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RESEARCH PAPER

Effectiveness of STEM-based Approach on Enhancing Critical Thinking Skill of Elementary School Students in Faisalabad

[1]Muhammad Azeem and [2]Dr. Shafqat Rasool*

1. PhD Scholar, Department of Education, Government College University Faisalabad, Punjab, Pakistan
2. Assistant Professor, Department of Education, Government College University Faisalabad, Punjab, Pakistan

***Corresponding Author**	Dr.shafqat.rasool@gcuf.edu.pk

ABSTRACT

This study evaluates how the STEM approach to teaching might address global educational concerns while enhancing elementary school students' critical thinking skills. A key component of creative and social advancement, STEM-based instruction provides a cutting-edge framework that combines conventional instruction with skills that are relevant to the future. Employing a Solomon Four-Group experimental design, the study analyzes data from 184 public school pupils in the eighth grade. In a 2x2 factorial design, pretext, posttest, and retention posttest measures were used to compare the critical thinking results of STEM and traditional education methods. While STEM-based instruction dramatically enhanced critical thinking (posttest: $M = 63.47$, $SD = 5.03$; retention: $M = 61.89$, $SD = 4.72$, Cohen's $d = 1.52$), traditional groups only made minor increases (pretest: $M = 4.87$, $SD = 4.23$). Treatment effects were found to be significant ($F (1, 180) = 576.21$, $p < 0.05$). STEM education gives young people the critical thinking skills they need to succeed in today's complicated, interconnected world, producing workforce and informed citizens.

KEYWORDS Critical Thinking Skills, Elementary School Students, Solomon Four-Group Design, STEM Approach

Introduction

STEM education seems to be here to stay, despite the fact that educational trends can change over time. The acronym for this integration is STEM, which stands for science, technology, engineering, and mathematics. Students need to learn how to think critically in order to study, assess, and create knowledge in the twenty-first century. The STEM approach uses multidisciplinary teaching and learning techniques that promote problem-solving and critical thinking skills, claims Bybee (2010). In recent years, there has been a worldwide effort to include STEM education in curricula to better prepare students for the problems of the future (National Research Council, 2011).

The implementation and results of STEM education are greatly impacted by cultural factors, educational regulations, and teacher preparation. The ability to think critically is essential for addressing difficult problems and making decisions (National Research Council, 2012). According to Bybee (2010), traditional educational methods' low levels of engagement and real-world application make them less effective in fostering the development of higher-order cognitive skills. The STEM approach integrates several fields and provides an intensive, multidisciplinary learning experience (Sanders, 2009). Honey, Pearson, and Schweingruber (2014) contented that because of its focus on experimental learning, group learning, and real-world problem-solving, this method improves critical thinking skills more successfully than conventional approaches.

There is still uncertainty regarding the advantages of STEM-based education, particularly in elementary schools, and in-depth evaluations are advised to determine how they affect critical thinking. The purpose of this study is to close this knowledge gap by comparing how STEM-based approach and traditional teaching methods affect elementary school pupils' critical thinking skills. In order to investigate both the immediate and long-term impacts of the instructional approaches, using a Solomon Four-Group design, this study will use retention posttests (Campbell & Stanley, 1963). The study's findings will provide valuable insights into how STEM approaches promote critical thinking as more effective teaching methods are created. Today's technologically evolved world requires a STEM-based approach to foster innovation and economic success. Countries may compete in global markets by prioritizing STEM education since it produces critical thinkers and problems solvers (UNESCO, 2017). However, it may be difficult to properly adopt STEM instruction due to a number of issues with Pakistan's educational system, including inadequate teacher preparation, obsolete training, and a lack of finance (Khalid & Khan, 2021).

The Solomon Four-Group Persistence The study employ post-tests to investigate the immediate and long-term impacts of the teaching strategies (Campbell & Stanley, 1963). This framework provides a comprehensive understanding of how successfully STEM training encourages critical thinking, and it will serve as a roadmap for future educational efforts. By encouraging students to shift their focus from experimental to abstract reasoning, the STEM method of instruction specifically supports Piaget's theory of learning. According to Yenlimex and Erosy (2008), STEM-based approach promotes critical and collaborative problem-solving skills, cognitive flexibility, and the creation of new ideas based on preexisting information. The 7E cognitive Cycle can help students develop, apply, and improve their educational results, all of which can foster critical thinking, even if it is currently rare in STEM education (Kapila & Iskander, 2015). By encouraging students to use their information practically, this experimental technique helps them to better strengthen their critical thinking (Cakir & Altun Yalcin, 2021).

