ideas while continuing to develop learners' literacy skills.

Structured hands-on activities offer one such approach. Learners can observe and manipulate materials, discuss what happens, and connect their observations to scientific explanations. Practical work is most useful when teachers help learners make these conceptual connections; similarly, a meta-analysis of inquiry-based science teaching highlights the importance of instructional guidance (Abrahams & Reiss, 2012; Furtak et al., 2012). Demonstrations, visual supports, oral explanations, and guided questions may also reduce reliance on independent reading during an activity. Experiential

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learning theory provides a rationale for linking concrete experience with reflection and conceptual understanding (Kolb, 2015).

This approach is relevant to Philippine Grade 7 science, where instruction must remain aligned with curriculum competencies while responding to learners' needs (Department of Education, 2023). A Philippine study has examined hands-on science activities among Grade 7 learners (Raymundo, 2023), and research has described teachers' experiences with junior high school students who are non-decoders (Buagas & Cabrera, 2025). These studies provide useful context, but neither establishes whether a structured, text-reduced hands-on intervention is associated with changes in science achievement among Grade 7 learners specifically identified as non-readers. The present study addresses that narrower question by comparing learners' science achievement before and after the intervention.

Objectives

The study aimed to examine changes in learning outcomes following text-reduced, hands-on Science activities among Grade 7 non-reader learners in a Philippine secondary school. Specifically, it sought to: (1) determine the learners' pretest and posttest Science achievement scores; and (2) determine whether a significant difference existed between the learners' pretest and posttest Science achievement scores.

Literature Review

Practical and Hands-On Science Learning

Practical science activities allow learners to observe phenomena, handle materials, test ideas, and discuss results. These experiences support conceptual learning when teachers make the purpose of an activity clear and help learners connect what they do with scientific explanations (Abrahams & Reiss, 2012). A meta-analysis of inquiry-based science teaching likewise found positive learning outcomes and identified the degree of teacher guidance as an important feature of instruction (Furtak et al., 2012). Thus, participation in an activity alone does not establish that learners have understood the underlying concept.

This distinction matters for learners with substantial reading difficulties. A practical task can remain inaccessible if learners must independently decode lengthy instructions, unfamiliar terms, or written recording sheets before they can participate. Demonstrations, brief oral instructions, visual cues, and guided discussion may reduce those initial demands while retaining observation, explanation, and the use of evidence as learning goals. This is a rationale for designing the present intervention; the cited studies do not establish that these adaptations are effective specifically for learners identified as non-readers.

Cognitive Demands, Reading Barriers, and Text-Reduced Instruction

Reading in science involves more than decoding individual words. Learners must interpret disciplinary vocabulary and representations, relate information across a text, and use what they read to reason about scientific ideas. Shanahan and Shanahan (2008) argue that these discipline-specific literacy practices require attention within secondary subject teaching. Learners who struggle to decode text may therefore face an access barrier before they can fully engage with a science task.

Text-reduced instruction addresses the way learners first encounter a concept; it does not remove reading and writing from science education. A teacher might introduce a phenomenon through materials, pictures, modeling, and oral discussion, then connect that experience to relevant terms and short written explanations. Mayer (2021) provides a basis for designing coordinated verbal and visual representations, although multimedia research should not be taken as direct evidence about this study's non-reader population. The instructional question is whether learners can access the scientific idea while receiving appropriate support to develop the language used to describe it.

Constructivist and Experiential Perspectives

The intervention assumes that learners can develop understanding by relating new observations to prior ideas and revising their explanations through guided activity. Experiential Learning Theory describes a cycle that connects concrete experience, reflection, conceptualization, and active

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experimentation (Kolb, 2015). In a science lesson, handling materials provides an experience, but questions about what happened and why are needed to help learners develop and apply an explanation.

Social interaction also has a role. Vygotsky's account of learning and development emphasizes the significance of interaction with others in the development of understanding (Vygotsky, 1978). For learners who cannot independently read extended instructions, teacher guidance and peer discussion may support participation in observation and explanation. These perspectives inform the design of the intervention; they do not, by themselves, demonstrate its effect on achievement.

