



Effect of Culturo-Techno-Contextual Instructional Approach on Achievement in Mathematics and Mathematical Anxiety of Low Achievers among Secondary School Students

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ABSTRACT

Mathematics is a foundational discipline critical for logical reasoning, problem-solving, and informed decision-making, yet many secondary school students perceive it as challenging, often resulting in low Achievement and heightened Mathematical Anxiety. This study investigates the effect of the Culturo-Techno-Contextual Instructional Approach on enhancing Achievement in Mathematics and reducing Mathematical Anxiety of Low Achievers among Secondary School Students. Grounded in constructivist, sociocultural, and experiential learning theories, CTC Instructional Approach integrates cultural relevance, technology, and real-life contextualization to make Mathematics more meaningful, engaging, and accessible. The study employed a single-group pretest–posttest experimental design. From the population, namely Secondary School Students of Thiruvananthapuram District, following Kerala State Syllabus, 118 students were chosen through multistage cluster sampling and among that 34 low achievers were identified and administered instructional material developed using the 7E Model (Elicit, Engage, Explore, Explain, Elaborate, Evaluate, Extend). Achievement in Mathematics was assessed using a 42-item test, while Mathematical Anxiety was measured with a 54-item Likert



scale. Repeated measures ANOVA indicated significant improvement in achievement scores across pretest, posttest, and delayed posttest, with post hoc analysis confirming that the intervention led to sustained gains. Mathematical Anxiety decreased significantly from pretest to posttest and from pretest to delayed posttest, though changes between posttest and delayed posttest were not significant, indicating partial retention. The findings suggest that culturally responsive, technology-supported, and contextually grounded instructional strategies effectively enhance learning outcomes and can mitigate Mathematical Anxiety. The study highlights the importance of integrating cognitive and affective dimensions in Mathematics pedagogy, offering practical implications for teachers, curriculum planners, and policymakers to align with the vision of NEP 2020.

Introduction

Mathematics is often described as the language of science and technology, forming the foundation for logical thinking, problem-solving, and informed decision-making in daily life. Yet, despite its universal importance, a significant number of students perceive Mathematics as a difficult and intimidating subject. This challenge is especially evident at the secondary school level, where the abstract nature of mathematical concepts frequently triggers feelings of tension, helplessness, and fear. Such negative emotions, collectively referred to as **Mathematical Anxiety**, interfere with students' ability to concentrate, process information, and perform effectively. For many low-achieving students, Mathematics becomes not only an academic hurdle but also an emotional burden that restricts their participation, impedes achievement, and hinders their long-term academic and career choices. Low achievement in Mathematics is often both a cause and consequence of high anxiety, creating a cycle that limits learning opportunities and erodes confidence.

The persistence of Mathematical Anxiety and low Achievement among secondary school learners highlights an urgent problem in Mathematics Education. Traditional teacher-centered methods—characterized by rote memorization, procedural drills, and abstract instruction—tend to widen the gap between high and low achievers. These approaches rarely connect learning to students' personal lives, cultural practices, or social realities, leaving low achievers feeling alienated and demotivated. Without addressing both the cognitive and affective needs of such learners, efforts to improve achievement remain



incomplete. There is therefore a strong need to explore instructional strategies that not only enhance Achievement in Mathematics but also reduce anxiety and foster confidence in the subject.

The **National Education Policy (NEP) 2020** strongly emphasizes competency-based education, conceptual understanding, and the reduction of rote-based learning. It envisions a holistic, flexible, and multidisciplinary approach that nurtures cognitive skills, critical thinking, creativity, and emotional well-being. NEP 2020 highlights the importance of making mathematics “enjoyable and engaging” and stresses the integration of technology, experiential learning, and local contexts to enhance both relevance and accessibility. For low-achieving students, this shift is particularly crucial, as the policy advocates inclusive practices, individualized support, and innovative pedagogies that reduce learning gaps and enhance Achievement in Mathematics. The present study aligns with the vision of NEP 2020 by addressing Mathematical Anxiety while also aiming to improve Achievement in Mathematics through a culturally responsive, technologically enriched, and contextually meaningful instructional approach.

One promising framework that resonates with this vision is the **Culturo-Techno-Contextual (CTC) Instructional Approach**, which integrates cultural relevance, technological support, and contextual application into the teaching-learning process. By drawing on cultural practices and everyday experiences, the approach situates Mathematics in a familiar environment that students can relate to. Through technology, abstract concepts are made more visual, interactive, and engaging, reducing the intimidation associated with symbolic manipulation. Contextualization further grounds mathematics in real-life, social, and environmental situations, allowing learners to see its utility beyond the classroom. Together, these dimensions create a supportive and meaningful learning environment where students can actively participate, develop conceptual understanding, reduce anxiety, and achieve better academic outcomes.

The need for such an approach is emphasized by the fact that existing research has mostly examined the roles of cultural pedagogy, technology integration, or contextual learning in isolation. Very few studies have explored the combined and holistic impact of these dimensions, particularly in relation to both Achievement in Mathematics and Mathematical **Anxiety** of Low Achievers among Secondary School Students. Since anxiety is not merely a by-product of poor performance but a powerful barrier that shapes students’ attitudes and Achievement in Mathematics, addressing it directly through an innovative pedagogy becomes essential.

The significance of investigating the CTC Instructional Approach lies in its potential to transform mathematics classrooms into inclusive spaces where all learners, including those who traditionally



struggle, can thrive. For teachers, it offers a practical and evidence-based method to make Mathematics less intimidating, more engaging, and more effective in improving achievement. For low-achieving students, it promises an opportunity to reduce fear, rebuild confidence, and enhance performance. For policymakers and curriculum developers, it provides insights into designing learner-centered, culturally responsive, and technologically supported instructional strategies that promote both equity and excellence in Mathematics Education.

In this context, the present study seeks to examine the effect of the **Culturo-Techno-Contextual Instructional Approach on both Achievement in Mathematics and Mathematical Anxiety** of Low Achievers among Secondary School Students. By focusing on this intersection of pedagogy, technology, culture, affective learning, and academic performance—and by aligning with the vision of NEP 2020—the study aims to fill a critical gap in existing literature and contribute to the development of effective strategies that can support vulnerable learners in Mathematics Education.