As a result of global scientific advancements, STEM approach was created to help pupils think critical and solve problems creatively (Kuenzi, 2008). Cinar et al. (2016) stress that a STEM education helps students acquire 21st century skills by allowing them to apply abstract concepts to practical problems. Akgunduz (2017) asserts that by incorporating STEM instruction into national curricula, nations may develop innovative leaders who will advance technological and economic progress.

Science and engineering schooling in Pakistan has the ability to significantly boost the country's development by introducing students to these fields. According to Bal and Bedir (2021), these experience could improve the country's ability to conduct scientific research, technology, and economic competitiveness. Emphasizing STEM education, according to Altan (2017), meets the demand for a skilled work force and promotes innovative and economic progress. The necessity to abandon antiquated rote learning techniques is highlighted by this study, which investigates how a STEM-based approach for Pakistani education may help elementary school pupils develop their critical thinking skills. Stakeholders, educators, and lawmakers will gain a better understanding of how to incorporate STEM-based learning to enhance overall educational results thanks to the findings.

There are multiple reasons why this study is significant. The results of this study could impact instructive practices and strategies in two ways; first, it contributes to the small quantity of published work on the topic by providing valuable insights into the way STEM instruction in Pakistan develops critical expertise; second, it assists in aligning methods of instruction with the demands of the educational system of the twenty-first century. The study also examines the impact of STEM education on students' attitudes, as evidence suggests that students who engage in STEM activities are more enthusiastic about studying (Bybee, 2010).

Last but not least, the information acquired from this study can help Pakistani teacher preparation programs. Teachers will be better equipped to use successful teaching strategies if they understand how STEM-based learning may encourage analytical thinking and student's involvement. More capable and driven educators who can inspire students and deliver top-notch STEM approach will most likely result from this.

Literature Review

Critical Thinking

It is a complicated process that occurs both internally, within a person's cognitive functioning, and externally, through the educational environment and teaching strategies. Critical thinking skills are developed and enhanced through the cooperation of two pillars: extrinsic educational institutions and intrinsic cognitive processes.

Internal Cognitive Mechanisms of Evaluating Information

Cognitive processes that aid in information analysis, evaluation, and reflection are a part of critical thinking, which enables people to thoroughly examine issues. This approach requires open-mindedness because it removes prejudices and widens viewpoints (Facione, 2015). Critical thinking is characterized by the ability to solve problems, reason through complicated situations, and take into account other points of view (Halpern, 2014). Making critical thinking a habit necessitates applying newly acquired knowledge in real-world contests and reflecting on prior learning experiences (Dewey, 1933). In order to assess beliefs and bolster reasoning, cooperation with other people is also essential (Paul & Elder, 2019). Thinkers who are critical and creative can investigate novel concepts and come up with creative fixes. Lastly, the capacity for successful communication exhibits critical thinking through the systematic presentation of concepts (Ennis, 1996). In many situations, these mental operations serve as the basis for problem-solving.

Outside Academic Setting for Fostering Critical Thought

To build a comprehensive intellectual framework, critical thinking skills should be included into all subject areas and are greatly enhanced by learning settings and instructional practices (Brookfield, 2012; Zohar & Dori, 2003). Fostering critical thinking requires a secure, encouraging atmosphere where students may openly share their thoughts and participate in debates without worrying about failing (Brookfield, 2012). Students can practice higher-order thinking skills, use critical thinking in a variety of circumstances, and challenge preconceived assumptions with time recurring opportunities like inquiry-based, problem-based, and group discussions (Paul & Elder, 2019; Zohar & Dori, 2003). By encouraging reflection and discussion, scholarly discourse promotes intellectual development and increases understanding (Brookfield, 2012).

Establishing productive learning settings and employing teaching techniques that motivate pupils to take steps toward solutions are two important ways that scientific education aims to promote critical thinking (Kek & Huijser, 2011). In order to accomplish this, students require assistance in developing their critical thinking skills through changes to take control of their education and work together to solve problems (Johns, 2012). By classifying cognitive abilities, Bloom's taxonomy (Bloom, 1956) lays the groundwork for critical thinking while highlighting the significance of higher-order thinking. Higher-order thinking activities, like STEM exercise, improve scientific and critical thinking skills by providing authentic, real-world problem-solving scenarios (Duraon, Limback, & Waugh, 2006; Schulz, Schulz, & Fitz Patrick, 2016).

