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Research Article

Efficacy of Constructivist Approach (CA) in Teaching Science at Upper Primary Level Students of Tripura

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ABSTRACT

In the 21st century, modern-day teachers are under immense pressure to employ innovative instructional techniques to enhance and shape their students' cognitive abilities. Constructivist approach is a modern student-centred approach of teaching where students construct their knowledge based on active involvement and experience. The present study was conducted to assess the effectiveness of the Constructivist Approach (CA) on upper primary students' conceptual understanding of Science. The research objectives included creating lesson plans incorporating the Constructivist Approach and evaluating its impact on students' comprehension. The investigation employed an experimental methodology involving a sample of 40 students. Researchers analysed the difference between pre-test and post-test scores of experimental and control groups. The findings revealed a notable disparity in conceptual understanding scores between the two groups, with the experimental group receiving instruction through the Constructivist Approach and the control group taught using conventional teaching methods. The findings indicated that the group instructed with the constructivist approach outperformed the conventional teaching group in delayed performance after two weeks, i.e., retention levels were higher with the constructivist approach.

Keywords: Constructivist Approach (CA), Conventional Method of Teaching (CMT), Academic Achievement, Delayed Performance, Retention.

1. Introduction:

Education is a crucial process that aims to develop individuals, foster social transformation, and promote national development. It helps individuals acquire knowledge, skills, and attitudes, enhancing their quality of life for themselves, their communities, and the nation. To achieve this, proper planning of educational activities and a paradigm shift in the teaching-learning process are necessary. The education system should be revamped to include innovative teaching and learning methods to meet the needs and aspirations of a resurgent society. India's school system is dominated by rote memorisation and traditional teaching methods, leading to limited independent thought, inquiry, and engagement. To make education more exciting and relevant, the educational system should be modified to encourage children to learn from their experiences, think more, and apply what they learn outside of school to classroom learning.

Science education plays a crucial role in developing individuals' head and heart qualities, allowing them to be practical, productive, and progressive members of society. Science education helps people reduce poverty, ignorance, and superstition in a progressive society that looks to the future. Science education fosters critical inquiry, respect for truth, simplicity, adaptability, and systematic labour, which are essential for social transformation and country growth. The National Curriculum Framework (2005) supports the Constructivist Approach in school instruction to improve children's willingness to learn. This approach emphasises the learners' role in learning and understanding, focusing on the 5E (Engage, Explore, Explain, Elaborate, and Evaluate) method. Constructivist education focuses on teaching students how to connect the parts to the whole, offering numerous benefits such as better retention, development of knowledge, collaboration, and support for students with social or emotional issues. By adopting a learner-centred approach, the education system can become more engaging, relevant, and effective in meeting the needs and aspirations of a resurgent society.

1.1 Constructivist Approach (CA) of Teaching Science:

Constructivism, a learning theory developed from Jean Piaget's 1970s research, is widely recognised in educational theory and research. It posits that individuals actively construct knowledge from their assumptions, personal experiences, and cognitive frameworks. Constructivism stresses developing problem-solving abilities in ambiguous situations and challenges conventional teaching methods. In science education, this approach requires teachers to use strategies that engage students in understanding scientific concepts and facilitate conceptual shifts. Unlike traditional or behaviourist methods, which emphasise knowledge transmission through a structured approach, constructivist educators encourage students to reflect on how activities enhance their conceptual understanding and learning processes. They advocate for direct instruction to support the construction of mental models and activities that allow learners to evaluate and refine their knowledge.

In science teaching, constructivism involves prompting students to ask questions, engaging them in class activities, and continually assessing their comprehension and performance. The approach benefits students by distinguishing the fundamental idea of informing science from the practice of imparting knowledge. It acknowledges the diversity within science fields, including Biology, Physics, and Chemistry education, with the primary aim of facilitating optimal student learning. Numerous studies have explored teaching methodologies and curriculum improvements to enhance science education. Thus, constructivism remains a significant approach in science instruction, emphasising active learning strategies, diverse learning approaches, and essential skill development for advanced science success.

In a constructivist framework, students should engage in collaborative, inquiry-based, reflective, problem-based, and developmental learning methods. These methods integrate new and existing knowledge to develop current ideas. Project-based learning follows a production model, while problem-based learning uses an inquiry-based approach. Collaborative learning involves group work, cooperative learning involves small groups, brainstorming generates new ideas, scaffolding supports student growth, inquiry-based learning promotes questioning and surveys, guided instruction provides direction, and the 5E Learning Cycle Model is employed.

