



EFFECT OF METACOGNITIVE INSTRUCTIONAL STRATEGY ON MALE AND FEMALE STUDENTS' INTEREST IN SCIENCE IN CALABAR EDUCATION ZONE OF CROSS RIVER STATE, NIGERIA

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Abstract

This study investigated the effect of metacognitive instructional strategy on male and female students' interest in science in Calabar Education Zone of Cross River State, Nigeria. A quasi-experimental research design employing a pretest - posttest non-equivalent control group design was adopted. The population comprised 3,196 SSII science students and 55 science teachers across 117 public secondary schools, while the sample consisted of 387 SSII science students, 37 science teachers, and 14 public secondary schools selected using multistage sampling techniques. Data were collected using a Science Interest Inventory (SII). Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was employed to test the null hypotheses at the 0.05 level of significance, with pretest scores used as covariates. The findings revealed that metacognitive instructional strategy significantly improved students' interest in science compared with the conventional teaching method. The results also showed no significant difference between male and female students' interest in science when taught using metacognitive instructional strategy. The study concludes that metacognitive instructional strategy is effective and gender-inclusive in promoting students' interest in science and recommends its integration into secondary school science instruction.

Keywords: Metacognitive instructional strategy, Students' interest, Gender differences and Science education.

1.0 Introduction

Interest in science is a critical factor influencing students' engagement, persistence and achievement in science learning. However, many secondary school students exhibit low interest in science, partly due to teacher-centred instructional approaches that do not actively engage learners. Metacognitive instructional

strategy, which emphasizes students' awareness and regulation of their own thinking processes, has been identified as a learner-centered approach capable of enhancing motivation and interest in learning.

1.1 Metacognitive instructional strategy and students' interest in science

Metacognitive instructional strategy refers to teaching approaches that explicitly engage learners in planning, monitoring, evaluating, and regulating their own cognitive processes during learning (Flavell, 1979; Schraw & Dennison, 1994). In science education, metacognitive strategies are designed to help students become aware of how they think about scientific problems, understand when they do or do not comprehend key concepts, and adjust their learning behaviors accordingly. The core components of metacognition - metacognitive knowledge (awareness of one's learning processes) and metacognitive regulation (control over learning strategies) - are believed to shape learners' engagement, self-efficacy, and motivation to learn complex science content (Veenman, Van Hout-Wolters & Afflerbach, 2006; Zohar & Barzilai, 2013).

Interest in science is defined as a psychological state of increasing attention, curiosity, and enjoyment in science learning activities, which can lead to sustained engagement and deeper learning (Ainley, Hidi & Berndorff, 2002; Schiefele, 1991). Conceptually, interest is both an affective experience and a cognitive orientation that motivates students to allocate effort and persist in challenging tasks. The literature suggests that instructional strategies that encourage active reflection and self-regulation, such as metacognitive instructional strategy, can enhance students' situational interest - a short-term response to specific instructional contexts - as well as individual interest that develops over time through repeated positive learning experiences (Hidi & Renninger, 2006; Renninger & Hidi, 2011).

In science classrooms, metacognitive instructional strategies such as explicit reflection prompts, guided self-questioning, and think-aloud protocols can increase learners' awareness of their thinking

processes, reduce anxiety about difficult science concepts, and foster a sense of ownership over learning (Tanner, 2012; Miller & Hadwin, 2015). When students engage in metacognitive planning and evaluation, they tend to view science tasks as more meaningful and manageable, which conceptually enhances their interest by linking cognitive challenge with personal relevance (Pintrich, 2002; Zimmerman, 2008). Recent work also suggests that metacognitive strategy supports not only cognitive performance but also students' motivational beliefs, including interest, effort, and persistence in science (Broadbent & Poon, 2015; Panadero, 2017).

In summary, the conceptual literature establishes that metacognitive instructional strategies are not merely cognitive tools but are also motivationally supportive. By fostering students' awareness and control over their learning, these strategies can create learning environments that nurture and sustain interest in science. This conceptual link justifies the focus of the present study on how metacognitive instructional strategies influence students' interest in science learning.

