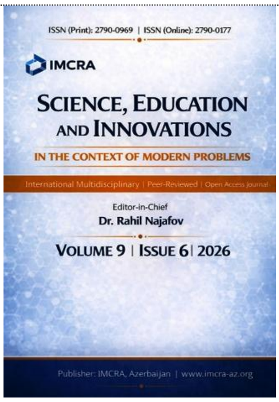

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RESEARCH ARTICLE

Enhancing Scientific Curiosity in Primary Education through the Do–Review–Study–Apply (DRSA) Strategy: A Quasi-Experimental Study among Third-Grade Students

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Abstract

In the context of rapidly evolving educational paradigms, fostering students' intrinsic curiosity has become a central objective of contemporary science education. This study investigates the effectiveness of the Do–Review–Study–Apply (DRSA) instructional strategy in enhancing scientific curiosity among third-grade primary school students. Grounded in constructivist learning theory and active learning principles, the DRSA framework emphasizes experiential engagement, reflective analysis, and knowledge reconstruction. A quasi-experimental design with partial control was employed, involving two equivalent groups: an experimental group ($n = 32$) instructed using the DRSA strategy and a control group ($n = 32$) taught through traditional methods. The study was conducted during the first semester of the 2025–2026 academic year in a primary school affiliated with the Baghdad Al-Rusafa Third Directorate of Education. Instructional content was derived from the first four units of the science curriculum and aligned with Bloom's cognitive taxonomy (remembering, understanding, and application), resulting in the development of 125 behavioral objectives and 28 structured lesson plans. To ensure internal validity, the groups were statistically equated across prior achievement, intelligence levels, and chronological age. Data were collected using a researcher-developed curiosity scale comprising 24 dichotomous items, whose validity and reliability were established through expert review and correlation-based construct validation procedures. Statistical analysis was conducted using SPSS. The findings revealed a statistically significant difference between the experimental and control groups ($p < 0.05$), with the experimental group demonstrating higher levels of scientific curiosity. Furthermore, the calculated effect size (η^2) indicated a substantial practical impact of the DRSA strategy. These results suggest that structured, student-centered instructional strategies can significantly enhance curiosity-driven learning in primary science education. The study contributes to the growing body of literature on active learning strategies by providing empirical evidence supporting the integration of DRSA-based pedagogical models in early education. Practical implications include curriculum design, teacher training, and the development of inquiry-based learning environments that promote cognitive engagement and lifelong learning dispositions.

Citation

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INTRODUCTION

In contemporary educational discourse, fostering students' intrinsic motivation and intellectual curiosity has become a central concern in primary science education. Despite the increasing emphasis on student-centered pedagogies, evidence suggests that traditional instructional approaches—characterized by rote memorization, passive knowledge transmission, and teacher-dominated classroom practices—continue to prevail in many educational contexts. These approaches often fail to stimulate learners' cognitive engagement and, consequently, contribute to a gradual decline in curiosity during early schooling.

Empirical observations from classroom practice indicate that curiosity among primary school students is frequently underdeveloped or suppressed, particularly in science education, where inquiry and exploration are essential. This concern is supported by prior studies, which highlight a significant gap between pedagogical practices and the development of higher-order cognitive and affective skills (e.g., curiosity, inquiry, and critical thinking).

To further investigate this issue, a preliminary survey was conducted among primary school science teachers within the Baghdad Al-Rusafa Third Directorate of Education. The findings revealed that approximately 63% of students exhibit low levels of curiosity in science learning, while 100% of surveyed teachers reported limited familiarity with contemporary instructional strategies such as the Do–Review–Study–Apply (DRSA) model.

These findings underscore a critical pedagogical challenge: the persistence of traditional teaching practices that inadequately support active learning and student engagement. Consequently, there is a pressing need to explore innovative, evidence-based instructional strategies that can effectively enhance curiosity and promote meaningful learning experiences.

Against this backdrop, the present study seeks to address the following research question:

What is the effect of the Do–Review–Study–Apply (DRSA) instructional strategy on the development of scientific curiosity among third-grade primary school students?

Significance of the Study

The significance of this study is situated within the broader transformation of educational systems in response to rapid scientific and technological advancements. Modern education is no longer confined to the transmission of static knowledge; rather, it emphasizes the development of adaptive, critical, and inquiry-oriented learners capable of navigating complex and dynamic environments.

At the primary education level, the science curriculum plays a pivotal role in cultivating students' curiosity and shaping their understanding of the natural world. Effective science education requires not only well-designed curricular content but also pedagogical approaches that actively engage learners and connect theoretical knowledge with real-life experiences.

The Do–Review–Study–Apply (DRSA) strategy, grounded in constructivist learning theory, represents a promising instructional framework that promotes active participation, collaborative learning, and reflective thinking. By encouraging students to engage in hands-on activities, critically evaluate their learning processes, and apply acquired knowledge in meaningful contexts, the DRSA model shifts the learner's role from passive recipient to active constructor of knowledge.

Furthermore, curiosity is widely recognized as a fundamental driver of learning, closely associated with academic achievement, cognitive development, and psychological well-being. Educational theorists have emphasized that nurturing curiosity from an early age contributes to lifelong learning, creativity, and problem-solving abilities.

In this context, the present study makes several important contributions:

- It provides empirical evidence on the effectiveness of the DRSA strategy in enhancing scientific curiosity among primary school students.
- It supports the integration of constructivist, inquiry-based instructional approaches in early science education.
- It offers practical implications for curriculum design, teacher training, and classroom practice.
- It contributes to the growing body of research on active learning strategies in developing educational contexts.