1.2 5E Model of Constructivist Approach: The 5E Model is a systematic approach to teaching that consists of five stages: Engaging, Exploring, Explaining, Elaborating, and Evaluating. These stages help students apply prior knowledge, construct meaning, and regularly evaluate their understanding of a concept.

- The Engaging phase involves combining past and present learning experiences, using short exercises to connect existing knowledge to new experiences.
- The Explore phase involves students identifying and developing concepts, procedures, and skills through lab inquiries or hands-on activities.
- The Explain phase helps clarify students' understanding of subjects, allowing them to demonstrate new skills and behaviours.
- The Elaborate phase allows students to practice behaviours and abilities while expanding their conceptual understanding.
- The Evaluating stage allows students to reflect on their knowledge and skills while teachers can assess their understanding of essential ideas and skills. The teaching-learning condition is essential for both teachers and students, and students must demonstrate a firm understanding of the basics they've been taught.

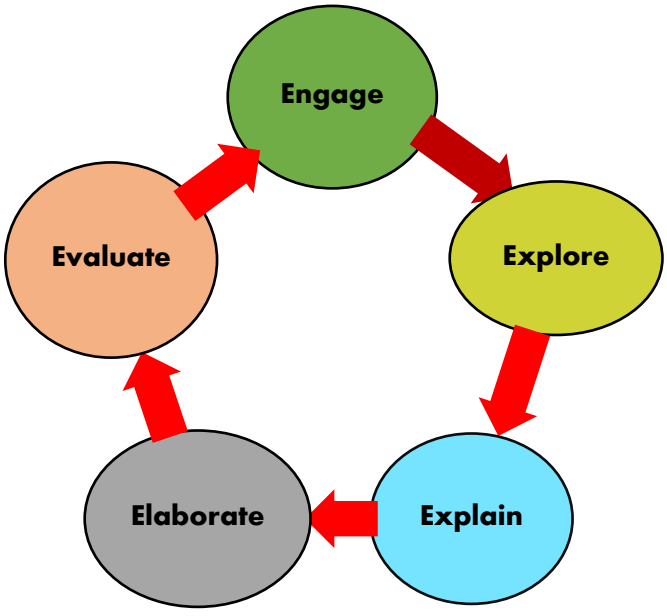

Figure 1: Different Phases of 5E Instructional Model

Research indicates that the constructivist approach, particularly the 5E learning cycle model, has proven effective in both international and Indian educational settings. In university chemistry education, Sartika and Hadi (2021) demonstrated the 5E model's efficacy in enhancing students' comprehension of salt hydrolysis. Hector et al. (2022) found that the 5E model, as part of the Constructivist Approach, improved conceptual understanding and attitudes toward science. Owusu et al. (2022) reported an increase in mathematics problem-solving abilities using this model, while Kibici (2022) observed improvements in music lesson performance, attitude, and retention through an online 5E model. The enhanced 5E model's effectiveness in teaching natural science was highlighted by Vu et al. (2022), and Nadeem & Awan (2022) showed its superiority over traditional lecture methods in academic achievement. Physics students' performance and learning were enhanced by the 5E model, as noted by Dahal (2023) and Lasaiba (2023). Nurpatri et al. (2021) and Arthur (2021) observed that constructivism boosted critical thinking and motivation in physics and statistics instruction. Improvements in science achievement and math interest were reported by Doss (2022) and Unodiaku (2022). Siagian et al. (2023) further illustrated the model's capacity to enhance physics learning through animated video. The present study employed the 5E Model of Constructivist Approach to investigate its effectiveness in teaching science to upper-primary students in Tripura.