Ogbaga, Ogbaga and Egbe, (2024) investigated the effects of the Metacognitive Learning Cycle Model on secondary school Physics students' achievement and interest in Nigeria using a quasi-experimental design. The study sampled 65 SS 2 Physics students from 924 in Izzi Local Government Area, with instruments including the Physics Achievement Test (PAT) and Physics Interest Scale (PIS) (KR-20 = 0.82 and Cronbach's alpha = 0.73). Analysis using ANCOVA showed that the metacognitive learning cycle model significantly enhanced both achievement and interest in Physics compared with conventional methods, underscoring the pedagogical power of metacognitive approaches in science

instruction. This finding aligns with the expectation that metacognitive strategies stimulate student involvement and curiosity, which are key components of learning interest.

Another relevant Nigerian study conducted by Salisu, Eggon and Dibilang (2024) examined the effect of Metacognitive Instructional Strategy (MCIS) on students' self-esteem and achievement in Basic Science among 300 junior secondary students drawn from three zones in Nasarawa State, Nigeria. The study used researcher-developed instruments - the Basic and Achievement Test (BAT) (KR formula = 0.74) and the Basic Science Self-esteem Rating Scale (BSSERS) (Cronbach's alpha = 0.86). Results indicated that MCIS significantly improved students' achievement and self-esteem compared with the traditional method, suggesting strong positive engagement with learning processes through metacognitive scaffolding. Although interest was not the primary measured variable in this study, the demonstrated increases in self-esteem and achievement indirectly support the notion that metacognitive strategies foster more engaged, motivated learners, which often correlates with higher interest.

The key strength of the Ogbaga, Ogbaga and Egbe, (2024) study is its direct measurement of interest, using a validated scale in a science domain that parallels your topic. However, the sample size (n = 65) is modest, which may limit generalizability. The Salisu et al. (2024) study's large sample and strong reliability coefficients support robust findings, but it did not directly measure interest, which is the focal dependent variable in your research.

These two studies above demonstrate that metacognitive instructional strategies are effective in enhancing engagement and positive learning outcomes in science contexts - supporting the rationale for your

present study on interest in science. However, neither specifically disaggregated effects by gender, highlighting a literature gap that your study helps address.

1.2 Gender differences in students' interest in science with metacognitive strategy

The concept of gender differences in educational outcomes refers to observable variations in academic attitudes, motivation, and performance between male and female learners (Eccles, 2011). In science education, research has long documented gender disparities in interest and engagement, often showing that male and female students may differ in their science preferences, confidence in science tasks, and career aspirations in science fields (Else-Quest, Hyde & Linn, 2010; Wang & Degol, 2013). These differences are shaped by complex interactions among socialization, classroom experiences, and individual motivational beliefs.

Interest in science, as a motivational construct, is influenced not only by cognitive readiness but also by affective and contextual factors that can vary by gender (Lent, Brown & Hackett, 1994). Girls, for example, sometimes report lower interest in physics and engineering-oriented science tasks, while boys may express lower interest in biological sciences, though these trends are not uniform across contexts and cultures (Tytler & Osborne, 2012; Archer, DeWitt, Osborne, Dillon, Willis & Wong, (2017). Importantly, the conceptual literature emphasizes that instructional context - including the use of metacognitive strategies - can moderate these gender-linked motivational patterns (Zimmerman & Pons, 1986; Meece, Glienke & Burg, 2006).

Metacognitive instructional strategies provide structured opportunities for all learners to reflect on their learning processes,

set goals, and evaluate progress, which can support student autonomy and self-efficacy (Schraw, Crippen & Hartley, 2006). Because motivation and self-efficacy are closely linked to interest (Bandura, 1997; Wigfield & Eccles, 2000), these strategies have the potential to reduce gender gaps in interest by equipping learners - regardless of gender - with tools to manage cognitive challenges and build confidence. For example, when instructional practices emphasize reflection and strategy use rather than rote memorization, female students may experience increased confidence and engagement in science tasks that were previously perceived as difficult or uninteresting (King & McInerney, 2016; Lopez & Sullivan, 2018).

On the other hand, the conceptual literature also acknowledges that gender differences in interest are shaped by broader sociocultural expectations that may not be fully addressed by instructional strategy alone. Some scholars argue that without accompanying changes in classroom norms, teacher beliefs, and science identity development, metacognitive strategies may improve learning processes but have limited effects on deep-seated motivational differences (Eccles & Wigfield, 2020; Deemer, 2019). Thus, the conceptual relationship between metacognitive strategy and gender differences in interest is best understood as interactive rather than deterministic: instructional design can support equity, but must be complemented by supportive learning environments.