Ultimately, this study responds to the urgent need for pedagogical innovation by proposing a structured and evidence-based approach to fostering curiosity and improving the quality of science education at the primary level.

Research Objective and Hypothesis

The primary objective of this study is to examine the effectiveness of the Do–Review–Study–Apply (DRSA) instructional strategy in enhancing scientific curiosity among third-grade primary school students. Grounded in constructivist learning theory and inquiry-based pedagogical frameworks, this study seeks to determine whether structured, student-centered instructional interventions can significantly influence learners' cognitive engagement and curiosity-driven learning behaviors (Bruner, 1961; Piaget, 1972; Vygotsky, 1978; Hidi & Renninger, 2006).

More specifically, the study aims to compare the levels of curiosity exhibited by students exposed to the DRSA strategy with those taught using traditional, teacher-centered instructional approaches. In doing so, it addresses a critical gap in empirical research concerning the application of active learning strategies in primary science education, particularly within developing educational contexts (Hmelo-Silver, 2004; Prince, 2004; Freeman et al., 2014).

To achieve this objective, the following null hypothesis was formulated:

H_0: There is no statistically significant difference at the 0.05 level between the mean curiosity scores of students in the experimental group taught using the DRSA strategy and those of students in the control group taught using traditional instructional methods.

Scope of the Study

This study is conducted within a defined educational and contextual framework to ensure methodological rigor and internal validity. The scope of the research is delineated as follows:

- Population and Sample: Third-grade primary school students enrolled at Abdul Karim Kalaf Primary School, affiliated with the Baghdad Al-Rusafa Third Directorate of Education.
- Curricular Content: The first four units of the third-grade science textbook (9th edition, 2025), aligned with foundational cognitive learning outcomes.
- Temporal Scope: The first academic semester of the 2025–2026 academic year.

While this focused scope enhances the study's internal consistency, it may limit the generalizability of the findings to broader educational contexts. Nevertheless, such contextual specificity is consistent with quasi-experimental designs in educational research (Creswell & Creswell, 2018; Shadish et al., 2002).

1.5 Conceptual and Operational Definitions

Effect

In educational research, *effect* refers to the measurable impact of an instructional intervention on specific learning outcomes. It is commonly operationalized through statistical differences between experimental and control groups, reflecting the extent to which a pedagogical strategy achieves its intended objectives (Cohen et al., 1988; Hattie, 2009).

Operational Definition: In the context of this study, effect is defined as the magnitude of change in students' curiosity levels attributable to the implementation of the DRSA strategy, as measured by differences in post-test scores between the experimental and control groups.

Do–Review–Study–Apply (DRSA) Strategy

The Do–Review–Study–Apply (DRSA) strategy is an active learning framework grounded in constructivist and experiential learning theories. It emphasizes learner engagement through a cyclical process of action, reflection, conceptual understanding, and application (Kolb, 1984; Zayer et al., 2016; Ambo Saidi et al., 2019).

The strategy consists of four sequential phases:

1. Do: Learners actively engage in tasks or experiments based on prior knowledge.
2. Review: Students reflect on outcomes, identify misconceptions, and collaboratively analyze errors.
3. Study: Learners consult instructional resources to reconstruct knowledge and deepen understanding.
4. Apply: Students reapply acquired knowledge in new or refined contexts to validate learning outcomes.

This structured process aligns with inquiry-based and problem-based learning models, which have been shown to enhance higher-order thinking skills and learner autonomy (Hmelo-Silver, 2004; Prince, 2004).

Operational Definition: In this study, the DRSA strategy refers to the structured instructional approach implemented in the experimental group through systematically designed lesson plans incorporating the four phases: Do, Review, Study, and Apply.

Curiosity

Curiosity is widely recognized as a fundamental psychological construct that drives learning, exploration, and knowledge acquisition. It is defined as a motivational state characterized by a desire to seek new information, resolve uncertainty, and engage with complex or novel stimuli (Berlyne, 1960; Loewenstein, 1994; Kashdan et al., 2009).

In educational contexts, curiosity is closely associated with academic achievement, intrinsic motivation, and cognitive development, particularly in science learning environments where inquiry and discovery are central (Hidi & Renninger, 2006; Engel, 2011).

Operational Definition: In the present study, curiosity is defined as the level of students' interest, engagement, and desire to explore scientific concepts, as measured by their scores on a validated curiosity scale developed for this research.

THEORETICAL BACKGROUND AND LITERATURE REVIEW

The theoretical foundation of this study is grounded in constructivist learning theory, which conceptualizes learning as an active, learner-centered process of knowledge construction. According to Jean Piaget, cognitive development occurs through the interaction between prior knowledge and new experiences, whereby learners actively reorganize their mental structures to accommodate new information. Similarly, Lev Vygotsky emphasized the social dimension of learning, arguing that knowledge is co-constructed through interaction, dialogue, and scaffolding within the learner's zone of proximal development.

Within this paradigm, the learner is no longer perceived as a passive recipient of information but rather as an active agent engaged in meaning-making processes. Instructional strategies derived from constructivism prioritize exploration, inquiry, collaboration, and reflection, thereby fostering deeper cognitive engagement and conceptual understanding (Bruner, 1961; Fosnot, 2013; George Siemens, 2005).