Due to its inclusion in Evaluation and Instruction of 21CC (ATC21S) and Hart Research Associates' (2013) list of five key learning objectives, critical thinking has received a lot of attention recently as a critical 21st century skill. Critical thinking is also essential for employment 21st century skill in recent years. According to white papers released by the World Economic Forum (WEF) and the Organization for Economic-Cooperation and Development (OECD), critical thinking will also be necessary for employment in the future due to the way that technological advancement are changing the nature of work (Sternberg, 2013).

The reason critical thinking matter is that employers value it. The most crucial elements for employee success in today's intricately linked workplace are interpersonal skills like cooperation, communication, creativity (critical thinking), and flexibility, as per a 2012 IBM Global research that comprised 1709 chief executive officers, CEOs, and senior executives from the public sector (IBM, 2012).

Successful application of critical thinking the absence of a commonly agreed-upon definition frequently impedes instruction. While Paul and Elder (2006) define critical thinking as "thinking critically about thinking while thinking to enhance thinking," Collier (2013) defines it as a willingness to explore, a tolerance for uncertainty, and an openness to new ideas. These divergent viewpoint affect how programs include critical thinking. The humanities and philosophy concentrate on cultivating rational thought, which has its roots in the writings of Aristotle, Plato, and Socrates, while the hard sciences and social sciences frequently depend on educating the scientific approach as an efficient way to promote critical thinking (Robert & Ennis, 1996).

Benefits of STEM approach

Science, technology, engineering, and math (STEM) education give pupils 21st-century skills like problem-solving, critical thinking, and teamwork that are crucial for future employment. The Sustainable Development Goals (SDGs), which address global concerns including poverty, injustice, and climate change, must be included into STEM education in order to secure a sustainable future. In addition to improving student performance, this method equips them to successfully handle problems in the actual world as,

Improves Creativity, Increases Team Collaboration, Develops Communication Skills, Empowers Critical Thinking Skills, Boosts Curiosity, Improves Cognitive Skills, Introduces STEM careers at early ages, teaches how to take initiative, Enhances media literacy, and Boosts social-emotional learning (SEL): innovative thinking and multidisciplinary problem-solving are encouraged in STEM education, which stimulates creativity. It highlights communication, leadership, and teamwork – skills necessary for overcoming obstacles in the real world. Group activities improve communication by fostering constructive criticism, open-mindedness, and active listening. In addition to fostering analytical thinking, curiosity, and discovery, STEM also improves cognitive abilities and introduces ideas in engineering and coding. Students are prepared for future chances by early involvement in STEM careers. STEM encourages initiative, which boosts self-esteem and proactive attitude toward education. Media literacy is improved by inquiry-based learning, and academic achievement, personal development, and emotional intelligence are supported by including social-emotional learning (SEL) (Imran & Gunduz, 2023).

Methodology

The study evaluates how successfully STEM approach enhances elementary-school pupils' decision-making (critical thinking) skills by using pretesting and treatment. Confounding factors are adjusted using the Solomon Four-Group design. Both pretest and non-pretested groups are used, and participants are randomly assigned, allowing for a more accurate evaluation of the instructional influence (Solomon RL, 1949; Campbell & Stanley, 1963)." (Table 1)

Table 1
The Solomon Four-Group Design

		Pretest	Treatment	Posttest
R	Group 1	O1	X	O2
R	Group 2	O3		O4
R	Group 3		X	O5
R	Group 4			O6

Note: R: Randomization, X: Treatment, O: Outcomes.

In a study conducted at the public sector school in district Faisalabad, Pakistan, 184 eighth-grade elementary students, ages 12 to 14, participated. To guarantee equal representation, computer–generated random number tables and basic random selection were used to gather the data. The study's low generalizability stems from its sole emphasis on a particular institution, where control groups received traditional instruction and experimental groups received STEM-based approach.

In contrast to traditional textbook-based learning, the STEM-based educational method encompasses investigation-, discovery-, project-, and problem-based, transdisciplinary tasks, as well as hands-on activities, all of which adhere to the Next Generation Science Standards. Posttests assess how well critical thinking skills are retained.