Review of Related Literature

Okigbo and Oshabaonuh (2024) examined the effect of the Culturo-Techno-Contextual Approach (CTCA) on secondary school students' achievement in Biology in Nsukka Education Zone, Nigeria, using a quasi-experimental design. A sample of 81 SS2 students was selected from two schools. Data were collected using a validated Biology Achievement Test with a reliability coefficient of 0.87. Results showed that CTCA significantly improved students' achievement compared to the lecture method. Findings also revealed CTCA is gender-friendly, benefiting both male and female students equally. It was recommended that teachers be trained and encouraged to adopt CTCA in Biology instruction.

Sari and Lutfi (2024) aimed to investigate the impact of self-efficacy and mathematical anxiety on student performance in Economic Statistics. The sample consisted of 50 students from the Economics and Sharia Banking program at STES Manna Wa Salwa. Tools included a self-efficacy questionnaire and a mathematics anxiety scale, both with 20 items. Data were collected post-course and analyzed using multiple linear regression. Findings showed that self-efficacy significantly influenced achievement, while math anxiety did not. However, both variables together accounted for 22.7% of the variance in performance, revealing complex dynamics.

Boadu and Boateng (2024) studied about the factors influencing students' achievement in mathematics (ACH) in the 21st century, focusing on the mediating role of student interest (STI). Key determinants included technology integration (TCI), collaborative learning (COL), and student



motivation (SMO). Using a descriptive survey, data were collected from 385 students across six senior high schools in Kumasi through stratified and random sampling. A validated questionnaire measured TCI, COL, SMO, STI, and ACH. Structural Equation Modelling (SEM) with Amos v.23 revealed that TCI and COL had significant positive effects on ACH, while SMO showed a positive but insignificant effect. STI exhibited no mediating effect on the relationships among TCI, COL, SMO, and ACH.

Ifeanacho (2023) compared the effects of the traditional lecture method and the Culturo-Techno-Contextual Approach (CTCA) on students' achievement in the nervous system. A mixed-method explanatory sequential design was used, involving pretest-posttest with 60 SS3 students in Lagos, Nigeria. The control group (30 students) was taught with lecture method, while the experimental group (30 students) was taught with CTCA. Data were collected using the Nervous System Achievement Test and a student perception interview guide. Results showed that the CTCA group ($M = 12.37$) outperformed the lecture group ($M = 10.00$). Students' perceptions were largely positive, though some noted time constraints, leading to the recommendation of CTCA for teaching science subjects.

Sangral and Kumar (2023) examined mathematical test anxiety and numerical anxiety among secondary school students in Samba block, focusing on gender, locality, and school type. A sample of students from various schools was studied using standardized anxiety scales. Findings showed no significant gender or school-type differences in test anxiety, but numerical anxiety differed significantly by gender and locality, suggesting that specific demographic factors influence different forms of anxiety.

Ablian and Parangat et al. (2022) aimed to understand the relationship between math anxiety and self-efficacy among senior high school students in Botolan District, Philippines. Using a descriptive method, tools like ANOVA, t-tests, and Pearson's r were used to analyze data from surveys. Results indicated high levels of both anxiety and self-efficacy among students. Anxiety was negatively correlated with motivation, while self-efficacy varied across demographic variables such as age, sex, and school type.

Yurt (2022) studied how task value influences math anxiety through the mediating role of self-efficacy. The study involved 203 secondary school students and used the Motivated Strategies for Learning Questionnaire and Mathematics Anxiety Scale. Structural equation modelling revealed that self-efficacy partially mediated the relationship, suggesting that emphasizing the usefulness of math enhances self-efficacy and reduces anxiety.



Çağırğan and Soytürk (2021) aimed to explore the predictive roles of math anxiety and engagement in students' responsibility toward learning. Using hierarchical regression analysis, data were collected from 568 Turkish middle school students. Tools included questionnaires assessing engagement, anxiety, and learning responsibility. Emotional, cognitive, and behavioural engagement positively predicted learning responsibility, while anxiety was a negative predictor.

Pérez-Fuentes et al. (2020) examined the mediating effect of math anxiety on the relationship between self-efficacy and math achievement. The sample included 2,245 Spanish students (grades 7–10). Tools included the Fennema-Sherman Mathematics Attitudes Scales and Sternberg Triarchic Abilities Test. Findings confirmed that self-efficacy strongly predicted achievement and that math anxiety mediated and moderated this relationship.

Okereke and Anyanwu (2018) examined the effect of culturally relevant pedagogy on math performance and anxiety among low-achieving Nigerian students. Using a quasi-experimental design, culturally familiar contexts were integrated into instruction. The study found improved performance and reduced anxiety in the experimental group.

Sandhya (2012) conducted a study on effect of Mathematics Self Concept on Problem Solving Ability and Achievement in Mathematics of Secondary School Pupils. Major objectives of the study are to find the effect of Mathematics Self Concept on Problem Solving Ability and Achievement in Mathematics. The sample of study consists of 300 pupils from different secondary schools in Kollam district. The study concluded that there exists significant relationship between the variables.

Tatar (2012) studied the relationship between high school students' mathematics anxiety and learning styles. Sample of the study were 441 eleventh grade students enrolled in six different high schools. The data were obtained primarily from two scales, namely "Mathematics Anxiety Scale" and "Learning Style Inventory." A Quantitative research approach was used in analyzing and collecting the data. The results of the analysis revealed that there exists a significantly positive relation between mathematics anxiety and an avoidant learning style. In addition, there exists a significant negative correlation between anxiety and collaborative learning. Results also revealed that avoidant learning style was the strongest predictor of mathematics anxiety

Ashcraft and Kirk (2001) examined the cognitive effects of mathematics anxiety on working memory. Using a controlled lab setting, participants performed arithmetic tasks under timed and untimed



conditions. Results indicated that high anxiety impaired working memory efficiency, leading to poor math performance.