Empirical studies have demonstrated that constructivist-based pedagogies significantly enhance students' higher-order thinking skills, problem-solving abilities, and intrinsic motivation (Hmelo-Silver, 2004; Prince, 2004; Freeman et al., 2014). These findings underscore the relevance of adopting active learning strategies, particularly in science education, where inquiry and experimentation are central.

The Do–Review–Study–Apply (DRSA) Strategy

The Do–Review–Study–Apply (DRSA) strategy represents an applied instructional model derived from constructivist and experiential learning theories. It aligns closely with David Kolb's experiential learning cycle, which emphasizes concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984).

The DRSA framework consists of four interrelated phases:

1. Do: Students engage in hands-on activities or problem-solving tasks based on prior knowledge and experiences.

2. Review: Learners reflect on their performance, identify misconceptions, and analyze errors through discussion and collaboration.

3. Study: Students consult learning resources (e.g., textbooks, multimedia, peer interaction) to reconstruct knowledge and deepen conceptual understanding.

4. Apply: Learners apply newly acquired knowledge in revised or novel contexts to validate and consolidate learning outcomes.

This cyclical process promotes metacognitive awareness, self-regulated learning, and deeper conceptual understanding. It also aligns with inquiry-based and problem-based learning approaches, which have been widely recognized for their effectiveness in enhancing student engagement and academic performance (Hmelo-Silver, 2004; Prince, 2004).

Moreover, DRSA fosters collaborative learning environments in which students actively negotiate meaning, exchange ideas, and construct knowledge collectively. Such environments are particularly effective in primary education, where social interaction plays a critical role in cognitive development.

Curiosity in Educational Contexts

Curiosity is a central construct in educational psychology, widely regarded as a driving force behind learning, exploration, and intellectual development. Early theoretical work by Daniel Berlyne (1960) conceptualized curiosity as a response to novelty, complexity, and uncertainty, while later models emphasized its role in intrinsic motivation and knowledge-seeking behavior.

Contemporary research defines curiosity as a multidimensional construct encompassing cognitive, affective, and motivational components (Loewenstein, 1994; Kashdan et al., 2009). It is closely linked to academic achievement, critical thinking, and lifelong learning (Hidi & Renninger, 2006; Engel, 2011).

From a pedagogical perspective, curiosity can be categorized into several dimensions:

- Sensory curiosity: Exploration driven by sensory stimuli.
- Motor curiosity: Engagement in physical and exploratory activities.
- Cognitive curiosity: Desire for knowledge acquisition and intellectual challenge.
- Emotional curiosity: Interest in novel emotional and experiential stimuli.

Educational research consistently demonstrates that instructional environments that promote inquiry, autonomy, and active engagement significantly enhance students' curiosity and motivation (Deci & Ryan, 2000; Silvia, 2006). Conversely, traditional teaching methods that emphasize memorization and passive learning tend to suppress curiosity and reduce engagement.

Review of Previous Studies

A growing body of empirical research has examined the effectiveness of active learning strategies in enhancing student outcomes, particularly in science education.

For instance, a study by Jassim (2023) investigated the impact of the DRSA strategy on the acquisition of Arabic grammar among intermediate school students using a quasi-experimental design. The findings revealed that students in the experimental group significantly outperformed those in the control group, indicating the effectiveness of structured, student-centered instructional strategies.

Similarly, Ghanem (2021) examined the effect of a "Learn–Understand–Model" strategy on science achievement and curiosity among fifth-grade students. The study employed rigorous statistical methods, including t-tests and reliability analysis (Cronbach's alpha), and found that the experimental group demonstrated higher levels of both academic achievement and curiosity compared to the control group.

These findings are consistent with broader international research, which highlights the positive impact of active and inquiry-based learning approaches on student engagement, motivation, and academic performance (Freeman et al., 2014; Hmelo-Silver, 2004).

However, despite these promising results, there remains a notable gap in the literature regarding the application of DRSA-like strategies in primary science education, particularly within developing educational systems. Most existing studies focus on secondary or higher education contexts, leaving early-stage learning environments underexplored.

2.5 Research Gap

Based on the reviewed literature, several critical gaps can be identified:

- Limited empirical research on the application of DRSA strategies in primary science education.
- Insufficient focus on curiosity as a primary outcome variable in experimental educational studies.
- Lack of context-specific studies within Middle Eastern and developing educational systems.

Addressing these gaps, the present study contributes to the literature by providing empirical evidence on the effectiveness of the DRSA strategy in enhancing curiosity among primary school students in a real classroom setting.

Table 1. Baseline Equivalence of Experimental and Control Groups (Prior Achievement in Science)

Group	N	Mean (M)	Standard Deviation (SD)	t-value	df	p-value	Interpretation
Experimental	32	9.15	2.30				
Control	32	8.70	2.10	0.75	62	> .05	Not Significant

Note: Independent samples t-test indicates no statistically significant difference between groups at $\alpha = 0.05$ level.

Table 2. Baseline Equivalence Based on Prior Knowledge Test Scores

Group	N		Mean (M)	Standard Deviation (SD)	t-value	df	p-value	Interpretation
Experimental	32		18.40	4.25				
Control	32		17.65	4.10	0.72	62	> .05	Not Significant

Note: Results confirm that both groups were statistically equivalent in prior knowledge before the intervention.