Inclusive Science Education

Inclusive education calls for attention to barriers within the learning environment, including how content is presented and how learners can participate (UNESCO, 2020). In science, accessibility may depend on the wording of instructions, the use of visual and concrete materials, opportunities for discussion, and the form of assessment. Tomlinson (2021) similarly emphasizes planning instruction in response to differences among learners, while Wade et al. (2023) describe the planning needed for participation in inclusive STEAM activities.

For learners identified as non-readers, inclusion therefore extends beyond shortening a worksheet. Teachers must consider whether learners can understand the task, handle materials safely, share observations, and demonstrate scientific understanding. At the same time, adaptations should preserve the intended science competencies and provide opportunities to develop relevant vocabulary.

Hands-On Science in the Philippine Context

The Philippine MATATAG science curriculum provides the competency context for Grade 7 instruction (Department of Education, 2023). Within Philippine research, Raymundo (2023) examined hands-on activities for Grade 7 science, and Buagas and Cabrera (2025) documented science teachers' experiences in teaching junior high school students described as non-decoders. A review by Laid and Adlaon (2025) also examined innovative science teaching strategies, including hands-on learning. These publications address related parts of the problem, but they involve different research questions and populations; their findings should not be treated as direct evidence that a text-reduced intervention improves achievement among the learners in the present study.

Research Gap

Existing work provides reasons to examine guided practical activities, accessible representations, and the reading demands of science lessons. The Philippine studies cited above also establish the relevance of hands-on teaching and the challenges associated with non-decoding learners. However, they leave a narrower question open: how does science achievement change among Grade 7 learners identified by their school as non-readers after they participate in a structured, text-reduced, multimodal hands-on intervention? The present study examines that question through pretest and posttest scores. Because it has no comparison group and combines several instructional supports, it can describe change following the intervention package but cannot isolate the effect of hands-on activity or establish causation.

Conceptual Framework

The study is anchored in Constructivist Learning Theory, Experiential Learning Theory, and Social Constructivism, which emphasize learning through direct experience, reflection, interaction, and scaffolding. These perspectives provide the basis for using text-reduced, hands-on Science activities to support Grade 7 learners identified as non-readers.

The framework views the learners' reading-related access barriers as the starting condition and the 20 structured hands-on Science activities as the intervention. The intervention package incorporated concrete materials, demonstrations, visual supports, oral explanations, teacher modeling, peer collaboration, guided questioning, observation, manipulation, and structured reflection. These components were implemented together and therefore are treated as a single instructional package rather than as independently tested interventions.

These strategies provide alternative ways of accessing scientific concepts while reducing unnecessary dependence on written text. The principal outcome is Science achievement, measured through pretest and posttest scores. The framework therefore proposes that structured, text-reduced,

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multimodal hands-on experiences may provide a more accessible pathway to Science learning while maintaining intended scientific competencies. The framework is interpretive rather than causal because the study did not include a comparison group.