These studies collectively highlight the intricate relationships among mathematics self-concept, self-efficacy, anxiety, engagement, and contextual teaching approaches in shaping students' academic performance. Evidence consistently shows that higher self-efficacy and positive self-concept enhance achievement, while anxiety—particularly mathematical and test-related—negatively affects performance and cognitive processes such as working memory. Moreover, engagement and motivation act as mediating factors that influence learning responsibility and sustained achievement. Importantly, research on the Culturo-Techno-Contextual Approach and culturally relevant pedagogy demonstrates that integrating cultural relevance, contextualized instruction, and technological supports can improve performance, reduce anxiety, and create equitable learning opportunities for both high- and low-achieving students. Together, these findings establish a strong empirical foundation for adopting CTC Instructional Approach as a promising pedagogical strategy to address the diverse needs of learners while fostering achievement, retention, and reduced mathematics anxiety.

Research Questions

- **Is the Culturo-Techno-Contextual Instructional Approach effective in enhancing Achievement in Mathematics of Low Achievers among Secondary School Students?**
- **Is the Culturo-Techno-Contextual Instructional Approach effective in reducing Mathematical Anxiety of Low Achievers among Secondary School Students?**

Statement of the Study

Low achievement in Mathematics among Secondary School Students is often associated with heightened Mathematical Anxiety and limited engagement, which together hinder learning and academic performance. Traditional instructional methods, heavily reliant on rote memorization and abstract presentation, frequently fail to address these challenges and overlook the importance of students' cultural backgrounds, real-life experiences, and the potential of technology to enhance learning. The Culturo-Techno-Contextual (CTC) Instructional Approach integrates cultural relevance, technological tools, and contextualized real-life examples to create more engaging, meaningful, and supportive learning environments. This study aims to examine the effectiveness of the CTC approach in improving **Achievement in Mathematics** and reducing **Mathematical Anxiety** of Low Achievers among Secondary School Students. Hence, the study is entitled as:



“Effect of Culturo-Techno-Contextual Instructional Approach on Achievement in Mathematics and Mathematical Anxiety of Low Achievers among Secondary School Students.”

Objective of the study

1. To identify Low Achievers among Secondary School Students.
2. To develop an instructional material based on the Culturo-Techno-Contextual Instructional Approach for enhancing Achievement in Mathematics and reducing Mathematical Anxiety of Low Achievers among Secondary School Students
3. To find out the effect of **Culturo-Techno-Contextual Instructional Approach in enhancing Achievement in Mathematics of Low Achievers among Secondary School Students.**
4. To find out the effect of **Culturo-Techno-Contextual Instructional Approach in reducing Mathematical Anxiety of Low Achievers among Secondary School Students.**

Hypotheses of the Study

1. **The Culturo-Techno-Contextual Instructional Approach is significantly effective in enhancing Achievement in Mathematics of Low Achievers among Secondary School Students.**
2. **The Culturo-Techno-Contextual Instructional Approach is significantly effective in reducing Mathematical Anxiety of Low Achievers among Secondary School Students.**

Theoretical Framework

Mathematical anxiety is widely recognized as a significant barrier to learning Mathematics, especially among low-achieving students. It manifests as tension, worry, or fear when engaging in mathematical tasks, often impairing concentration, working memory, problem-solving abilities, and overall academic performance. Students experiencing high levels of Mathematical Anxiety may avoid mathematics-related tasks, perform poorly in assessments, and develop negative attitudes towards the subject. Addressing this affective barrier is therefore crucial for enhancing engagement, achievement, and persistence in Mathematics learning. In this study, the **Culturo-Techno-Contextual (CTC) Instructional Approach** is adopted to reduce Mathematical Anxiety while simultaneously improving Achievement in Mathematics. The instructional material consists of 12 contents developed using the **7E Model**—Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend—covering key topics in



Arithmetic, Algebra, and Geometry. Each content is designed to activate prior knowledge, connect mathematics to real-life contexts, and provide hands-on experiences supported by technology, making abstract concepts more concrete and relatable.

The approach draws on principles of **constructivism**, which emphasize that learners actively construct knowledge through interaction with their environment. Piaget's cognitive constructivism highlights mental restructuring through assimilation and accommodation, while Bruner's discovery learning promotes scaffolding and sequential learning. Vygotsky's sociocultural theory further stresses that learning occurs through social interaction within cultural and technological contexts, where cultural tools and collaborative dialogue support understanding. In CTC Instructional Approach, students engage with culturally relevant examples, real-life situations, and digital tools to construct mathematical knowledge. For example, arithmetic concepts may be taught using local market data, geometry through architectural patterns in the community, and algebra through practical resource allocation problems. These experiences help students relate Mathematics to familiar contexts, reducing anxiety and supporting improved achievement, particularly for low achievers.

The framework also draws on **Bronfenbrenner's Ecological Systems Theory**, which underscores that learning outcomes are shaped by interactions between learners and multiple environmental systems, including home, school, community, and culture. CTC Instructional Approach operationalizes this principle by embedding instruction in learners' cultural and contextual realities. Connecting mathematical concepts to students' everyday experiences and local environments not only enhances comprehension but also provides emotional reassurance and motivation, creating a more engaging and supportive learning environment.

Further, the approach is informed by **Kolb's Experiential Learning Theory**, which emphasizes learning through experience, reflection, conceptualization, and application. CTC Instructional Approach integrates experiential cycles by engaging students in hands-on tasks: collecting real-world data, analyzing patterns with digital tools, conceptualizing mathematical relationships, and applying solutions collaboratively. Such experiences provide mastery opportunities, reduce fear and anxiety, and enhance Achievement in Mathematics by making learning active, meaningful, and socially supported.

The **7E Model** operationalizes these theoretical principles in a structured and sequential manner. The **Elicit** and **Engage** phases activate prior knowledge and interest, creating a non-threatening entry point into mathematical tasks. **Explore** and **Explain** allow students to investigate concepts using technology and articulate their understanding, promoting confidence and reducing anxiety. **Elaborate**



and **Evaluate** provide opportunities to apply knowledge in contextualized and collaborative tasks, reinforcing mastery and positive emotional responses. Finally, **Extend** encourages students to generalize and transfer skills to new situations, fostering adaptive problem-solving and higher achievement.