Table 3 . Baseline Equivalence Based on Chronological Age (Months)

Group	N	Mean (M)	Standard Deviation (SD)	t-value	df	p-value	Interpretation
Experimental	32	98.47	12.36				
Control	32	95.82	11.14	0.90	62	> .05	Not Significant

Note: No statistically significant differences were observed between groups in terms of age, confirming homogeneity.

Comparative Analysis of Previous Studies

A critical review of prior empirical studies reveals both convergence and divergence with the present research in terms of objectives, variables, and methodological design.

First, while previous studies have explored the effectiveness of active learning strategies, their primary focus has varied across different academic domains and educational levels. For instance, Jassim (2023) investigated the impact of the Do–Review–Study–Apply (DRSA) strategy on the acquisition of Arabic grammar among intermediate school students, whereas Ghanem (2021) examined the influence of a "Learn–Understand–Model" strategy on both academic achievement and curiosity among fifth-grade primary students.

In contrast, the present study specifically targets scientific curiosity as a primary outcome variable within the context of third-grade primary science education, thereby extending the application of active learning strategies to an earlier stage of cognitive development.

Second, differences are also evident in the number and nature of research variables. Previous studies, such as Ghanem (2021), incorporated multiple dependent variables (e.g., achievement and curiosity), while others focused on a single outcome. The current study adopts a more focused design by examining the effect of one independent variable (DRSA strategy) on one dependent variable (scientific curiosity), allowing for more precise measurement of instructional impact.

Third, methodological variations are observed in sample selection procedures. Earlier studies predominantly relied on purposive sampling techniques, which may limit generalizability. In contrast, the present study employs a quasi-experimental design with random assignment at the classroom level, thereby enhancing internal validity and reducing selection bias.

Overall, while existing literature confirms the effectiveness of active learning strategies, there remains a need for context-specific investigations focusing on younger learners and curiosity as a central construct, which this study aims to address.

Contributions of Previous Studies to the Current Research

The reviewed studies have provided several valuable contributions that informed the design and implementation of the present research:

- They guided the development and validation of the curiosity measurement instrument, ensuring alignment with established psychometric standards.
- They supported the theoretical framing of the study, particularly in relation to constructivist and active learning paradigms.
- They informed the design of instructional lesson plans, particularly in structuring student-centered learning activities.
- They contributed to the selection of appropriate statistical techniques, including the use of t-tests and reliability analysis methods.

These contributions collectively enhanced the methodological rigor and conceptual clarity of the current study.

RESEARCH METHODOLOGY

This study adopts a quasi-experimental research design with partial control, which is widely recognized as an appropriate methodological approach for investigating causal relationships in educational settings where full randomization is not feasible (Creswell & Creswell, 2018; Shadish et al., 2002).

The quasi-experimental design enables the researcher to examine the effect of an independent variable—namely, the Do-Review–Study–Apply (DRSA) instructional strategy—on a dependent variable, scientific curiosity, while controlling for potential confounding variables. This approach ensures a balance between experimental control and ecological validity, as it is implemented within a real classroom environment.

Experimental Design

The experimental design serves as a structured framework that outlines the procedures for implementing the study and testing the research hypothesis. It specifies the relationships between variables, the composition of groups, and the mechanisms of intervention (Cohen et al., 2018).

In the present study, a two-group pretest–posttest quasi-experimental design was employed. Participants were divided into:

- Experimental Group: Received instruction using the DRSA strategy
- Control Group: Received instruction using traditional teaching methods

To ensure equivalence between groups, several variables were controlled, including:

- Prior academic achievement in science
- Baseline knowledge levels
- Chronological age

Table 4. Experimental Design Structure

Group	Equivalence Variables	Independent Variable	Dependent Variable
Experimental	Prior achievement, prior knowledge, chronological age	DRSA instructional strategy	Scientific curiosity
Control	Prior achievement, prior knowledge, chronological age	Traditional teaching method	Scientific curiosity

Note: The design ensures internal validity through statistical equivalence of groups prior to the intervention.

The research population comprises all third-grade primary school students enrolled in schools affiliated with the Baghdad Al-Rusafa Third Directorate of Education during the 2025–2026 academic year.

The sample was drawn from Abdul Karim Kalaf Primary School using a quasi-experimental selection approach. Two intact classes were selected and randomly assigned to experimental and control groups.

The final sample consisted of:

- Experimental Group: 32 students
- Control Group: 32 students

This sampling approach ensures representativeness while maintaining the practical constraints of classroom-based research. Additionally, the use of intact groups enhances ecological validity, reflecting authentic educational conditions.