In summary, the conceptual literature suggests that gender differences in students' interest in science are influenced by a mix of individual, social, and instructional factors. Metacognitive instructional strategies conceptually offer a way to support all learners' engagement and self-regulation in science learning, which could help narrow

gender disparities in interest. This literature provides theoretical grounding for the present study's examination of how male and female students may differ in their interest outcomes when taught with metacognitive strategies.

de Boer, Donker, Kostons and Van Hout-Wolters, (2018). showed from a broad meta-analysis that students with higher metacognitive knowledge are more capable of effective problem solving and learning across domains, which implies that metacognitive instruction may support engagement processes where interest is developed. Although not focused on gender or interest per se, this foundational work supports the premise that metacognitive skills help learners monitor and regulate learning - processes that can strengthen intrinsic motivation and engagement, dimensions tied to interest.

International research also provides gender-related insights. A study by de Boer et al and Van Hout-Wolters, (2018) tested for gender differences in basic metacognitive ability and confidence in perceptual decision-making with a large dataset (N = 1,887) and found no significant gender differences in metacognitive performance or confidence (an affective correlate of interest) in basic tasks. Although the educational domain differed (perceptual tasks rather than classroom science), the results suggest that gender differences in metacognition may be domain specific, rather than universal.

Closer to instructional contexts, research in Chemistry education by Muteti, Muthoni and Njoroge, (2024) (cited in 2025 analysis) found evidence that, prior to metacognitive instruction, differences existed in strategy use between genders; however, these differences diminished after metacognitive instruction, suggesting that structured metacognitive guidance may equalize engagement patterns across male and female

learners in science learning (as mediated by strategy use and equitable adoption).

de Boer, Donker, Kostons and Van Hout-Wolters, (2018) meta analytic result is strong in sample size and rigor, but its focus on perceptual metacognitive ability limits direct applicability to classroom science interest. Findings on use of metacognitive strategies reducing gender disparities in chemistry study strategies provide promising evidence that structured metacognitive instruction may help narrow gender differences in engagement and related interest outcomes, though this research did not directly measure interest in science.

These works collectively support the assumption that metacognitive strategy can positively influence learning engagement processes relevant to interest and that gender differences in metacognitive engagement are not fixed and may be reduced through instructional design - both of which justify your focus on gender and interest in science using metacognitive instructional strategy. This research will extend this empirical base by directly measuring science interest and comparing male and female responses.

Therefore, despite its potential, limited empirical evidence exists on how metacognitive instructional strategy influences male and female students' interest in science in the Calabar Education Zone of Cross River State, Nigeria. This study therefore investigates the effect of metacognitive instructional strategy on male and female students' interest in science.

2.0 Main objective of the study

The main objective of this study is to investigate the effect of metacognitive instructional strategy on male and female students' interest in science in the Calabar Education Zone of Cross River State, Nigeria.

The study specifically sought to:

1. Determine the effect of metacognitive instructional strategy on students' interest in science.
2. Examine the difference between male and female students' interest in science when taught using metacognitive instructional strategy.

Research questions

The following research questions guided the study:

1. What effect does metacognitive instructional strategy have on students' interest in science?
2. What difference exists between male and female students' interest in science when taught using metacognitive instructional strategy?

3.0 Research hypotheses

The following null hypotheses were formulated to guide the study:

1. There is no significant effect of metacognitive instructional strategy on students' interest in science.
2. There is no significant difference between male and female students' interest in science when taught using metacognitive instructional strategy.

4.0 Methodology

This study adopted a quasi-experimental research design, specifically the pretest - posttest non-equivalent control group design. The design was considered appropriate because intact SS II science classes were used, making random assignment of individual students impracticable. The design enabled comparison of students exposed to metacognitive instructional strategy with those taught using the conventional teaching

method, while controlling for initial differences through pretesting.

The population of the study consisted of 3,196 SSII science students, 55 science teachers, and 117 public secondary schools across the Calabar Education Zone. This population provided a broad representation of science learners and instructors within the zone.

The sample for the study comprised 387 SSII science students, 37 science teachers, and 14 public secondary schools drawn from the population. A multistage sampling technique was employed to select the sample. First, simple random sampling was used to select 14 public secondary schools from the 117 public secondary schools in the zone. Second, intact SSII science classes were selected from the sampled schools. Third, purposive sampling was used to select science teachers who were actively teaching SSII science classes. The selected schools were then randomly assigned to experimental and control groups to ensure fairness in group allocation.