By integrating cultural, technological, and contextual elements, CTC Instructional Approach simultaneously addresses the cognitive and affective dimensions of mathematics learning. Culturally meaningful examples, real-life problem scenarios, and technology-assisted collaborative activities make learning relevant, reduce abstraction, and provide social support. This supportive environment offers repeated successful experiences, mitigates mathematical anxiety, and promotes engagement. Consequently, low-achieving students gain confidence, participate actively, and improve both their **Achievement in Mathematics** and their emotional disposition towards the subject. This theoretical framework, grounded in constructivist, ecological, and experiential learning perspectives, provides the foundation for designing instructional materials, selecting measurement tools, and interpreting the outcomes of this study.

Methods

The study employed an experimental method with a single-group pretest–posttest design to investigate the effect of the Culturo-Techno-Contextual Instructional Approach on Achievement in Mathematics and Mathematical Anxiety of Low achievers among Secondary School Students. The population of the study consisted of Secondary School Students of Thiruvananthapuram District, following Kerala State Syllabus. Using a Multistage Cluster Sampling technique, 118 students were selected and administered an **Achievement Test in Mathematics** developed and validated by the investigator. Based on the test scores, 34 students identified as Low Achievers in Mathematics were selected for experimentation. The same Achievement Test was also used to measure Achievement in Mathematics during the study. The test was constructed based on the cognitive objectives of the Revised Bloom’s Taxonomy and covered the content areas of Arithmetic, Algebra, and Geometry. Initially consisting of 50 multiple-choice items, the draft version was reduced to 42 items in the final form after item analysis and expert validation. The reliability of the test, established through the split-half method, was 0.76, and the content validity index, calculated using Lawshe’s (1975) method, was 0.86.

Data on Mathematical Anxiety were collected using a **Mathematical Anxiety Scale** developed by the investigator, following the framework of Richardson and Suinn (1972). The scale consisted of two domains: Mathematical Test Anxiety (including Evaluation Anxiety and Learning Mathematics Anxiety) and Numerical Anxiety (including Problem-Solving Anxiety, Everyday Numerical Anxiety, Performance



Anxiety, Course Anxiety, and Social Responsibility Anxiety). The draft tool consisted of 70 items, which were reduced to 54 items in the final version after validation. Items were rated on a 5-point Likert scale ranging from *Not at all Anxious* to *Extremely Anxious*. The reliability of the scale, established using the Test–Retest Method, was 0.83, and the content validity index (Lawshe, 1975) was 0.92.

Both Achievement in Mathematics and Mathematical Anxiety were measured at three points: pretest (before the intervention), posttest (immediately after the completion of the instructional program), and delayed posttest (21 days after the posttest). The delayed posttest was conducted to assess the retention of learning and the sustained impact of the Culturo-Techno-Contextual Instructional Approach on students' achievement and anxiety levels over time.

Description of the developed Instructional Material

The instructional material was specifically developed for Low Achievers among Secondary School Students to enhance their Achievement in Mathematics and reduce Mathematical Anxiety by integrating the Culturo-Techno-Contextual Instructional Approach. The material was structured around the 7E instructional model—Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend—to ensure a comprehensive inquiry-based learning experience. The contents of the instructional material were carefully selected based on a need assessment survey conducted among secondary school teachers, which identified topics where students experienced significant difficulties, ensuring that the material focused on areas requiring maximum support and improvement.

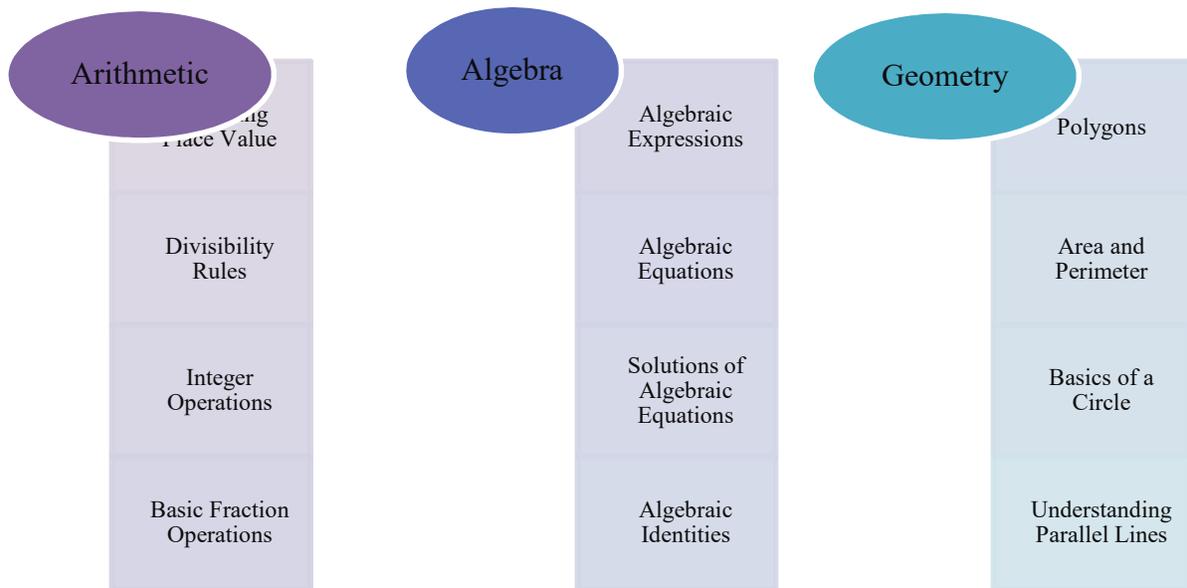
The content incorporated examples, problems, and activities from the students' local environment, daily life, and cultural practices. Arithmetic problems were contextualized around local market transactions, farming practices, festivals, and other real-life scenarios familiar to the students, helping them relate abstract mathematical concepts to their lived experiences. The material included digital resources such as interactive presentations, simulations, videos, and interactive worksheets to support visual and experiential learning. Students were encouraged to use mobile phones or computers to explore patterns, visualize mathematical operations, and analyze data interactively. Contents emphasized real-life applications of Mathematics through practical problem-solving, project-based learning, and collaborative exercises.