2. Review of Related Literature:

A few studies on the efficacy of the Constructivist Approach are given below:

2.1 Studies conducted in abroad:

- A study by Igwebuike and Oriaifo (2014) found that the Constructivist Approach improved students' affective outcomes in science subjects.
- A meta-analysis by Ayaz and Sekerci (2015) found that the constructivist approach positively affected students' academic performance compared to conventional instructional strategies.
- A study by Aydisheh and Gharibi (2015) found that constructivist instruction significantly enhanced students' knowledge, comprehension, application, analysis, synthesis, and evaluation.
- A study by Qarareh (2016) found that the constructivist approach significantly improved students' performance in chemistry subjects. The findings suggest that more consideration should be given to incorporating the constructivist teaching approach into science courses and further research should be conducted to understand its impact on various learning outcomes.
- Demir and Emre (2020) studied the impact of the 5E learning paradigm on fourth-grade science students' academic progress, fundamental process skills, attitudes toward science, and misperception elimination. The study found that the experimental group had higher scores in academic success, attitude toward science, and misunderstandings.
- Nurpatri et al. (2021) found that the constructivist approach improved students' critical thinking abilities.
- Grau et al. (2021) found that the 5E model significantly boosted students' conceptual development.
- Subedi (2021) investigated the efficacy of the constructivist method in teaching chemistry.
- Rahmawati et al. (2021) found that the learning cycle 5E model worked better than the discovery learning model for students using fresh milk quality standards.
- Sartika and Hadi (2021) found that the 5E model improved students' comprehension of salt hydrolysis.
- Hector et al. (2022) examined the cognitive aspects of learning and the impact of instructional aids on students' performance.

2.2 Studies conducted in India:

- Sridevi (2013) and Sharma (2014) conducted studies on the effectiveness of a constructivist approach in science education. They found that constructivist teaching was more successful than conventional methods, improved achievement scores and attitudes for both genders and fostered a more conducive learning environment.
- Bhattacharjee and Mehera (2014) found that the constructivist approach significantly affected students' performance in science.
- Kaur and Kaur (2016) found that constructive instruction was superior to traditional methods, and constructivist 5E learning enhanced math achievement.
- Siddiqui (2016) conducted an empirical study on the constructivist approach to help learners with the 9th standard understand chapter colloids.
- Parveen (2017) studied the impact of the 5E model on the academic performance of primary school students with hearing impairments in Science.
- Adak (2017) found that the constructivist method improved secondary science academic performance, with students exposed to the 7E model scoring higher at every IQ level.
- Pangat (2017) found that the constructivist approach improved secondary school students' mathematical performance, leading to increased knowledge and self-reflection abilities.

- Banu and Mahmood (2019) found that the constructivist approach improved ninth-grade students' mathematics performance.
- Singh et al. (2021) found that the 5E teaching modality and peer group methods were influential during the pandemic.
- Shivam and Mohalik (2022) found that an ICT-integrated 5E model enhanced students' higher-order thinking skills in biology among secondary-level students.

The prosperity of India hinges on its capacity to deliver exceptional educational opportunities to its young population, who seek employment and skill development. By 2030, the Sustainable Development Agenda aims to accomplish this objective, with a focus on high-quality education. To reach this target, India must prioritise enhancing primary and elementary schooling. Novel instructional approaches, such as the Constructivist Approach (CA), have demonstrated their ability to boost academic performance and foster active learning and critical thinking. Studies conducted in India corroborate these findings, revealing that CA results in superior academic outcomes and surpasses traditional teaching methods in effectiveness. An ongoing investigation in Tripura seeks to evaluate the impact of the Constructivist Approach on improving academic achievement and higher-order thinking abilities among upper-primary students in science education.

3. Objectives of the study

The researchers formulated the following objectives:

1. To study the mean Pre-Test score of upper-primary students' performance in Science on the Criterion-Referenced Test.
2. To study the efficacy of the Constructivist Approach (CA) and Conventional Method of Teaching (CMT) on upper-primary students' immediate performance in Science on the Criterion-Referenced Test.
3. To study the efficacy of the Constructivist Approach (CA) and Conventional Method of Teaching (CMT) on upper-primary students' two-week delayed performance in Science on the Criterion-Referenced Test.

4. Hypotheses of the study

The following hypotheses were formulated by the researcher keeping in view the nature of the objectives of the study:

1. There is no significant difference in the Pre-Test achievement scores between the 7^{th}-grade students in Science on the Criterion-Referenced Test.
2. There is no significant difference in the Post-Test immediate achievement score between the 7^{th}-grade students following the Constructivist Approach (CA) and the Conventional Method of Teaching (CMT) in Science on the Criterion-Referenced Test.
3. There is no significant difference in the two-week delayed achievement score between the 7^{th}-grade students following the Constructivist Approach (CA) and the Conventional Method of Teaching (CMT) in Science on the Criterion-Referenced Test.