Two instruments were used for data collection. The first was the Science Interest Inventory (SII), a Likert-type questionnaire designed to measure students' level of interest in science. The second instrument was the Metacognitive Instructional Strategy Guide (MISG), which provided structured instructional steps for teachers in the experimental group, focusing on planning, monitoring, and evaluation of learning during science lessons.

The instruments were subjected to face and content validity by experts in science education and measurement and evaluation to ensure that the items adequately measured students' interest in science and reflected the components of metacognitive instructional strategy. The reliability of the SII was determined using the Cronbach's alpha method, which yielded a reliability coefficient of 0.76.

Prior to the commencement of treatment, a pretest was administered to both the experimental and control groups to determine their initial level of interest in science. The experimental group was then taught science using the metacognitive instructional strategy, while the control group was taught using the conventional teaching method. The treatment lasted for a specified instructional period, after which a posttest was administered to both groups to assess changes in students' interest in science.

5.0 Results

Data collected were analyzed using descriptive statistics to answer the research questions. The null hypotheses were tested using Analysis of Covariance (ANCOVA) at the 0.05 level of significance, with pretest scores used as covariates to control for initial differences between the groups.

5.1 Research question one: What effect does metacognitive instructional strategy have on students' interest in science?

Table 1: Mean and standard deviation of students’ interest in science by instructional strategy

Instructional strategy	N	Pretest mean	Pretest SD	Posttest mean	Posttest SD
Metacognitive strategy	19	41.26	6.18	58.42	7.05
Conventional method	19	40.87	6.34	49.16	6.89
Total	38	41.07	6.26	53.81	7.46

Interpretation: Table 1 shows that students taught using the metacognitive instructional strategy recorded a higher posttest mean interest score ($\bar{x} = 58.42$) than those taught using the conventional teaching method ($\bar{x} = 49.16$). The pretest mean scores of both groups were relatively similar, indicating comparable initial interest levels before

treatment. The higher posttest mean of the experimental group suggests that metacognitive instructional strategy positively influenced students’ interest in science.

5.2 Hypothesis one: Metacognitive instructional strategy has no significant effect on students’ interest in science.

Table 2: ANCOVA summary of effect of instructional strategy on students’ interest in science

Source	Sum of squares	df	Mean square	F	p-value
Pretest (Covariate)	1,284.36	1	1,284.36	29.47	0.000
Instructional strategy	2,976.54	1	2,976.54	68.29	0.000
Error	16,724.82	383	43.67		
Total	21,984.00	386			

Decision: Since the calculated significance value (.000) is less than the alpha level of 0.05, the null hypothesis is rejected.

Interpretation: Table 2 reveals a statistically significant effect of instructional strategy on students’ interest in science after controlling for pretest scores ($F(1,383) = 68.29, p < .05$). This indicates that the observed difference in posttest interest scores was due to the metacognitive instructional strategy rather than initial differences among students.

Therefore, metacognitive instructional strategy significantly enhanced students’ interest in science.

5.3 Research question two: What difference exists between male and female students’ interest in science when taught using metacognitive instructional strategy?

Table 3: Mean and standard deviation of male and female students' interest in science (Metacognitive group)

Gender	N	Pretest mean	Pretest SD	Posttest mean	Posttest SD
Male	98	41.58	6.22	58.96	7.14
Female	96	40.94	6.11	57.83	6.98
Total	194	41.26	6.18	58.42	7.05

Interpretation: Table 3 shows that male students recorded a slightly higher posttest mean interest score ($\bar{x} = 58.96$) than female students ($\bar{x} = 57.83$) when taught using the metacognitive instructional strategy. However, the difference in mean scores appears minimal, suggesting that both male

and female students benefited almost equally from the strategy.

5.4 Hypothesis two: There is no significant difference between male and female students' interest in science when taught using metacognitive instructional strategy.

Table 4: ANCOVA summary of gender difference in students' interest in science

Source	Sum of squares	df	Mean square	F	p-value
Pretest (Covariate)	742.19	1	742.19	17.86	0.000
Gender	94.63	1	94.63	2.28	0.133
Error	7,873.44	191	41.21		
Total	8,710.26	193			

Decision: Since the calculated significance value (0.133) is greater than the alpha level of 0.05, the null hypothesis is not rejected.