A pretest conducted on both groups (G1 and G3) of elementary eighth graders was used to assess their prior knowledge. G1 and G3 received STEM-based teaching individually for six weeks, while G2 and G4 received traditional instruction. According to Watson and Glaser (2006), the modified Watson-Glaser Critical Thinking Skills Appraisal was used to gather data because of its established validity and reliability. A pretest, a posttest, and a retention posttest were used to give the tests. A total of 80 multiple-choice questions were used to test the students' critical thinking skills and knowledge. A critical thinking test that evaluated inference, interpretation, argument, assumption and deduction was adjusted for eighth-grade pupils in order to ensure their ability to take it.

To verify homogeneity and normality, the data analysis procedure uses Shapiro-Wilk and Wilcoxon's tests to compare the experimental and control groups' pretest, posttest, and retention posttest outcomes. As necessary, data transformations were applied to validate these hypothesis. The implications of modifications throughout time as well as between groups was evaluated using two statistical methods: ANOVA and the t-test.

Results and Discussion

Pretest, Posttest, and Retention Posttest Results

Students' critical thinking skills are much enhanced by the STEM approach, as demonstrated by the effect size (Cohen's d = 2.53) and the statistically significant rise in critically thought ratings in Group 1 (the experiment group). The retention posttest's apparent improvement over time provides additional evidence of the instructional method's long-lasting impacts.

Group 1: STEM Intervention Group, CTS

The critical thinking scores of Group 1 improved significantly from the preliminary tests (pre-test) (M = 36.4, SD = 7.03) towards the follow-up test (post-test) (M = 69.1, SD = 4.41) following instruction in a STEM-based approach. According to the results of the paired t-test, the improvement was statistically, significant, with a difference in mean of 32.65, a t-value of 31.219 (df = 45, p < 2.2e-16), and a 95% probability range between 30.55 and 34.76. (Table 3).

Table 2
Summary of Pretest and Posttest Scores

Test	Mean	(SD)	(N)	(SE)
Pretest	36.4	7.03	46	1.04
Posttest	69.1	4.41	46	0.650

Table 3
Paired t-test Results

Statistic	Value
t-value	31.219
Degree of Freedom (df)	45
p-value	<2.2e-16
Mean Difference	32.65217
95% Confidence Interval	(30.54560, 34.75875)

Group 2: Traditional Instruction Group, CTS

After receiving conventional instruction, Group 2's critical thinking skills little changed between M = 36.4, SD = 6.93 for the pre-test and M = 36.7, SD = 6.66 for the post-test. The pretest and posttest scores did not differ statistically significantly, based on the paired t-test (p = 0.8332, df = 45, t-value = 0.212). 95% confidence interval between -2.59 and 3.20 is presented alongside the mean difference of 0.304 in Table 5.

Table 4
Summary of Pretest and Posttest Scores

Test	Mean	(SD)	(N)	(SE)
Pretest	36.4	6.93	46	1.02
Posttest	36.7	6.66	46	0.982

Table 5
Paired t-test Results

Statistic	Value
t-value	0.21186
Degree of Freedom (df)	45
p-value	0.8332
Mean Difference	0.3043478
95% Confidence Interval	(-2.588989, 3.197684)

Group 3 vs. Group 4: Traditional vs. Intervention, CTS

A comparison between the STEM treatment in Group 3 and the traditional approach used in Group 4 reveals significant differences in the outcomes of the two instructional modalities. A statistically significant difference between the two groups' averages was also confirmed by the Welch Two-Sample t-test, which yielded a t-value of 10.724 (df = 68.555, p = 2.623e-16) and a 95% confidence interval of 15.78 to 22.95. Compared to Group 3, the interventional group's posttest scores were M = 36.4, SD = 5.74, SD = 10.8. When the F-test was used to compare two variances, the F-value of 3.5383 (p = 4.375e-0.5) showed a significant difference between the groups. With a mean score of 55.72, the intervention groups outperformed the traditional group, which had a mean score of 36.37. (Table 8).