5. Method and Material

The study aims to evaluate the effectiveness of the Constructivist Approach (CA) over the Conventional Method of Teaching (CMT) in enhancing the academic performance in Science of upper-primary students in Tripura using an experimental research method.

5.1Research Design:

The researcher adopted the Pre-Test-Post-Test Experimental Research Design for the completion of this study. The present study was conducted with a sample of 40 students with two comparable groups, i.e., i) Constructivist Approach Group and ii) Conventional Method of Teaching Group. The Research Design is illustrated graphically below:

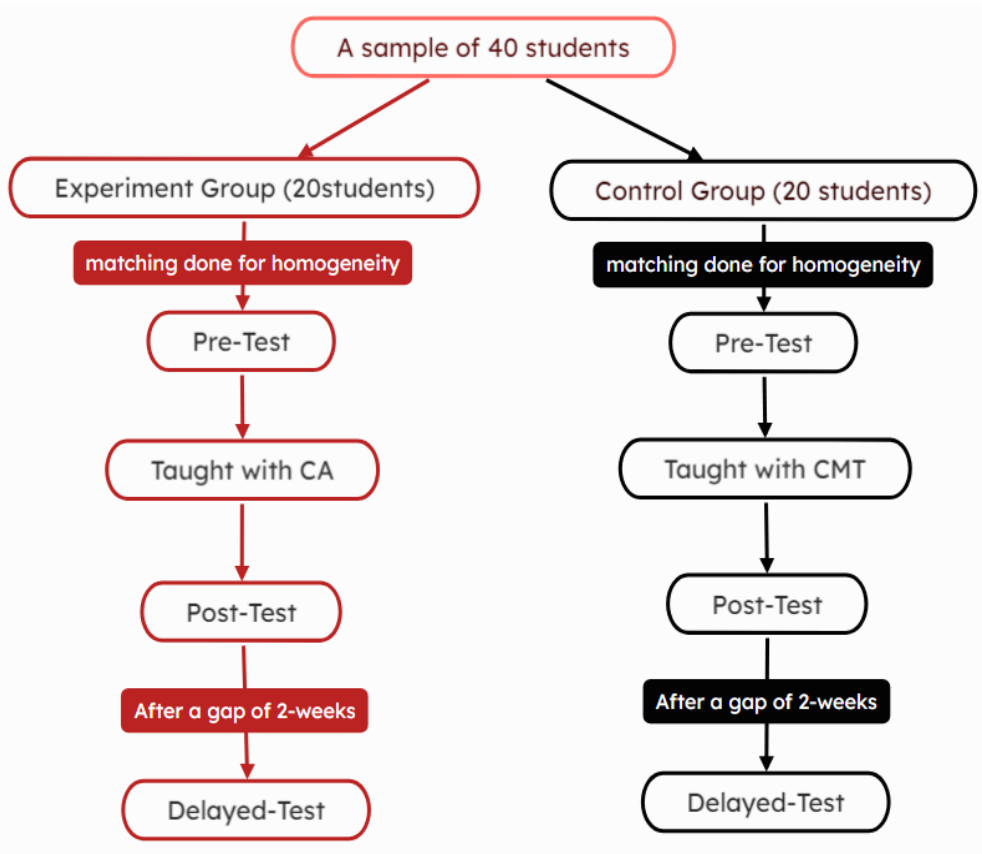

Figure 2: Research Design of the Experiment

5.2 Population:

The study population comprises the entire enrollment of seventh-grade students from Nivedita Children's School and Radha Kishore Institute in Unakoti District, Tripura, India. The selected schools are situated in the Unakoti district of Tripura, under the jurisdiction of the Directorate of Elementary Education, Government of Tripura. The total number of seventh-grade students at these two schools was 199 in the academic session 2023-24. Furthermore, it is hypothesised that the study's findings may be applicable to all seventh-grade students in the district regarding the learning of Science topics.

5.3 Sample and Sampling Technique:

Two schools for the experiment were selected based on feasibility and willingness to cooperate on the part of the school authorities. Thus, random sampling was employed to choose the schools for experimental and control groups. The control and experimental groups comprised 20 students of class VII. The randomisation technique ensured the equivalence of the three experimental groups by taking into account their prior achievement scores.