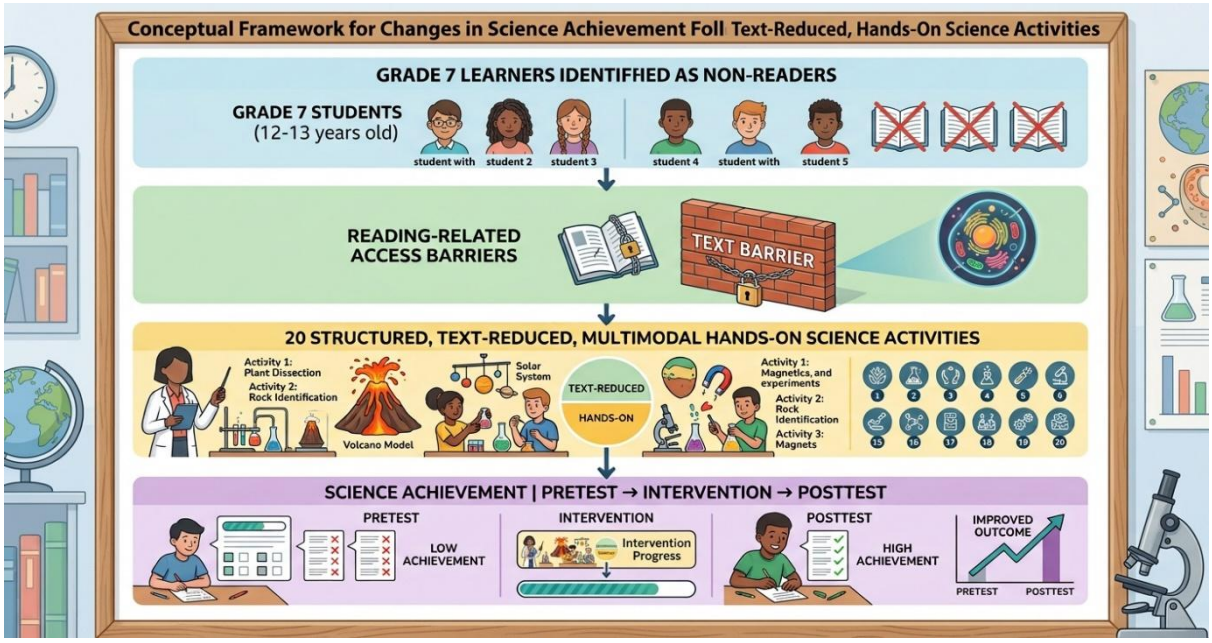


Figure 1. *Conceptual Framework of Changes in Science Achievement Following Text-Reduced, Hands-On Science Activities*

Methodology

Research Design

The study employed a quantitative one-group pretest-posttest design. The design examined changes in Science achievement before and after implementation of the hands-on Science intervention among the identified Grade 7 non-reader learners.

The design was used to determine whether a measurable within-participant change occurred between the two assessment points. Because the study did not include a control or comparison group, the findings are interpreted as changes observed following the intervention rather than definitive evidence of a causal effect. Factors such as maturation, history, testing effects, teacher attention, concurrent instruction, and regression toward the mean may also have contributed to the observed changes.

Research Participants

The participants were 43 Grade 7 learners from the participating Philippine secondary school during the study period. Purposive sampling was used because the study specifically targeted learners identified by the school as non-readers based on its established reading assessment and classification procedures.

Participants were required to be enrolled in Grade 7, identified as non-readers through the school's established procedures, regularly participating in science classes, and covered by parental or guardian consent and learner assent.

The use of the school's established classification procedure provides the operational basis for identifying the target population in this study. Demographic characteristics were not included because the present analysis focused on the paired Science achievement data.

Research Instrument

The primary instrument for measuring academic achievement was a 50-item Grade 7 Science Achievement Test administered before and after the intervention. The assessment was aligned with the intended Grade 7 Science competencies covered during the intervention. The same achievement

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instrument was administered at both measurement points. This allowed direct comparison of learners' scores but also introduced the possibility of testing or familiarity effects.

Accordingly, the observed change is interpreted cautiously. The supplied study record does not provide psychometric coefficients, item-analysis results, or detailed validation documentation. Therefore, no unsupported reliability or validity statistics are reported in this manuscript. If the researchers have original validation, pilot-testing, item-analysis, or reliability records, these should be reported in the final journal submission.

Intervention

The intervention consisted of 20 structured, text-reduced hands-on Science activities aligned with Grade 7 Science competencies. The activities incorporated concrete materials, teacher demonstrations, visual or picture-supported instructions, oral explanations, teacher modeling, peer-assisted learning, guided questioning, observation, manipulation, and structured reflection.

The intervention was designed to reduce unnecessary dependence on independent text decoding while maintaining the intended scientific concepts and learning competencies. The activities were not conceived as unrestricted physical tasks but as structured learning experiences supported by teacher guidance.