Each content includes intended learning outcomes, prerequisites, hook activities, and 7E-based stages with step-by-step guidance for teachers. Activities were designed to actively engage students, stimulate curiosity, and promote problem solving, critical thinking and logical reasoning. Formative



assessments were embedded within the material, including quizzes, puzzles, and interactive problem-solving exercises, allowing ongoing monitoring of student understanding and providing feedback to guide further learning. To address Mathematical Anxiety, the material incorporated low-stress activities, collaborative learning, and scaffolded exercises to gradually build confidence. Strategies such as peer support, self-assessment, and real-world problem contexts helped students perceive Mathematics as meaningful and achievable.

A total of twelve contents were developed, covering three key areas of mathematics—Arithmetic, Algebra, and Geometry—with four contents in each area.



The developed material was administered on a small sample group of fifteen students to assess its usability, engagement, and effectiveness. Expert validation was conducted by experienced Mathematics educators and Secondary School Mathematics teachers to evaluate the accuracy, relevance, and instructional quality of the material. Based on the observations, experiences, and feedback from both students and experts, relevant modifications were made to optimize the material for classroom use.

Analysis and Interpretation

Identifying Low Achievers in Mathematics among Secondary School Students

The investigator administered an Achievement test in Mathematics for identifying Low Achievers in Mathematics among Secondary School Students and it is represented in Table 1

Table 1

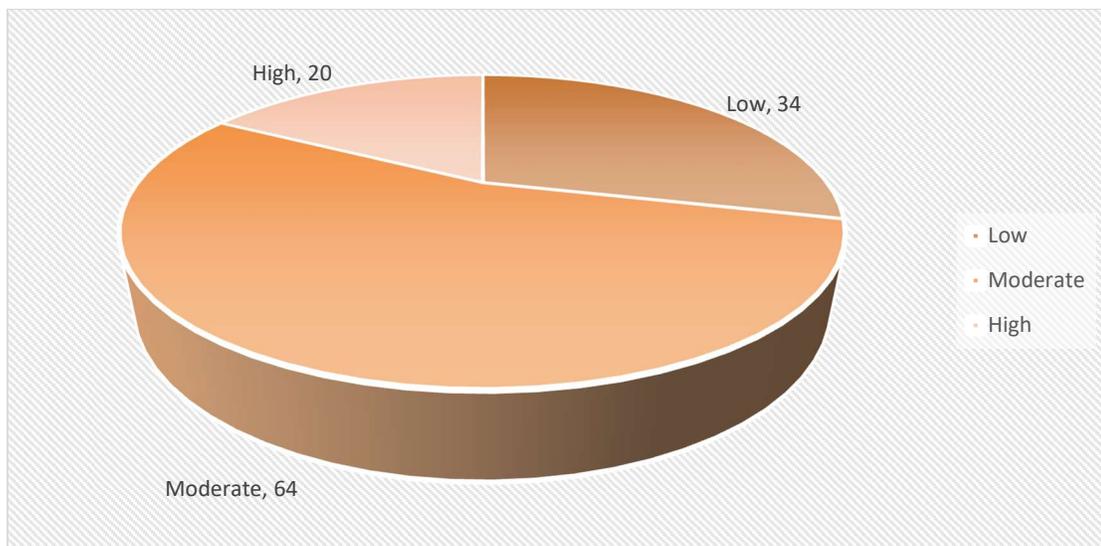
Percentage showing low achievers

Levels	Number of Students	Percent
Low	34	28.81
Moderate	64	54.24
High	20	16.94
Total	118	100

From Table, of the 118 respondents, who took the achievement test, 34 are low achievers, 64 are moderate and 20 are high achievers, indicating that majority of the students possess only a moderate level of achievement. Based on this and by referring previous records showing marks obtained by students, 34 students are identified as low achievers for the experimental part of the study.

Figure 1

Graphical Representation showing the Percentage of low achievers



Analysis of Achievement in Mathematics

Table 2

Descriptive Statistical Analysis of Pretest, Posttest and Delayed Posttest Scores of low achievers among Secondary School Students with respect to Achievement in Mathematics



	Pretest	Posttest	Delayed Posttest
N	34	34	34
Mean	33.6	35.9	34.9
Standard deviation	7.17	7.84	6.85
Skewness	-1.26	-0.867	-0.944
Kurtosis	1.83	0.279	0.0544
Shapiro-Wilk W	0.906	0.930	0.899
Shapiro-Wilk p	0.007	0.032	0.004

From the table, the mean scores of Achievement in Mathematics in the pretest, posttest, and delayed posttest are **33.6, 35.9, and 34.9** respectively, and the standard deviation are **7.17, 7.84, and 6.85** respectively. The skewness values of **-1.26, -0.867, and -0.944** indicate a negatively skewed distribution for all three tests, suggesting that most students scored above the average. The kurtosis values of **1.83, 0.279, and 0.0544** show that the pretest scores are more peaked compared to a normal distribution, while the posttest and delayed posttest are closer to normality. The Shapiro–Wilk test results ($W = 0.906, 0.930, 0.899$; $p = 0.007, 0.032, 0.004$) indicate that the pretest, posttest, and delayed posttest scores are distributed normally.

Effect of Culturo-Techno-Contextual Instructional Approach on enhancing Achievement in Mathematics of Low Achievers among Secondary School Students.

This part of the analysis is aimed to explore whether the Culturo-Techno-Contextual Instructional Approach could bring about changes in the Achievement in Mathematics of Low Achievers among Secondary School Students. The intervention was designed to integrate cultural context, technology, and real-life situations into classroom instruction to make mathematics more meaningful and accessible. Achievement scores were measured through a pretest, posttest, and delayed posttest to capture both immediate and retention of the approach. The analysis thus provides evidence on the effectiveness of CTC Instructional Approach in improving mathematical performance over time.