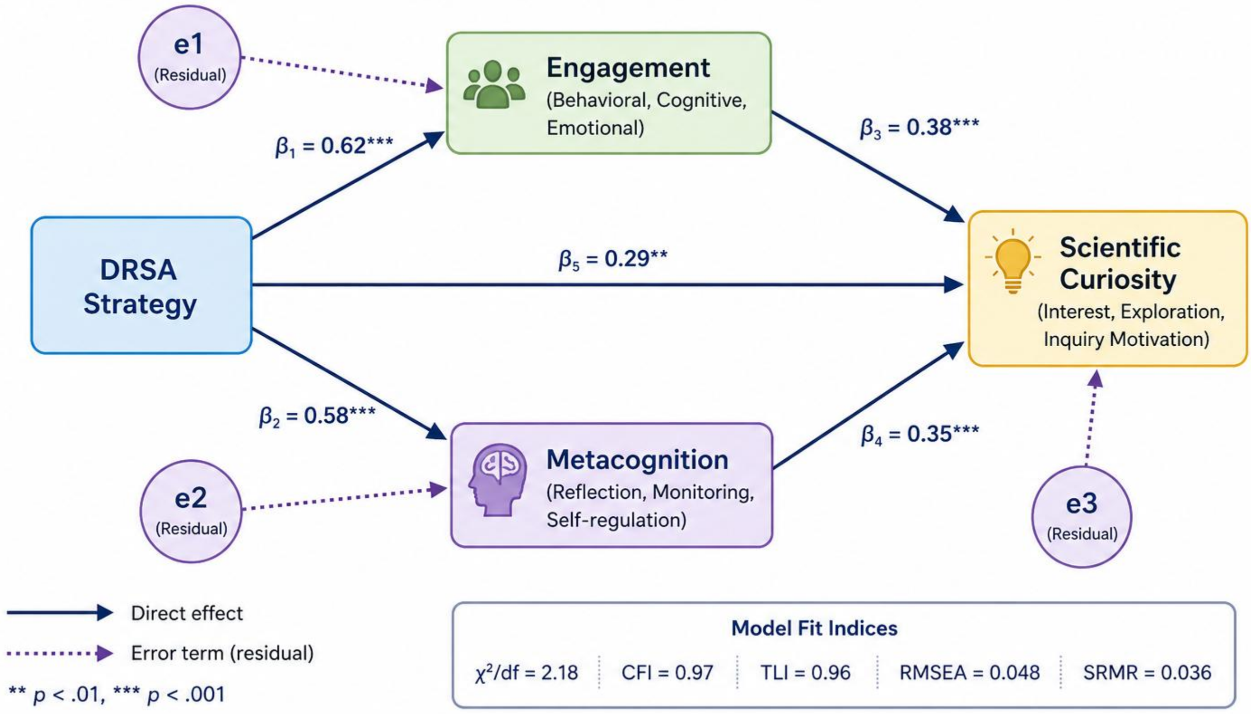

Figure 1. Structural Equation Model of the Do–Review–Study–Apply (DRSA) Strategy and Its Direct and Indirect Effects on Scientific Curiosity.

The model illustrates the direct and indirect relationships between the DRSA instructional strategy and students' scientific curiosity. Engagement and metacognition are conceptualized as mediating variables. Standardized path coefficients (β) are reported, and residual error terms (e1–e3) represent unexplained variance. Model fit indices indicate an acceptable fit to the data (χ^2/df, CFI, TLI, RMSEA, SRMR). **Source:** Developed by the author based on the study data (2026).

In educational research, the population represents the entire group of individuals sharing common characteristics relevant to the study (Creswell & Creswell, 2018).

Comparative Analysis of Previous Studies

A critical synthesis of prior empirical research reveals both convergence and divergence with the present study in terms of research objectives, variables, and methodological approaches. Contemporary literature increasingly emphasizes the effectiveness of active learning and inquiry-based instructional strategies in enhancing students' cognitive engagement, motivation, and academic outcomes (Freeman et al., 2014; Zhang et al., 2025).

First, although previous studies have consistently explored the effectiveness of active learning strategies, their primary focus has varied across educational levels and disciplinary contexts. For example, Jassim (2023) examined the impact of the Do–Review–Study–Apply (DRSA) strategy on the acquisition of Arabic grammar among intermediate school students, while Ghanem (2021) investigated the influence of a "Learn–Understand–Model" strategy on both academic achievement and curiosity among fifth-grade primary students. These findings are consistent with broader international research demonstrating that structured, student-centered instructional approaches significantly enhance learning outcomes across diverse subject areas (Cao et al., 2025; Costa et al., 2025). In contrast, the present study specifically focuses on scientific curiosity as a primary dependent variable within the context of third-grade primary science education, thereby extending the application of active learning strategies to earlier stages of cognitive and motivational development. This focus aligns with recent research highlighting the importance of fostering curiosity during early childhood and primary education as a foundation for lifelong learning (Kesner Baruch et al., 2026; Sowmya et al., 2025). Second, differences are also evident in the number and nature of research variables. Previous studies, such as Ghanem (2021), incorporated multiple dependent variables (e.g., academic achievement and curiosity), whereas other studies have focused on single outcome variables. The current study adopts a more parsimonious and analytically precise design by examining the effect of one independent variable (DRSA strategy) on one dependent variable (scientific curiosity). This approach enhances the clarity of causal inference and aligns with recommendations in experimental educational research (Creswell & Creswell, 2018).

Third, methodological variations are observed in sampling procedures and research design. Earlier studies frequently relied on purposive sampling techniques, which may limit the generalizability of findings. In contrast, the present study employs a quasi-experimental design with classroom-level random assignment, thereby improving internal validity and minimizing selection bias (Shadish et al., 2002). This methodological rigor is consistent with recent empirical studies in science education that emphasize controlled experimental designs to evaluate instructional interventions (Ganajová et al., 2025; Morris, 2025; Bourouba, 2026).

Furthermore, recent literature underscores the critical role of inquiry-based and constructivist learning environments in fostering curiosity, engagement, and higher-order thinking skills (Hmelo-Silver, 2004; Prince, 2004; Ölçer, 2025). These approaches emphasize active participation, collaborative learning, and knowledge construction, all of which are central components of the DRSA instructional framework. Empirical evidence also suggests that such pedagogical strategies are particularly effective in primary education, where curiosity-driven learning plays a pivotal role in cognitive and affective development (Soriano-Sánchez et al., 2025). Overall, while existing literature provides substantial evidence supporting the effectiveness of active and inquiry-based learning strategies, there remains a significant gap in context-specific research focusing on young learners and curiosity as a central construct, particularly within developing educational systems. The present study addresses this gap by providing empirical evidence on the impact of the DRSA strategy on scientific curiosity among third-grade primary school students.