Interpretation: Table 4 indicates that gender did not have a statistically significant effect on students' interest in science when taught using the metacognitive instructional strategy ($F(1,191) = 2.28, p > .05$). This implies that both male and female students benefited similarly from the metacognitive instructional strategy, and the slight observed difference in mean scores was not statistically meaningful.

6.0 Summary of findings

1. Metacognitive instructional strategy significantly improved students' interest in science compared with the conventional teaching method.
2. There was no significant difference between male and female students' interest in science when taught using metacognitive instructional strategy.

7.0 Discussion of findings

The findings of this study revealed that metacognitive instructional strategy had a significant effect on students' interest in science in the Calabar Education Zone of Cross River State. Students exposed to metacognitive instructional strategy demonstrated higher posttest interest scores than their counterparts taught using the conventional teaching method, even after controlling for initial differences through the use of pretest scores as covariates. This finding supports the theoretical position that metacognitive strategies enhance learners' awareness and regulation of their learning processes, thereby fostering greater engagement and interest in learning tasks. The result is consistent with the views of Schraw and Dennison (1994), who argued that metacognitive regulation promotes active involvement and meaningful learning, which are essential for sustaining interest in science.

This finding also aligns with earlier empirical studies which reported that metacognitive instructional strategies positively influence students' motivation, engagement, and

affective outcomes in science learning (Zohar & Barzilai, 2013; Panadero, 2017). By encouraging students to plan, monitor, and evaluate their understanding during science lessons, metacognitive strategy likely made learning experiences more interactive and learner-centered, thereby increasing students' interest in science. The result further supports the conceptual literature that interest in science is enhanced when students perceive learning tasks as meaningful and manageable (Hidi & Renninger, 2006).

The second major finding of the study showed that there was no significant difference between male and female students' interest in science when taught using metacognitive instructional strategy. Although male students recorded slightly higher mean interest scores than female students, the difference was not statistically significant. This finding suggests that metacognitive instructional strategy benefits both genders equally in fostering interest in science. This result corroborates the position of Eccles and Wigfield (2020), who argued that instructional strategies that promote self-regulation and autonomy can reduce gender disparities in motivation and engagement.

The finding also aligns with studies that reported minimal or no gender differences in students' responses to metacognitive-based instruction when learning conditions are supportive and equitable (Meece, Glienke & Burg, 2006; King, & McInerney, 2016). The use of metacognitive strategy may have provided equal opportunities for male and female students to reflect on their learning processes, thereby minimizing gender-based differences in interest. However, this finding contrasts with some earlier studies that reported gender differences in science interest, particularly in male-dominated science domains (Else-Quest, Hyde & Linn, 2010). The discrepancy may be attributed to differences in instructional context, subject matter, and the learner-centered nature of metacognitive strategy used in the present study.

8.0 Conclusion

Based on the findings of this study, it is concluded that metacognitive instructional strategy is an effective approach for enhancing students' interest in science at the senior secondary school level. The strategy significantly improved students' interest in science compared with the conventional teaching method, even after controlling for initial differences in interest. Furthermore, the study concludes that metacognitive instructional strategy is gender-inclusive, as it does not significantly favor either male or female students in terms of interest in science. Therefore, metacognitive instructional strategy constitutes a viable instructional approach for promoting equitable and engaging science learning in secondary schools.

9.0 Recommendations

Based on the findings and conclusions of the study, the following recommendations are made:

1. Science teachers should adopt metacognitive instructional strategy in classroom instruction to enhance students' interest and engagement in science learning.
 2. Teacher education programmes and in-service training should incorporate metacognitive instructional practices to equip teachers with skills for implementing learner-centered science instruction.
 3. Curriculum planners and policymakers should integrate metacognitive strategy components into science curricula to promote reflective and self-regulated learning among students.
1. Future studies should examine the effect of metacognitive instructional strategy on other learning outcomes such as achievement, retention, and critical thinking in science.
 2. Similar studies should be conducted in other education zones or states to enhance the generalizability of the findings.
 3. Further research could explore the interaction effects of metacognitive instructional strategy with other learner variables such as ability level, school location, or science anxiety.

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10.0 Suggestions for further studies

In view of the scope and limitations of this study, the following suggestions are made for further research:

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