Table 3

Mauchly's Test of Sphericity

Within Subjects	Mauchly's W	Approx. Chi-	df	Sig.	Epsilon ^b		
					Greenhous	Huynh-	Lower-



Effect		Square		e-Geisser	Feldt	bound	
Time	.835	5.763	2	.056	.859	.901	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Time

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

From the table, the test statistic for Mauchly's test of sphericity is the chi-square statistic, which in this case has a value of **5.763** with a p-value of **0.056**. Since the p-value is greater than 0.05, the null hypothesis of sphericity is not rejected, indicating that the assumption of sphericity has been met. Therefore, the variance of the differences between time points (pretest, posttest, and delayed posttest) can be assumed to be equal, and the standard uncorrected F-ratios in the repeated measures ANOVA may be used. As the sphericity assumption holds, there is no need to rely on corrected tests such as Greenhouse-Geisser or Huynh-Feldt adjustments. The results of the tests of within-subjects effects are discussed below.

Table 4

Test of Within-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity	83.118	2	41.559	12.197	.000	.270
	Assumed						
	Greenhouse- Geisser	83.118	1.717	48.408	12.197	.000	.270
	Huynh-Feldt	83.118	1.802	46.120	12.197	.000	.270
	Lower-bound	83.118	1.000	83.118	12.197	.001	.270



Error (Time)	Sphericity	224.882	66	3.407
	Assumed			
	Greenhouse-Geisser	224.882	56.661	3.969
	Huynh-Feldt	224.882	59.473	3.781
	Lower-bound	224.882	33.000	6.815

The table showed the result of repeated measures ANOVA for Achievement in Mathematics. The first line of the factor “Time” indicates “Sphericity Assumed,” which can be interpreted if the assumption of sphericity has been met. The second, third, and fourth lines represent F tests with adjustments (Greenhouse-Geisser, Huynh-Feldt, and Lower-bound) in case the sphericity assumption is violated. Here, the Greenhouse-Geisser adjusted F test is considered to determine whether there is a significant difference in Achievement in Mathematics across pretest, posttest, and delayed posttest scores. The Greenhouse-Geisser F value is **12.197**, with $df = 1.717/56.661$ and $p = 0.000$. Since the obtained F value is significant at 0.05 level, it indicates that there is a significant difference in Achievement in Mathematics across the three testing occasions. Therefore, a post hoc test (pairwise comparison) was carried out to identify between which testing points the significant differences occurred. The results and interpretation of the post hoc analysis are provided below.

Table 5

Post Hoc Analysis

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig. ^b	99% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
Pretest	Posttest	-2.206*	.503	.000	-3.797	-.615
	Delayed Posttest	-1.235	.478	.043	-2.747	.276
Posttest	Pretest	2.206*	.503	.000	.615	3.797
	Delayed Posttest	.971	.347	.026	-.127	2.068



Delayed	Pretest	1.235	.478	.043	-.276	2.747
Posttest	Posttest	-.971	.347	.026	-2.068	.127

Based on estimated marginal means

*. The mean difference is significant at the .01 level.

b. Adjustment for multiple comparisons: Bonferroni.

The Bonferroni post hoc test was used to determine where the significant differences exist between the three stages of testing in Achievement in Mathematics. From the table 4.20, the mean differences indicate that there is a significant difference between the pretest and posttest scores at the 0.01 level, showing improvement after the intervention. Additionally, the posttest and delayed posttest scores also differ significantly at 0.01 level, indicating some retention effect. The difference between the pretest and delayed posttest scores is significant at the 0.05 level, suggesting that the improvement in achievement was maintained to a considerable extent over time. Therefore, it can be concluded that the Culturo-Techno-Contextual Instructional Approach had a significant positive effect on the Achievement in Mathematics of low achievers among secondary school students across the three stages of testing.

Analysis of Mathematical Anxiety

Table 6

Descriptive Statistical Analysis of Pretest, Posttest and Delayed Posttest Scores of low achievers among Secondary School Students with respect to Mathematical Anxiety

	Pretest	Posttest	Delayed Posttest
N	34	34	34
Mean	75.0	78.6	78.1
Standard deviation	20.7	19.6	19.3
Skewness	0.0646	-0.0146	-0.0386
Kurtosis	-0.948	-0.927	-1.01
Shapiro-Wilk W	0.934	0.946	0.949
Shapiro-Wilk p	0.042	0.095	0.112



From the table, the mean scores of Mathematical Anxiety in the pretest, posttest, and delayed posttest are **75.0, 78.6, and 78.1** respectively, while the standard deviations are **20.7, 19.6, and 19.3**. These values indicate that the overall level of anxiety remained relatively stable across the three testing occasions, with only slight variations. The skewness values of **0.0646, -0.0146, and -0.0386** suggest that the score distributions are approximately symmetrical. The kurtosis values of **-0.948, -0.927, and -1.01** indicate that the distributions are **platykurtic**, meaning they are flatter than the normal distribution with lighter tails. The results of the Shapiro–Wilk test ($W = 0.934, 0.946, 0.949$; $p = 0.042, 0.095, 0.112$) show that the pretest posttest and delayed posttest scores are distributed normally.

Effect of Culturo-Techno-Contextual Instructional Approach on reducing Mathematical Anxiety of Low Achievers among Secondary School Students.

This part of the analysis is intended to examine whether the Culturo-Techno-Contextual Instructional Approach has an impact on reducing **Mathematical Anxiety** of Low Achievers among Secondary School Students. Since anxiety often acts as a barrier to mathematical learning and performance, addressing it is crucial in enhancing student outcomes. The study measured anxiety levels using pretest, posttest, and delayed posttest scores to evaluate both the immediate and lasting effects of the intervention. The analysis provides insights into how CTC Instructional Approach can create a supportive learning environment that helps reduce anxiety and build confidence in mathematics.

Table 7

Mauchly's Test of Sphericity

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^b		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Time	.408	28.716	2	.000	.628	.641	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

- a. Design: Intercept
Within Subjects Design: Time



- b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

From the table, the test statistic for Mauchly's Test of Sphericity is the chi-square value, which in this case is **28.716 with a p-value of 0.000**. Since the p-value is less than 0.05, the null hypothesis of sphericity is rejected, indicating that the assumption of sphericity has been violated. This means that the variances of the differences between the three testing occasions (pretest, posttest, and delayed posttest) are not equal. Therefore, the researcher must rely on corrected tests, such as the **Greenhouse-Geisser** or **Huynh-Feldt adjustments**, when interpreting the repeated measures ANOVA. The results of the tests of within-subjects effects are presented and discussed in the following section.