Importantly, the intervention represents a multicomponent instructional package. Because hands-on activities were implemented together with visual supports, oral instruction, teacher modeling, peer collaboration, guided questioning, and reflection, the design does not permit the independent contribution of the hands-on component to be isolated.

Data Gathering Procedure

Before data collection, permission was obtained from the appropriate school authorities. Parental or guardian consent and learner assent were secured before participation. The Science Achievement Test was administered as a pretest before implementation of the intervention. The 20 hands-on Science activities were then conducted using the planned text-reduced and scaffolded procedures. Following completion of the intervention, the same Science Achievement Test was administered as a posttest. The pretest and posttest scores were matched for the same 43 learners. Because the same achievement assessment was used at both measurement points, possible testing or familiarity effects were considered when interpreting the findings.

Data Analysis

Descriptive statistics were used to summarize the pretest and posttest Science achievement scores. The mean difference was calculated by subtracting the pretest score from the posttest score. A 95% confidence interval was calculated for the mean difference. Cohen's dz was used to describe the standardized magnitude of the paired difference, calculated from the mean paired difference and the standard deviation of the paired differences.

The relevant assumption for the paired-samples t-test concerns the distribution of the paired difference scores. Any assumption-testing statistic should be reported only if it was actually calculated from the study data.

Ethical Considerations

Before participation, parental or guardian consent and learner assent were secured. Permission was also obtained from the appropriate school authorities. Participation was voluntary, and procedures were conducted with attention to learner confidentiality and safety. If the study received formal institutional ethics approval, the actual approving body, approval date, and approval number should be reported here. No unsupported approval number is included.

Results

Pretest and Posttest Science Achievement

The academic performance of the 43 Grade 7 non-reader learners was examined using their paired Science pretest and posttest scores.

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Table 1. Pretest and Posttest Science Achievement of Grade 7 Non-Reader Learners

Measure	n	Mean	SD
Pretest	43	13.47	3.65
Posttest	43	30.30	4.09
Mean Difference	43	16.84	5.36

As presented in Table 1, the learners obtained a mean pretest score of 13.47 (SD = 3.65) and a mean posttest score of 30.30 (SD = 4.09). The mean paired difference was 16.84 points, indicating an increase in Science achievement between the two measurement points following implementation of the intervention package.

Paired Comparison of Science Achievement

Table 2 Paired-Samples t-Test of Pretest and Posttest Science Achievement

Comparison	Mean Difference	SD of Differences	95% CI	*t*	df	*p*	Cohen's *dz*
Posttest − Pretest	16.84	5.36	[15.19, 18.49]	20.61	42	< .001	**3.14**

The results showed a statistically significant difference between the learners' pretest and posttest Science achievement scores, t (42) = 20.61, p < .001. The 95% confidence interval indicated that the estimated mean improvement ranged from 15.19 to 18.49 points. The standardized within-participant difference was Cohen's dz = 3.14, indicating a substantial standardized difference between the two measurement points. This statistic describes the magnitude of the observed paired change and should not be interpreted as an unbiased estimate of the causal effect of the intervention because the study did not include a comparison group.

Discussion

Science achievement scores increased substantially among the 43 Grade 7 learners identified as non-readers after they participated in the structured, text-reduced hands-on intervention. The mean score rose from 13.47 (SD = 3.65) at pretest to 30.30 (SD = 4.09) at posttest, yielding a mean paired increase of 16.84 points, 95% CI [15.19, 18.49]. The difference was statistically significant, t (42) = 20.61, p < .001. Cohen's dz = 3.14 indicates a large standardized difference between the two measurements. These statistics describe the size and consistency of the observed change within the participating group; they do not establish how much of that change was caused by the intervention.