Table 1: The Study Sample

Sl. No.	Name of School	Groups	No. of samples taken
1	Nivedita Children's School, Kumarghat, Unakoti, Tripura	Experimental Group (CA Group)	20
2	Radha Kishore Institute, Kailashahar, Unakoti, Tripura	Control Group (CMT Group)	20
	Total		40

5.4 Tools Used:

- Lesson Plans prepared by the researcher on the Constructivist Approach (CA) with the 5E Model of teaching.
- The Criterion-Referenced Test (CRT) developed and standardised by the researcher.

5.5 Experiment Description:

The researchers followed the steps for the conduction of the experiment:

- **Step 1**: **Pre-Test Score**: In the first stage of the investigation, the Criterion-Referenced Test (CRT) was administered on both groups to obtain Pre-Test Scores. These ratings showed participants' knowledge about the sample students' Class VII Science chapters.

- **Step 2**: **Implementing Lesson Plan**: The Experimental Group received 27 nos. of CA-based lesson plans one by one. After completion of each Lesson Plan, one formative test was administered. Another Lesson Plan was started after ensuring that 80% of students must secure at least 80% marks in the formative test. As usual, the control group was instructed by the CMT. No formative test was administered to the Control Group.
- **Step 3**: **Post-Test Score**: After all the lesson plans were ted, the CRT was administered to both the Experimental and Control Groups to determine the Post-Test Score.
- **Step 4**: **Delayed Score**: Researchers allowed a 2-week interval between the instant execution of experimental and control group pupils. Afterward, the researchers re-administered the CRT to both groups of students after two weeks to obtain the 'Delayed Score.'

5.6 Delimitations:

The experimental study has the following delimitations:

- The study was delimited to 7th-grade students in Unakoti district of Tripura.
- The study is also delimited to schools affiliated with the English medium NCERT syllabus.
- The study was delimited to six chapters of 7th-grade Science, viz., Nutrition in Plants, Nutrition in Animals, Heat, Motion and Time, Acids, Bases and Salts, and Physical and Chemical Changes.
- Academic performance included knowledge, understanding, and application dimensions of the cognitive domain.

6. Results and Discussion:

The samples were compared by testing the significance of the difference between the mean scores of experimental and control groups using t-tests. The main findings of the study are presented below in accordance with the relevant objectives and hypotheses:

Objective-1: To study the mean Pre-Test score of 7th-grade students' performance in Science on the Criterion-Referenced Test.

Hypothesis: There is no significant difference in the Pre-Test achievement scores between the 7th-grade students in Science on the Criterion-Referenced Test.

Table 2: Showing t-value of mean pre-test scores of CA & CMT groups of 7th-grade students.

Groups	N	Mean	SD	t-value	Level of significance
CA Group	20	49.4	6.81	0.746	Not significant at 0.05 level of significance
CMT Group	20	47.8	6.76		

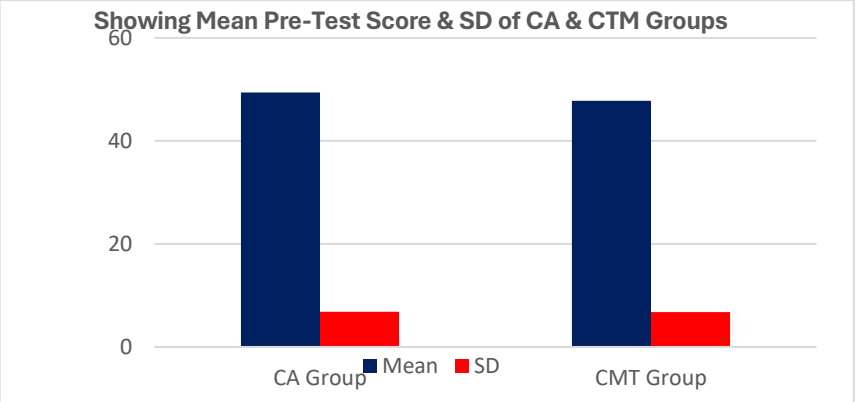

Figure 3: Comparison of Pre-Test Scores of CA & CMT Groups

Table 2 indicates that the computed t-value came out to be 0.746, which is less than the table t-value (2.02). Therefore, the computed t-value 0.746 has not been found significant at 0.05 level of significance for 38 df, and the formulated Hypothesis "*There is no significant difference in the Pre-Test achievement scores between the 7th-grade students in Science on the Criterion-Referenced Test*" got rejected. It means that 7th-grade students who were taught to teach using the Constructivist Approach and the Conventional Method of Teaching showed no significant difference in their Pre-Test scores on the CRT indicating the equivalence of the groups.