Table 8

Test of Within-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity	267.608	2	133.804	13.906	.000	.296
	Assumed						
	Greenhouse- Geisser	267.608	1.256	213.064	13.906	.000	.296
	Huynh-Feldt	267.608	1.282	208.701	13.906	.000	.296
	Lower-bound	267.608	1.000	267.608	13.906	.001	.296
Error (Time)	Sphericity	635.059	66	9.622			
	Assumed						
	Greenhouse- Geisser	635.059	41.448	15.322			
	Huynh-Feldt	635.059	42.314	15.008			
	Lower-bound	635.059	33.000	19.244			

The table shows the results of repeated measures ANOVA for Mathematical Anxiety across the three testing occasions (pretest, posttest, and delayed posttest). The first row of the factor "Time" presents the result assuming sphericity, while the subsequent rows (Greenhouse-Geisser, Huynh-Feldt,



and Lower-bound) provide adjusted F-tests in case the sphericity assumption is violated. Since Mauchly's Test of Sphericity indicated a violation, the Greenhouse-Geisser correction was considered. The adjusted F value is **13.906**, with $df = 1.256/41.448$ and $p < .001$, which is highly significant. This finding indicates a statistically significant difference in Mathematical Anxiety scores across the three time points. The partial eta squared value of **.296** suggests a large effect size, meaning that approximately **29.6% of the variance** in mathematical anxiety can be explained by the effect of time. Therefore, post hoc comparisons are required to determine between which testing occasions these significant differences occurred.

Table 9*Post Hoc Analysis*

(I) Time	(J) Time	Mean Differenc e (I-J)	Std. Error	Sig. ^a	99% Confidence Interval for Difference ^a	
					Lower Bound	Upper Bound
Pretest	Posttest	-3.647*	.879	.001	-6.430	.864
	Delayed Posttest	-3.176*	.891	.003	-5.996	.357
Posttest	Pretest	3.647*	.879	.001	.864	6.430
	Delayed Posttest	.471	.361	.605	-.673	1.614
Delayed	Pretest	3.176*	.891	.003	.357	5.442
Posttest	Delayed Posttest	-.471	.361	.605	-1.614	.673

Based on estimated marginal means

* The mean difference is significant at the .01 level

a. Adjustment for multiple comparisons: Bonferroni.

The Bonferroni post hoc analysis revealed significant differences between **pretest and posttest scores** ($p = .001$) and between **pretest and delayed posttest scores** ($p = .003$), indicating that students'



Mathematical Anxiety decreased significantly after the intervention and that this reduction was sustained over time. However, the difference between posttest and delayed posttest scores ($p = .605$) was not significant, suggesting that anxiety levels remained relatively stable after the initial reduction. Overall, these results highlight that the Culturo-Techno-Contextual Instructional Approach was effective in reducing Mathematical Anxiety among low achievers, and its positive effect was retained in the delayed posttest.

Result of the Analysis

- In terms of Achievement in Mathematics, repeated measures ANOVA revealed a significant improvement in achievement across pretest, posttest, and delayed posttest scores. However, Post hoc analysis confirmed that the posttest scores were significantly higher than the pretest scores, indicating the effectiveness of the Culturo-Techno-Contextual Instructional Approach in enhancing Achievement in Mathematics of Low Achievers among Secondary School Students. Achievement gains also retained to a considerable extent in the delayed posttest, showing long-term effectiveness of the intervention.
- In terms of **Mathematical Anxiety**, repeated measures ANOVA (with Greenhouse-Geisser correction due to violation of sphericity) indicated a significant reduction in anxiety scores across the pretest, posttest, and delayed posttest. Post hoc analysis revealed that anxiety decreased significantly from pretest to posttest and from pretest to delayed posttest. However, there is no significant difference between posttest and delayed posttest scores, indicating that the reduction in anxiety sustained over time. This confirms that the CTC Instructional Approach is effective in reducing Mathematical Anxiety of Low Achievers among Secondary School Students.

Educational Implications of the Study

- The findings of the study highlights that the use of culturally relevant, technologically supported, and context-based strategies can significantly enhance Achievement in Mathematics in secondary classrooms.
- The result of the suggest that Teachers should integrate real-life contexts and technological tools to make mathematics more engaging and meaningful.
- The findings of the study support the NEP 2020 emphasis on competency-based, experiential, and contextual learning approaches.



- The findings of the study highlights that curriculum planners should embed contextual and cultural linkages into textbooks and teaching-learning materials.
- Gaining insight from the findings of the study professional development programs should train teachers to design and implement CTC Instructional Approach based contents.
- The study highlights that training in addressing affective factors like anxiety should be included alongside cognitive-focused strategies.
- While achievement improved, stable anxiety levels suggest a need for complementary interventions such as counselling, peer support, and mindfulness training.

Delimitations of the Study

- The study was conducted only with secondary school students in one geographical region, limiting generalizability.
- Only two dependent variables were considered: Achievement in Mathematics and Mathematical Anxiety.
- The intervention was limited to a short period with 12 contents, which may not be sufficient to capture long-term affective changes.
- A single-group design was adopted, without including a control group for comparison.

Limitations of the Study

- The study relied on self-report scales for Mathematical Anxiety, which may be influenced by social desirability or response bias.
- External factors (e.g., parental support, peer influence, school environment) were not controlled but could have influenced achievement and anxiety.
- The intervention primarily focused on instructional design; other anxiety-reduction strategies were not integrated.



Recommendations for Further Research

- Conduct long-term studies to examine whether prolonged exposure to CTC Instructional Approach impacts mathematical anxiety more effectively.
- Use experimental or quasi-experimental designs with control groups to strengthen causal inferences.
- Include additional affective and cognitive variables such as motivation, self-efficacy, and critical thinking.
- Replicate the study across different states, cultural backgrounds, and type of schools.
- Combine CTC Instructional Approach with counselling, relaxation techniques, or metacognitive training to address both achievement and anxiety simultaneously.