Table 6
Summary of Traditional and Intervention Scores

Test	Mean	(SD)	(N)	(SE)
Pretest	36.4	5.74	46	0.847
Posttest	55.7	10.8	46	1.59

Table 7
F-test to compare two variances

Statistic	Value
F-value	3.5383
Numerator (df)	45
Denominator (df)	45
p-value	4.375e-0.5
95% Confidence Interval	(1.9557801, 6.394588)
Ratio of Variance	3.538267

Table 8
Welch Two Sample t-test

Statistic	Value
t-value	10.724
Degree of Freedom (df)	68.555
p-value	2.623e-16
95% Confidence Interval	(15.7815, 22.94750)
Mean in group intervention	55.71739
Mean in group traditional	36.36957

The Efficiency of Educational Interventions

Significant gains in critical thinking skills were seen in both in intervention groups, according to parried t-test. In particular:

Group 1 (Experimental): There was a mean difference of 8.07 ($p < 2.2e-16$) in the critical thinking scores, which increased significantly from a pretest mean of 7.72 (SD = 2.55) to a posttest mean of 15.8 (SD = 1.94).

Group 2 (Traditional): There was a 4.40 ($p = 2.548e-14$) mean difference in scores between the pretest mean of 5.26 (SD = 2.37) and the posttest mean of 9.65 (SD = 0.994).

Deduction and general critical thinking skills, as well as reasoning and assumption skills, showed notable improvements. But inference, interpretation, argument, and assumption skills showed no appreciable gains in the conventional groups, suggesting that traditional methods did not significantly improve these domains.

Results of the Statistical Analysis

The results of the investigation demonstrated that the STEM-based intervention regularly outperformed conventional techniques in a range of evaluations. The efficacy of the STEM method was demonstrated by descriptive statistics and variance comparisons, which showed that the intervention groups had higher mean scores and more diversity in their replies. The statistical significance of the difference between the intervention and traditional groups was established by Welch two-sample t-tests ($p < 0.05$).

The STEM-based approach significantly improves critical thinking skills, as seen by the ANOVA results, which showed strong benefits in all critical thinking domains. The treatment effect demonstrated the efficacy of the intervention, with F values ranging from 106.8665 to 576.214. The need of taking beginning skill levels into account when assessing educational interventions was further highlighted by the interaction between pretest scores and treatment type.

Variance Analysis (ANOVA)

ANOVA in Two ways

Table 9
Interaction of Achievement on Posttest Scores: Treatment vs. Pretest (Overall)

Sources	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Pretest	1	102.01	102.01	18.061	3.429e-05
Treatment (trt)	1	1734.92	1734.92	307.177	<2.2e-16
Pretest	1	71.87	71.87	12.726	0.0004622
Residuals	180	1016.63	5.65		

Posttest vs. retention Posttest for STEM Intervention Groups (G1 and G3)

According to descriptive data for the follow-up (post-test) and retention posttest of the STEM intervention groups, there was minimal variation in scores between the two tests (M = 62.4, SD = 10.6 and M = 62.8, SD = 10.3), suggesting that critical thinking skills were maintained over time.

Table 10
Descriptive Statistic for Posttest and Retention Posttest

Test	Mean	(SD)	(N)	(SE)
Posttest	62.4	10.6	46	1.11
Ret. Posttest	62.8	10.3	46	1.07

Posttest vs. retention Posttest for Traditional Instruction Groups (G2 and G4)

The retention posttest results (M = 36.7, SD = 6.04) and the follow-up test results (post-test) (M = 36.5, SD = 6.19) in the traditional instruction groups similarly showed little variation and were consistent. Comparing these groups' overall low scores to those of the experimental groups, however, demonstrates how unsuccessful traditional training is at fostering and maintaining critical thinking skills.

Table 11
Descriptive Statistic for Posttest and Retention Posttest

Test	Mean	(SD)	(N)	(SE)
Posttest	36.5	6.19	46	0.645
Ret. Posttest	36.7	6.04	46	0.629

Discussion

The study's conclusions provide insight into how well an eighth-grade STEM-based instructional approach fosters the growth of students' critical thinking skills. A comprehensive assessment of the possible pretest sensitization effect was made possible by the Solomon Four-Group design, which strengthens the validity of the findings presented. The traditional and intervention groups differed significantly, as shown by the analysis of variance (ANOVA), with the intervention interaction effects show that the success of the intervention differed based on the starting skill levels of the students, highlighting the significance of taking baseline skills into account when designing education interventions.