Objective-2: To study the efficacy of the Constructivist Approach (CA) and Conventional Method of Teaching (CMT) on upper-primary students' immediate performance in Science on the Criterion-Referenced Test.

Hypothesis: There is no significant difference in the Post-Test immediate achievement score between the 7th-grade students following the Constructivist Approach (CA) and the Conventional Method of Teaching (CMT) in Science on the Criterion-Referenced Test.

Table 3: Showing the t-value of mean post-test scores of CA & CMT groups of 7th-grade students.

Groups	N	Mean	SD	t-value	Level of significance
CA Group	20	131.3	6.08	16.7	Significant at 0.01 level of significance
CMT Group	20	95.3	7.65		

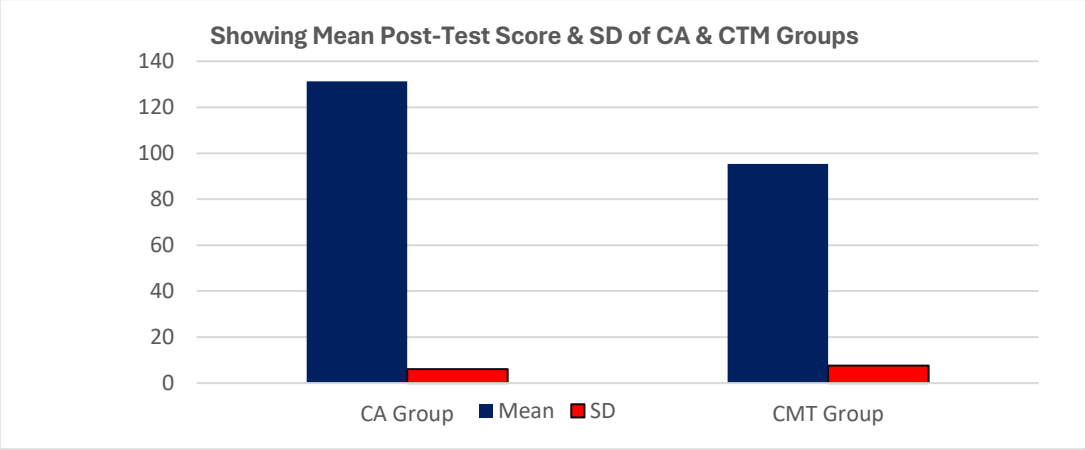

Figure 4: Comparison of Post-Test Scores of CA & CMT Groups

Table 3 shows the computed t-value as 16.7, surpassing the table t-value of 7.17, indicating significance at the 0.01 level for 38 df. Consequently, the Hypothesis "*There is no significant difference in the Post-Test immediate achievement score between the 7th-grade students following the Constructivist Approach (CA) and the Conventional Method of Teaching (CMT) in Science on the Criterion-Referenced Test*" was rejected. The finding suggests that students taught via CA outperformed those taught by CMT in immediate academic performance. Thus, the Constructivist Approach is deemed superior at the elementary school level. The CA group's mean score was 131.3 (87.53%), while the CMT group's was 95.3 (63.53%) on the Criterion-Referenced Test, further confirming CA's effectiveness. For clarity, the Post-test scores of the CA and CMT groups are shown in Figure 4. Supporting studies, such as Kaur and Kaur (2016), Gunsen et al. (2018), Holley and Park (2020), Nurpatri et al. (2021), Unodiaku (2022), and Siagian et al. (2023), conducted both in India and abroad, affirm the superiority of the Constructivist Approach.

Objective-3: To study the efficacy of the Constructivist Approach (CA) and Conventional Method of Teaching (CMT) on upper-primary students' two-week delayed performance in Science on the Criterion-Referenced Test.

Hypothesis: There is no significant difference in the two weeks delayed achievement score between the 7th-grade students following the Constructivist Approach (CA) and the Conventional Method of Teaching (CMT) in Science on the Criterion-Referenced Test.

Table 4: Showing t-value of mean delayed-test scores of CMT and CAI groups of 7th-grade students.