Conclusion

The present study examined the effect of the Culturo-Techno-Contextual Instructional Approach on Low Achieving Secondary School Students' Achievement in Mathematics and their Mathematical Anxiety. The findings revealed that the CTC Instructional Approach significantly enhanced students' achievement, with gains largely retained in the delayed posttest. Moreover, the approach produced a considerable reduction in Mathematical anxiety, which retained across the three testing points.

The study concludes that instructional approaches integrating cultural relevance, contextual learning, and technology are effective in improving achievement and in reducing anxiety related to the subject. These results support the vision of NEP 2020 in promoting experiential, contextual, and technology-supported education and offer guidance for teachers, curriculum planners, and policymakers to develop holistic interventions that target both cognitive and emotional outcomes in mathematics learning.

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Appendices

A Sample Excerpt from the Instructional Material

Topic/Title: Mastering Place Value

Subtopic: Understanding Place Value of Whole Numbers

Intended Learning Outcomes:

By the end of this lesson, students will be able to:

1. define place, digit, and face value.
2. explain the role of each digit in a number based on its position.
3. represent numbers in standard, expanded, and word forms.



4. compare and arrange numbers based on place value.
5. solve real-life problems involving large numbers.
6. perform activities related to place value accurately.
7. relate place value to daily life situations (money, population, distances).

Pre-requisites:

- Basic understanding of forward and backward counting (at least up to 100).
- Ability to understand quantity.
- Understanding which number is bigger/smaller.

Elicit (Access Prior Knowledge)

Hook Activity:

- Students are divided into groups of 3–4. Each group receives a game card
- Task: Find the hidden numbers



Tools/Materials: Game card, Colour Pencils

Engage (Focus Students on the Topic)

- Teacher says: “We use numbers every day—population, money, distances—but did you know that the position of a digit changes its value?”
- Example:
 - Number of students studying in this school is 6, 472. Ask students:



- What is the value of 7 in this number?
- What is the value of 6 in this number?
- Students discuss in pairs and share answers.

Tools/Materials: Whiteboard, markers, sample numbers

Explore (Provide a Common Experience)

- Students are given numbers on cards: 3,482; 57,216; 4,506, etc.
- Tasks:
 1. Identify place value and face value of each digit.
 2. Arrange numbers in ascending and descending order.
 3. Observe patterns in digits based on place.
- Key Questions:
 - Does the digit 5 always represent the same value?
 - Can we use place value knowledge to read large numbers in daily life?

Tools/Materials: Number cards

Explain (Teach the Concept – Interaction Included)

- Teacher introduces formal concept (using a video):
 - Place value = the value of a digit according to its position in a number.
 - Face value = the digit itself.





<https://youtu.be/Paza3CbdamI?si=meWyhIUOrSwGUFUX>

- Teacher uses a place value chart: Units, Tens, Hundreds, Thousands, Ten-thousands, Lakhs.
- Students practice:
 - Reading numbers in standard, expanded, and word forms.
 - Example: $5,46,203 = 5,00,000 + 40,000 + 6,000 + 200 + 3$
- Memory Trick: “Face is the digit; place gives its grace.”

Tools/Materials: Video, PPT, place value chart

Elaborate (Apply the Concept)

Activity: “Build Your Number” Game

- Rules:
 1. Students are given digits 0–9.
 2. Teacher calls out the place and value:
e.g., “Thousands place = 5, Tens place = 7.”
 3. Students create the number using cards.
- Contextual Link: Relate to real-life situations like:
 - Population of a city
 - Bank balances
 - Distance between cities

Tools/Materials: Number cards, worksheets

Evaluate (Check Learning)



- Worksheet tasks:
 1. Identify place and value of digits in 3,72,568.
 2. Write 4,56,203 in expanded form.
 3. Compare 2,35,678 and 2,53,678 and identify the greater number.
- Teacher observes and provides feedback on correct usage of place value concepts.

Tools/Materials: Worksheets

Extend (Deepen Understanding in New Contexts)

- Students discuss real-life situations requiring knowledge of place value:
 1. Calculating the population of villages/towns.
 2. Money in savings accounts.
 3. Distances in maps or travel planning.
- Students create their own word problems connecting numbers to local cultural or community contexts.

Reflection (Metacognitive Stage)

- Students reflect individually or in pairs:
 - Why is knowing place value important in daily life?
 - How does place value help us compare numbers?
 - Where else do you see large numbers in your surroundings?
- Teacher facilitates discussion to reinforce understanding and contextual relevance.

Sample of items in the Achievement Test in Mathematics

Instruction:



Read each question carefully and choose the correct option. Do not skip any question unanswered; try to attempt all of them.

- What is the place value of 7 in the number 57,482?
 - a. 7
 - b. 70
 - c. 7,000
 - d. 70,000
- Which of the following numbers is divisible by 9?
 - a. 5,237
 - b. 4,572
 - c. 3,648
 - d. 7,125
- The length of a rectangle is 12 cm and its breadth is 8 cm. What is its area?
 - a. 20 cm²
 - b. 96 cm²
 - c. 48 cm²
 - d. 100 cm²
- If $2x + 5 = 15$, then the value of x is:
 - a. 3
 - b. 5
 - c. 7
 - d. 10
- If two lines are parallel, what is the sum of co-interior angles on the same side of a transversal?
 - a. 90°
 - b. 120°
 - c. 180°
 - d. 360°



Sample of items in the Mathematical Anxiety Scale

Instruction:

Read each statement carefully and indicate how anxious you would feel in the given mathematics-related situation. Choose the option that best represents your level of anxiety. Remember, there are no right or wrong answers—respond based on your own experience.

Categories: Not all Anxious, Slightly Anxious, Moderately Anxious, Very Anxious, and Extremely Anxious

- Being assigned a tough set of mathematics problems to complete before the next class.
- Waiting to receive the results of a mathematics test you felt confident about.
- Watching a teacher solving a problem on the board.
- Being observed while solving mathematics problems.
- Hearing others discuss the answers to assignment questions that you are unable to solve.