Effectiveness of STEM approach

The findings clearly show that the STEM approach greatly enhances students' critical thinking skills when compared to conventional teaching techniques. The notable posttest score increases observed in Groups 1 (pretest + STEM instruction) and 3 (STEM solo) support the conclusions. An overall differential of (M = 32.65) and a p-value < 2.2e-16 showed that Group 1's critical thinking scores were substantially better. In contrast, Group 3, which received instruction utilizing the STEM approaches but was not given a pretest, had a significant improvement, as seen by the posttest mean of 55.7, which was higher than the 36.4 of the group that employed the conventional method (Group 4). These results suggest that improving critical thinking skills is a natural benefit of the STEM method, even in the absence of a pretest.

Pretest Sensitization Effects

The results of the study were impacted by pretest sensitization, as indicted by the substantial interaction effect uncovered by the two-way ANOVA (p < 8.453e-09, F = 36.530). Specifically, it appears that the pretest enhanced students' critical thinking skills, which in turn increased their openness to STEM-focused training. This is only demonstrated by the fact that Group 1 pretest + STEM had higher posttest scores than

Group 3 STEM. Despite the fact that both groups had significant gains in thinking critically, an additional spike was demonstrated by Group 1, suggesting that the STEM technique was more effective due to the preceding test sensitization impact.

On the other hand, regardless of prior knowledge, the previous approach showed no discernible improvement in critical thinking. As seen by the lack of improvement in Groups 2 Pretest + Traditional and 4 Traditional just, the STEM approach is superior. As seen by the substantial p-values ($p = 0.8332$ for Group 2), pretest sensitization had little effect on the efficacy of traditional training, suggesting that there is no variation between pretest and posttest results in these groups.

Retention (Advantages in Critical Thinking)

The comparison between the follow-up test (post-test) as well as retention posttest for Groups 1 and 3 shows that critical thinking skills are sustained over time, suggesting that the benefits of the STEM approach are transient. As seen by the slight increase in mean scores between the post-test and the retention post-test ($M = 62.4$ to 62.8), students' critical thinking skills were preserved and possibly enhanced beyond the immediate learning cycle. This long-term impact demonstrates how the STEM approach influences pupils' cognitive growth.

Inference

Students 'capacity to derive logical conclusions from the material was much enhanced by the STEM-based intervention. The intervention group's significant gain in inference scores highlights the significance of encouraging youngsters to pursue STEM fields that need problem-solving and critical thinking skills.

Interpretation

The comprehension and elucidation of knowledge by the students in the intervention group shown notable advancements. This implies that interpretive skills are effectively enhanced by STEM-based training, which frequently entails interpreting data and scientific events.

Argument

The ability to formulate and assess arguments was significantly improved in the intervention group. This result is consistent with the focus on critical analysis and evidence-based reasoning in STEM education.

Assumption

The intervention group showed a considerable improvement in their capacity to identify and assess assumption. This critical thinking skill may be developed through STEM activities that require the creation and testing of hypotheses.

Deduction

The intervention group's capacity for deductive thinking significantly improved. Logical deduction and systematic problem-solving are key components of STEM-based assignments that seem to be successful in building this area.

Implications

The study draws attention to important ramifications for educational practice and policy. To enhance critical thinking and guarantee that these skills are retained over time, STEM-based instruction should be incorporated into elementary and middle schools curricula. The importance of preparatory testes for maximizing STEM learning is shown by pretest sensitization. For reliable evaluations, researchers should take into account designs pretest sensitization. For reliable evaluations, researchers should take into account designs such as the Solomon Four-Group, which isolate the effects of the intervention and the pretest. To better encourage critical thinking, STEM-based techniques must be incorporated into teacher preparation programs. Last but not least, individualized STEM teaching methods help bridge critical thinking gaps and promote educational fairness by addressing a range of beginning skill levels.

Conclusion

According to this study, as compared to conventional approaches, STEM-based instruction considerably enhances eighth-grade students' thinking critically skills in all domains: deductive reasoning, inductive reasoning, interpretation, argument, and assumption. The results, which are were obtained using a strong Solomon Four-Group design, demonstrate how well the STEM-based instruction fosters long-term cognitive benefits with notable improvements in the follow-up test and retention posttest scores. Pretest sensitization emphasized the importance of preliminary assessments in improving STEM-based learning by amplifying these advantages even more. Larger, more varied sample and longitudinal research are suggested to improve generalizability and investigate long-term effects, while the study supports embed STEM across disciplines, empower educators through specialized training, adopt experiential and collaborative learning models, invest in advanced STEM facilities, strengthen Home-School-Community linkages, implement dynamic assessment practices.

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