The findings are consistent with research emphasizing the value of purposeful practical work in science. Abrahams and Reiss (2012) argue that the educational benefit of practical activities depends on helping learners connect what they do and observe with the scientific ideas being taught. Similarly, Furtak et al. (2012) found positive outcomes across studies of inquiry-based science teaching and highlighted the importance of teacher guidance. In the present intervention, learners did more than handle materials: activities also included demonstrations, oral explanations, visual supports, guided questions, peer interaction, and reflection. These features may have helped learners attend to relevant observations and explain their meaning. This is a plausible interpretation of the results, although the study did not measure how each feature contributed to achievement.

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The participants' reading difficulties make the form of instruction particularly relevant. If a learner must decode lengthy directions before beginning an experiment, performance may reflect reading access as well as science understanding. The text-reduced activities offered other ways to encounter the content before relying on extended written explanations. Visual cues and demonstrations could clarify what to do; oral questioning and discussion could help learners describe observations and connect them to scientific terms. This interpretation aligns with the rationale for coordinating verbal and visual representations in instruction (Mayer, 2021). It also responds to challenges reported by Philippine science teachers working with junior high school students described as non-decoders (Buagas & Cabrera, 2025). Nevertheless, this study did not assess reading demands or learners' use of individual supports separately. It cannot determine whether reduced text, hands-on experience, or another part of the package was chiefly responsible for the score increase.

The results also add a specific perspective to Philippine research on hands-on Grade 7 science instruction. Raymundo (2023) reported improved performance following hands-on activities in a study that included experimental and control groups. The present study examined learners identified by their school as non-readers, a population for whom access to written instructions was an explicit design concern. The two studies therefore address related but distinct questions. Their results should not be treated as directly comparable estimates of intervention effectiveness because their participants, instructional approaches, assessments, and research designs differ.

Several alternative explanations remain possible. All participants received the intervention, so the design provides no estimate of how their scores might have changed through regular instruction over the same period. Concurrent teaching, greater teacher attention, maturation, and other events during the study may have contributed to improvement. The same 50-item achievement test was also used at pretest and posttest, creating a possibility that familiarity with the questions affected posttest scores. In addition, the intervention combined multiple supports, preventing attribution of the observed change to hands-on activity alone. The large value of Cohen's *dz* should therefore be understood as a standardized within-group change, rather than as proof of a large causal effect.

Taken together, the findings provide evidence of improved science test performance following a structured, text-reduced, multimodal intervention among these 43 learners. They support further examination of instruction that maintains Grade 7 science goals while making activities more accessible to learners with substantial reading difficulties. A future study using a comparison group, an alternative posttest form, and records of how the activities were implemented would help determine whether the gains exceed those expected from other influences and which instructional supports are most useful.

Knowledge Contribution

This study contributes contextual evidence concerning the use of structured, text-reduced hands-on Science activities among Grade 7 learners identified as non-readers. While previous research has examined practical Science learning among general student populations, the present study focuses on learners for whom independent reading may constitute an important barrier to accessing Science instruction. The principal contribution is the proposition that Science learning can maintain its disciplinary expectations while providing learners with multiple pathways for accessing scientific concepts. Concrete materials, demonstrations, visual representations, oral explanations, and guided interaction can supplement written text and provide learners with opportunities to encounter scientific phenomena directly.

The study therefore contributes preliminary contextual evidence concerning changes in science achievement among Grade 7 learners identified as non-readers following a structured, text-reduced, multimodal hands-on intervention package. The observed increase in Science achievement provides

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preliminary evidence that such an instructional approach can be associated with improved performance among the participating learners. However, the findings should not be interpreted as establishing that hands-on activities alone produced the improvement. Rather, they provide a basis for further investigation of text-reduced and multimodal Science instruction for learners with significant reading difficulties.

The study also contributes to the classroom application of Constructivist Learning Theory, Experiential Learning Theory, and Social Constructivism. The intervention provided opportunities for learners to interact with materials, experience scientific phenomena, discuss observations, receive scaffolding, and connect practical experiences with scientific concepts. These theoretical perspectives therefore provide useful frameworks for interpreting why multiple modes of representation and interaction may be relevant to Science instruction for non-reader learners, but they were not directly tested as explanatory mechanisms in this study. From a practical perspective, the study suggests that inclusive Science teaching can incorporate low-cost and accessible instructional resources rather than relying exclusively on text-heavy materials.