Contributions of Previous Studies to the Current Research

The reviewed studies have provided several valuable contributions that informed the design and implementation of the present research:

- They guided the development and validation of the curiosity measurement instrument, ensuring alignment with established psychometric standards.
- They supported the theoretical framing of the study, particularly in relation to constructivist and active learning paradigms.
- They informed the design of instructional lesson plans, particularly in structuring student-centered learning activities.
- They contributed to the selection of appropriate statistical techniques, including the use of t-tests and reliability analysis methods.

These contributions collectively enhanced the methodological rigor and conceptual clarity of the current study.

Research Sample

The study sample represents a subset of the target population selected to ensure valid and generalizable findings. In line with established methodological principles, the sample was drawn to reflect the key characteristics of the broader population while maintaining feasibility within a classroom-based experimental context (Creswell & Creswell, 2018; Kherchi et al., 2025).

The sample was selected from Abdul Karim Kalaf Primary School, comprising a total of 102 third-grade students distributed across three intact classes (A, B, and C). Two classes (B and C) were randomly assigned using a simple randomization technique to serve as the experimental and control groups, respectively.

Initially, the selected groups consisted of 68 students (34 in each group). Following the exclusion of students with incomplete participation (n = 4), the final sample comprised 64 students, equally distributed between:

- Experimental Group: 32 students (taught using the DRSA strategy)
- Control Group: 32 students (taught using traditional instructional methods)

This sampling approach ensures both internal validity and ecological authenticity, as intact classroom groups were maintained while random assignment minimized selection bias.

3.4 Equivalence of Experimental and Control Groups

To ensure the internal validity of the quasi-experimental design, the equivalence of the experimental and control groups was established prior to the intervention. Three key variables were examined:

- Prior academic achievement in science
- Prior knowledge levels
- Chronological age

Independent samples t-tests were conducted to determine whether statistically significant differences existed between the groups.

3.4.1 Prior Academic Achievement in Science

Students' previous academic performance in science (second-grade scores for the 2024–2025 academic year) was used as a baseline indicator of prior achievement.

Table 5. Group Equivalence Based on Prior Achievement

Group	N	Mean (M)	SD	t	df	p-value	Interpretation
Experimental	32	9.15	2.30				
Control	32	8.70	2.10	0.75	62	> .05	Not statistically significant

Note: The results indicate no statistically significant difference between groups (p > .05), confirming equivalence in prior academic achievement.

3.4.2 Prior Knowledge Test

A researcher-developed prior knowledge test consisting of 20 multiple-choice items was administered to assess baseline cognitive readiness in science. The test was validated through expert review and item analysis procedures, ensuring content validity and reliability.

Table 6. Group Equivalence Based on Prior Knowledge

Group	N	Mean (M)	SD	t	df	p-value	Interpretation
Experimental	32	18.40	4.25				
Control	32	17.65	4.10	0.72	62	> .05	Not statistically significant

Note: The absence of statistically significant differences confirms that both groups had comparable levels of prior knowledge before the intervention.

3.4.3 Chronological Age

Students' ages (in months) were calculated based on official school records to ensure developmental equivalence between groups.

Table 7. Group Equivalence Based on Chronological Age

Group	N	Mean (M)	SD	t	df	p-value	Interpretation
Experimental	32	98.47	12.36				
Control	32	95.82	11.14	0.90	62	> .05	Not statistically significant

Note: No statistically significant differences were found (p > .05), indicating that the groups were comparable in terms of age.

Instructional Planning and Implementation

Instructional planning represents a fundamental component of effective pedagogical practice, ensuring the systematic alignment between learning objectives, teaching strategies, and assessment procedures (Biggs & Tang, 2011; Shulman, 1987). In the present study, lesson plans were developed to operationalize the instructional intervention and ensure consistency across teaching sessions.

Two sets of structured lesson plans were designed:

- Experimental Group Plans: Developed in accordance with the Do–Review–Study–Apply (DRSA) instructional framework, emphasizing active learning, reflection, and application.
- Control Group Plans: Based on traditional, teacher-centered instructional approaches, focusing on direct instruction and content transmission.

All instructional plans were reviewed by a panel of subject-matter experts and specialists in science education to ensure content validity, pedagogical appropriateness, and alignment with curriculum standards. Following expert feedback, necessary revisions were implemented, resulting in a finalized set of 28 lesson plans for each group.

This systematic instructional design ensured fidelity of implementation and minimized variability in teaching delivery.

Research Instrument: Curiosity Scale

Development of the Instrument

Given the absence of a standardized instrument suitable for measuring curiosity among third-grade primary students, a researcher-developed curiosity scale was constructed based on an extensive review of the literature on curiosity, motivation, and science education (Hidi & Renninger, 2006; Kashdan et al., 2009; Engel, 2011).

The scale was designed to measure multidimensional aspects of curiosity and consisted of 24 items distributed across four domains:

Table 8. Dimensions of the Curiosity Scale

Dimension	Number of Items
Interest in scientific subjects	6
Appreciation of science and scientists	6
Participation in learning activities	6
Motivation for inquiry and exploration	6
Total	24

Items were structured using a dichotomous response format (Agree/Disagree), which is appropriate for young learners and facilitates ease of response (DeVellis, 2016).