Groups	N	Mean	SD	t-value	Level of significance
CAI Group	20	127.1	7.29	13.84	Significant at 0.01 level of significance
CMT Group	20	92.55	8.46		

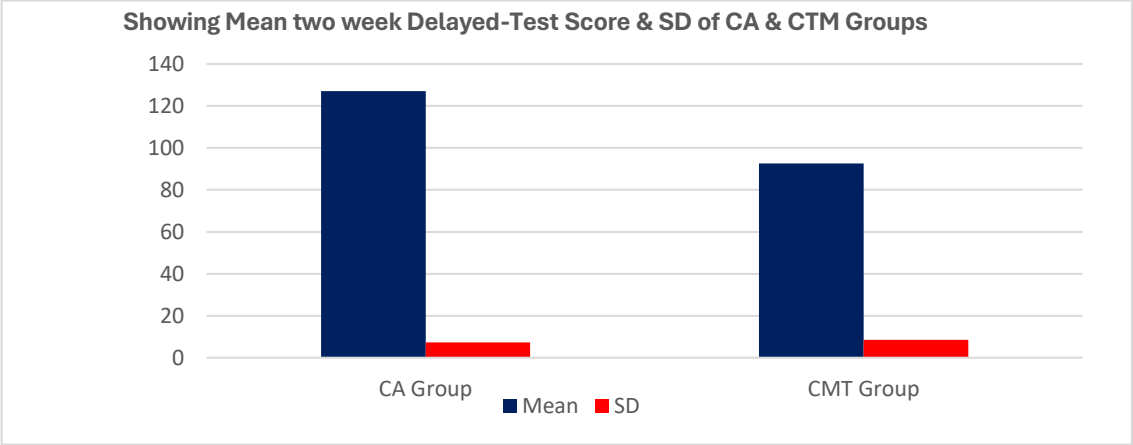

Figure 5: Comparison of two weeks Delayed-Test Scores of CA & CMT Groups

Table 4 reveals a computed t-value of 13.84, surpassing the table F value (2.704), indicating significance at the 0.01 level for 38 df, thus rejecting the hypothesis: "There is no significant difference in the two weeks delayed achievement score between the 7th-grade students following the Constructivist Approach (CA) and the Conventional Method of Teaching (CMT) in Science on the Criterion-Referenced Test." This signifies a significant difference in delayed performance between students taught via CA and CMT. The CA group's mean score was 127.1 (84.73%), while the CMT group's mean was 92.55 (61.7%) on the CRT, showing that CA students outperformed CMT students. For clarity, the two weeks Delayed-test scores of the CA and CMT groups are shown in Figure 5. Similar findings were reported by Elke & Lucyna (2001), Yadigaroglu & Demircioglu (2012), Tuna and Kascar (2013), Karsli & Ayas (2014), and Kibici (2022).

7. Findings of the study:

The findings of the study are stated as under:

- The initial assessment revealed no significant difference in the pre-test performance of seventh-grade science students before the experimentation was conducted.
- A substantial distinction emerged in the post-test results. Seventh-grade students who received instruction through the Constructivist Approach (CA) demonstrated superior academic achievement compared to their counterparts taught using the Conventional Method of Teaching (CMT) in science.
- The two-week delayed test scores exhibited a significant disparity between the two groups. Upper-primary students who were exposed to the Constructivist Approach (CA) in science education displayed enhanced retention of the material in their two-week delayed performance, surpassing those who were taught using the Conventional Method of Teaching (CMT).

The Constructivist Approach demonstrated greater efficacy than the Conventional Teaching Method in enhancing the academic performance of Class VII students in Tripura immediately following the experimental intervention. Furthermore, it exhibited sustained positive effects on students' performance two weeks post-intervention, indicating superior retention compared to the Conventional Method. This investigation suggests that educators may confidently implement the Constructivist Approach to facilitate paradigm shifts in education and effectively achieve Outcome-based education objectives.

8. Conclusion:

The National Policy on Education (NPE-1986), Programme of Action (PoA-1992), and National Education Policy (NEP-2020) all advocate for substantial changes in the educational system. Contemporary instructional techniques are essential to achieving these transformations in education. This research examined the effectiveness of the Constructivist Approach in teaching and learning Science at the upper-primary level in Tripura. The findings revealed that the Constructivist Approach enhanced the academic performance of 7th-grade students immediately following the instructional process, surpassing the results of traditional teaching methods. Additionally, when assessed two weeks later, the Constructivist Approach proved beneficial for Tripura's 7th-grade students' academic performance. Based on these results, the study suggests that educators should widely adopt the Constructivist Approach to facilitate educational paradigm shifts and effectively attain the goals of outcome-based education.

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