Teacher demonstrations, concrete materials, visual supports, oral questioning, peer collaboration, and structured reflection can be incorporated into regular Science lessons while maintaining curriculum-aligned learning objectives.

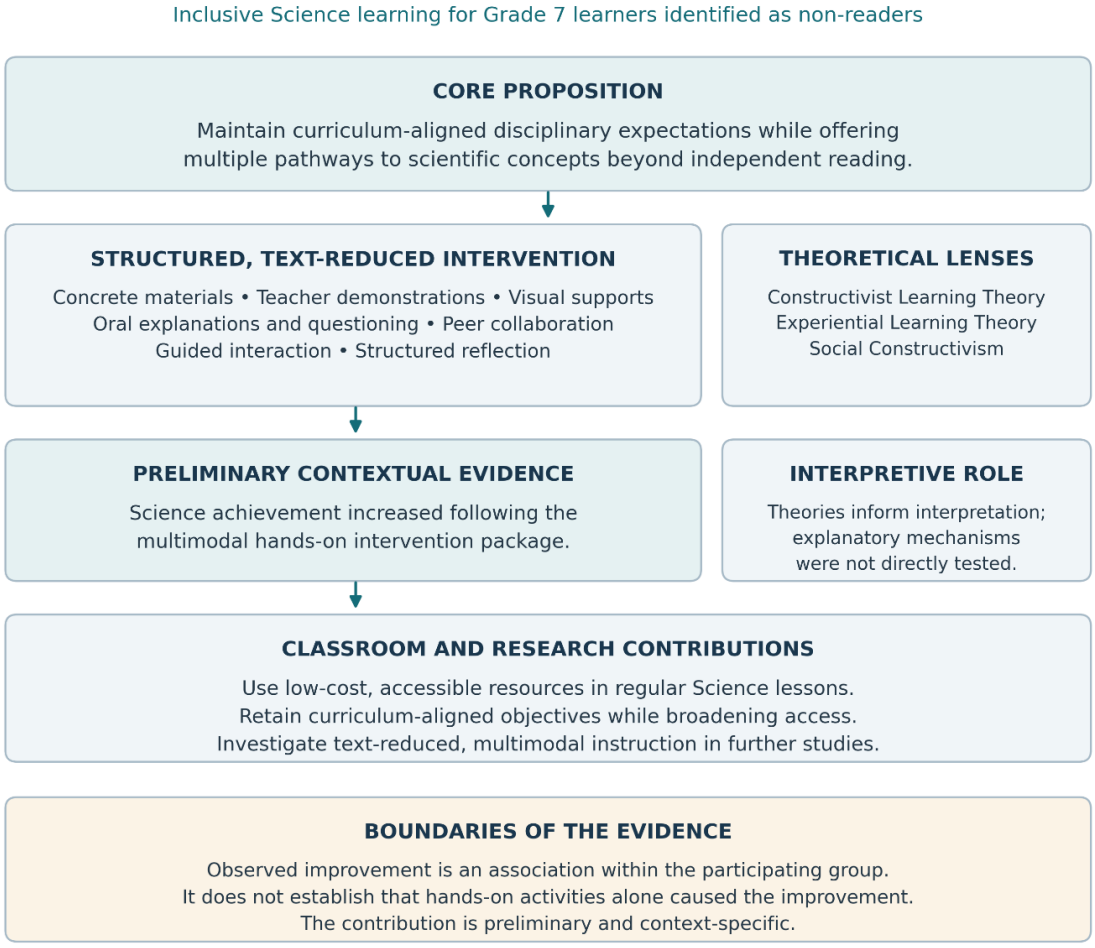


Figure 1. Knowledge contribution of structured, text-reduced, multimodal Science instruction for Grade 7 learners identified as non-readers

Limitations

Several limitations should be considered when interpreting the findings.