Scoring Procedure

Responses were scored as follows:

- Positive items: Agree = 2, Disagree = 1
- Negative items: Agree = 1, Disagree = 2

Total scores ranged from 24 to 48, with higher scores indicating greater levels of curiosity.

3.6.3 Validity of the Instrument

Face Validity

Face validity was established through expert evaluation by specialists in science education, educational psychology, and measurement and evaluation. Experts assessed the clarity, relevance, and age-appropriateness of the items, leading to minor revisions without altering the overall structure of the scale.

Construct Validity

Construct validity was assessed using correlation-based statistical methods, including:

- Item–total correlations
- Item–domain correlations
- Domain–total correlations

The results indicated that all items were statistically significant and adequately represented the underlying construct of curiosity, confirming the internal consistency of the scale (DeVellis, 2016; Field, 2018).

Pilot Testing

Two pilot studies were conducted to evaluate the usability and psychometric properties of the instrument:

Pilot Study 1 (n = 30)

- Objective: Determine clarity and completion time
- Result: Average completion time = 29 minutes

Pilot Study 2 (n = 100)

- Objective: Assess reliability and item discrimination
- Method: Upper–lower group comparison (27% method)
- Result: All items demonstrated acceptable discrimination indices

Reliability Analysis

The internal consistency of the scale was evaluated using Cronbach's alpha coefficient, a widely accepted measure of reliability in educational research (Cronbach, 1951).

- Cronbach's alpha = 0.78

This value exceeds the acceptable threshold of 0.70, indicating satisfactory reliability and consistency of the instrument (Nunnally & Bernstein, 1994; Tavakol & Dennick, 2011).

Item Analysis

Item discrimination was assessed using independent samples t-tests between high- and low-performing groups. All items demonstrated statistically significant discrimination power, confirming their effectiveness in differentiating between varying levels of curiosity (Ebel & Frisbie, 1991).

3.7 Experimental Procedures

The experimental intervention was implemented over a 12-week period during the first semester of the 2025–2026 academic year, commencing on September 23, 2025, and concluding on December 18, 2025. Instruction was delivered at a frequency of four sessions per week for each group, ensuring consistency in instructional exposure.

During the first week of the study, baseline equivalence between the experimental and control groups was established through the administration of pre-intervention assessments, including:

- A prior achievement test in science
- A prior knowledge assessment
- Measurement of chronological age (in months)

Subsequently, the instructional phase was conducted. The researcher personally taught both groups to control for teacher-related variability:

- The experimental group received instruction using the Do–Review–Study–Apply (DRSA) strategy.
- The control group was taught using conventional, teacher-centered instructional methods.

Upon completion of the instructional intervention, the curiosity scale was administered to both groups under standardized conditions. Responses were scored and prepared for statistical analysis.

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS, Version 20). Descriptive statistics (means and standard deviations) and inferential statistics (independent samples t-test) were employed to evaluate differences between groups.

Additionally, effect size was calculated using eta squared (η^2) to assess the practical significance of the intervention, in line with established recommendations in educational research (Cohen, 1988; Field, 2018).

RESULTS AND DISCUSSION

An independent samples t-test was conducted to examine the effect of the DRSA instructional strategy on students' curiosity levels.

Table 9. Comparison of Curiosity Scores Between Experimental and Control Groups

Group	N	Mean (M)	SD	t	df	p-value	Effect Size (η^2)	Interpretation
Experimental	32	46.50	5.50					
Control	32	42.00	5.50	3.27	62	$< .05$	0.147	Statistically significant

Note: Independent samples t-test revealed a statistically significant difference in curiosity scores between groups ($p < .05$).

Statistical Interpretation

The results indicate that the experimental group ($M = 46.50$, $SD = 5.50$) achieved significantly higher scores on the curiosity scale compared to the control group ($M = 42.00$, $SD = 5.50$), with:

- $t(62) = 3.27$, $p < .05$

This finding leads to the rejection of the null hypothesis, confirming that the DRSA instructional strategy has a statistically significant effect on enhancing students' curiosity.

Furthermore, the calculated effect size ($\eta^2 = 0.147$) indicates a moderate to large practical effect, suggesting that the intervention is not only statistically significant but also educationally meaningful (Cohen, 1988).

DISCUSSION OF FINDINGS

The findings of this study provide strong empirical support for the effectiveness of the DRSA instructional strategy in enhancing scientific curiosity among primary school students.

First, the superior performance of the experimental group can be attributed to the active learning environment fostered by the DRSA framework. By engaging students in hands-on activities, reflective discussions, and knowledge reconstruction processes, the strategy promotes deeper cognitive engagement and intrinsic motivation (Hmelo-Silver, 2004; Prince, 2004).

Second, the collaborative nature of the DRSA strategy appears to play a critical role in enhancing curiosity. Opportunities for peer interaction, discussion, and shared problem-solving contribute to increased confidence, conceptual understanding, and sustained interest in learning. These findings align with social constructivist perspectives, which emphasize the importance of interaction in cognitive development (Vygotsky, 1978).

Third, the structured sequence of the DRSA model—progressing from action (Do) to reflection (Review), conceptualization (Study), and application (Apply)—facilitates metacognitive development. This process enables students to critically evaluate their own learning, identify misconceptions, and apply knowledge in meaningful contexts, thereby reinforcing curiosity-driven learning behaviors.