First, the one-group pretest-posttest design does not permit strong causal attribution because no comparison group was included. Consequently, maturation, history, concurrent instruction, teacher attention, regression toward the mean, and other factors cannot be ruled out.

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Second, the same 50-item achievement test was used at both measurement points. This creates a possibility of testing or familiarity effects that may have contributed to the observed increase.

Third, the intervention was a multicomponent instructional package involving hands-on activities, visual supports, oral instruction, teacher modeling, peer collaboration, guided questioning, and reflection. Therefore, the independent contribution of hands-on activities cannot be isolated.

Fourth, the supplied study record does not contain detailed session-by-session intervention information, a quantitative implementation-fidelity measure, or psychometric statistics for the achievement test. Consequently, unsupported reliability or validity coefficients have not been reported.

Fifth, the participants were drawn from one participating school and were purposively selected using the school's non-reader classification procedures. The findings should therefore not be generalized automatically to all Grade 7 learners with reading difficulties or to other educational settings.

Finally, the study examines achievement around the intervention period and does not establish whether the observed improvement was retained over time.

Conclusion

The study examined changes in Science achievement among 43 Grade 7 learners identified as non-readers following implementation of 20 structured, text-reduced hands-on Science activities. The learners' mean Science achievement increased from 13.47 (SD = 3.65) in the pretest to 30.30 (SD = 4.09) in the posttest. The mean improvement was 16.84 points, and the difference was statistically significant, $t(42) = 20.61$, $p < .001$, with a 95% confidence interval of [15.19, 18.49]. The standardized within-participant difference was Cohen's $d_z = 3.14$.

These findings indicate substantial improvement in science achievement between the two measurement points following implementation of the intervention package. The results provide preliminary contextual evidence that structured, text-reduced, multimodal hands-on Science instruction may provide additional pathways for learners experiencing substantial reading difficulties to access scientific concepts. Nevertheless, the study's design does not establish causality. The absence of a comparison group, the use of the same assessment at both measurement points, and the multicomponent nature of the intervention prevent attribution of the observed improvement to hands-on activities alone. Future research using comparison groups or controlled designs, parallel assessment forms, larger and more diverse samples, detailed intervention descriptions, and documented implementation fidelity would provide stronger evidence regarding the contribution of text-reduced hands-on Science instruction to learning outcomes among non-reader learners.

Recommendations

1. **For Science Teachers.** Science teachers may integrate hands-on and real-life learning activities into Science lessons, particularly when teaching learners who experience reading difficulties. Demonstrations, experiments, concrete materials, pictures, oral explanations, and structured group activities should be used to provide multiple ways for learners to participate and demonstrate their understanding.
2. **For School Leaders.** School administrators may provide teachers with appropriate science materials, simple laboratory tools, and professional development opportunities focused on hands-on instruction, inclusive education, and learner-centered teaching. Learning Action Cell sessions and in-service training may also be used to share effective strategies for supporting learners with reading difficulties.
3. **For Curriculum Developers and Education Leaders.** Curriculum developers and education leaders may support the development of picture-based instructional materials, contextualized activity sheets, and teacher guides that incorporate hands-on and text-reduced approaches consistent with the MATATAG Curriculum.
4. **For Future Researchers.** Future researchers may conduct studies involving larger samples and learners from multiple schools or districts. Comparison-group or controlled research designs are also recommended to provide stronger evidence regarding the effects of hands-on Science activities.

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Future studies may further examine learner motivation, confidence, engagement, retention of learning, and long-term academic outcomes.

5. **For Program and Material Developers.** Program and material developers may periodically review and improve the hands-on science activities based on teacher observations, learner feedback, and expert evaluation. Continuous refinement can help ensure that the activities remain accessible, practical, curriculum-aligned, and responsive to the learning needs of students with reading difficulties.

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