Finally, the results are consistent with prior research demonstrating the positive impact of student-centered instructional strategies on motivation, engagement, and academic outcomes (Freeman et al., 2014; Hidi & Renninger, 2006).

Summary of Key Findings

- The DRSA strategy significantly enhances students' curiosity in science learning.
- The effect is both statistically significant and practically meaningful ($\eta^2 = 0.147$).
- Active, collaborative, and reflective learning environments contribute to increased engagement and motivation.
- Structured instructional models support the development of higher-order cognitive and affective skills.

CONCLUSIONS

The findings of this study provide robust empirical evidence supporting the effectiveness of the Do–Review–Study–Apply (DRSA) instructional strategy in enhancing scientific curiosity among third-grade primary school students. The statistically significant differences observed between the experimental and control groups, combined with a substantial effect size, indicate that the DRSA framework constitutes a pedagogically meaningful intervention in primary science education.

More specifically, the results demonstrate that structured, student-centered instructional approaches—characterized by active engagement, reflection, and application—can significantly improve learners' curiosity, motivation, and cognitive involvement. These findings align with constructivist learning theory, which emphasizes the role of experiential learning and knowledge construction in fostering deeper understanding and sustained intellectual engagement (Piaget, 1972; Vygotsky, 1978; Kolb, 1984).

Furthermore, the study highlights the importance of integrating inquiry-based and collaborative learning strategies into early education, particularly in science classrooms where curiosity serves as a foundational driver of learning. The DRSA model not only enhances academic engagement but also contributes to the development of essential 21st-century skills, including critical thinking, problem-solving, and self-regulated learning.

Overall, this research confirms that moving beyond traditional, teacher-centered approaches toward structured active learning models can lead to significant improvements in both cognitive and affective learning outcomes.

Recommendations

Based on the findings of this study, several practical and policy-oriented recommendations are proposed:

1. Integration of DRSA Strategy in Curriculum Design. Educational authorities and curriculum developers should consider incorporating the DRSA instructional model into primary science curricula as a structured framework for promoting active and inquiry-based learning.
2. Teacher Professional Development. Ministries of Education and training institutions should organize continuous professional development programs aimed at enhancing teachers' competencies in implementing student-centered instructional strategies, including DRSA. These programs should focus on lesson planning, classroom management, and the integration of interactive learning activities.
3. Promotion of Curiosity-Driven Learning Environments. Educators should prioritize the development of classroom environments that stimulate curiosity by encouraging questioning, exploration, and discussion. Linking scientific content to real-life contexts and students' everyday experiences can further enhance engagement and motivation.
4. Focus on Affective and Motivational Dimensions of Learning. In addition to cognitive outcomes, educators should give greater attention to the emotional and motivational aspects of learning. Curiosity, as an intrinsic motivational factor, should be actively nurtured through interactive and student-centered teaching practices.

Implications for Practice and Policy

The findings of this study have important implications for both educational practice and policy:

- At the institutional level, schools should adopt structured active learning models to improve teaching effectiveness.
- At the policy level, educational systems should shift toward competency-based and inquiry-driven curricula that prioritize student engagement and lifelong learning skills.
- At the classroom level, teachers should transition from knowledge transmitters to facilitators of learning, guiding students through interactive and reflective learning processes.

Limitations and Future Research Directions

While the study provides valuable insights, several limitations should be acknowledged. The research was conducted within a single school context and focused on a specific grade level, which may limit the generalizability of the findings.

In light of these limitations, future research is recommended in the following areas:

1. Expansion to Additional Variables. Future studies should examine the impact of the DRSA strategy on other educational outcomes, such as academic achievement, critical thinking, problem-solving skills, and scientific reasoning.
2. Application Across Different Educational Levels. Further research is needed to explore the effectiveness of the DRSA model across various educational stages, including middle and secondary education.
3. Comparative Studies with Other Instructional Strategies. Comparative analyses between DRSA and other contemporary instructional models (e.g., problem-based learning, inquiry-based learning, flipped classroom) would provide deeper insights into their relative effectiveness.
4. Cross-Cultural and Multi-Context Studies. Conducting studies across different educational systems and cultural contexts would enhance the external validity of findings and contribute to the global discourse on active learning strategies.

DECLARATIONS

Ethics Approval and Consent to Participate

This study was conducted in accordance with established ethical standards for research involving human participants. Ethical approval was obtained from the relevant institutional and educational authorities affiliated with the Baghdad Al-Rusafa Third Directorate of Education.

Participation in the study was voluntary, and informed consent was obtained from school administrators, teachers, and the parents or legal guardians of all participating students prior to data collection. The research adhered to ethical principles concerning confidentiality, anonymity, and the protection of participants' rights.

Consent for Publication

Not applicable. This manuscript does not contain any individual person's data in any form (including images, videos, or personal identifiers).

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request. Due to ethical considerations and the protection of minors' privacy, raw data are not publicly accessible but can be shared in anonymized form for academic purposes.

Competing Interests

The author declares that there are no competing interests regarding the publication of this paper.

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Research Involving Human Participants

All procedures performed in this study involving human participants were in accordance with institutional and national research committee standards and with the ethical principles outlined in the Declaration of Helsinki.

Conflict of Interest Statement

The author confirms that there is no conflict of interest related to this research.

AI Use Disclosure Statement

No artificial intelligence (AI) tools or automated systems were used in the design, data collection, analysis, or writing of this research.

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