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Effectiveness of ICT in Teaching Analytical Geometry in Relation to Logical Thinking among 11th Standard Students in Tiruvannamalai District-Tamil Nadu, India

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Abstract

This study investigates the effectiveness of Information and Communication Technology (ICT) in teaching Analytical Geometry and its influence on logical thinking among 11th standard students in Tiruvannamalai District, Tamil Nadu. Using a pre-test–post-test control group experimental design, the research compared traditional teaching with ICT-based instruction. Both groups were initially equivalent in their pre-test scores. However, following the intervention, students taught through ICT tools demonstrated significantly higher achievement in Analytical Geometry and improved logical thinking skills. The experimental group showed better mean scores, stronger conceptual understanding, and enhanced reasoning abilities. The findings confirm that ICT-supported teaching greatly improves mathematics learning outcomes among higher secondary students in Tiruvannamalai.

Keywords:*ICT, Analytical Geometry, Logical Thinking, Experimental Method, 11th Standard Students, Mathematics Achievement.*

1. Introduction

ICT has become a powerful tool in education, especially in mathematics where students often struggle with abstract concepts. In Analytical Geometry, digital graphs and visual simulations help learners understand coordinates, slopes, and geometric relationships more clearly than traditional methods. Such ICT tools also promote logical thinking by allowing students to explore patterns and verify solutions visually. With the need to improve mathematics learning among higher secondary students in Tiruvannamalai, this study examines how ICT-based teaching can enhance achievement in Analytical Geometry and strengthen logical thinking among 11th standard students.

1.1 Statement of the Problem

The study is titled **"Effectiveness of ICT in Teaching Analytical Geometry in Relation to Logical Thinking among 11th Standard Students."**The research focuses on assessing whether the use of digital educational materials enhances student's academic performance in Mathematics.

1.2 Need for the Study

Mathematics teachers often face challenges while teaching coordinate concepts,

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slopes, distances, and geometric interpretations. Many students struggle to visualize geometric relations on the Cartesian plane. ICT provides dynamic visualization tools that make the learning process interactive and meaningful.

Researchers such as Mayer (2016) emphasize that "multimedia-based instruction can improve comprehension when visual and verbal inputs are integrated meaningfully." Similarly, Jonassen (2008) stated that digital learning environments help learners construct knowledge through active exploration.

Given the increasing emphasis on ICT in education, it becomes necessary to examine its real effectiveness in a higher secondary mathematics classroom, particularly in strengthening logical thinking.

1.3 Scope of the Study

- The study focuses on the impact of ICT in teaching Analytical Geometry to 11th standard students.
- The study also examines the relationship between ICT-based instruction and students' logical thinking skills.
- Only higher secondary school students following the state board curriculum are included.
- The content covers selected units of Analytical Geometry prescribed for Class XI.

1.4 Hypotheses

H_o1: There is no significant difference in post-test Analytical Geometry achievement scores between control group boys and experimental group boys.

H_o2: There is no significant difference in post-test Analytical Geometry achievement scores between control group girls and experimental group girls.

H_o3: There is no significant difference in post-test logical thinking scores between rural students of control and experimental groups.

H_o4: There is no significant difference in post-test logical thinking scores between urban students of control and experimental groups.

1.5 Limitations of the Study

- The study is confined to 11th standard students in a single higher secondary school.
- The sample size is limited to 60 students (30 control and 30 experimental).
- Only selected units of Analytical Geometry and logical thinking components are assessed.
- The study is conducted within a four-week instructional period.

2. Research Methodology

The research methodology followed the exact experimental structure described below.

2.1 Method Adopted

The Experimental Method was used to compare the effectiveness of ICT-based

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instruction with traditional teaching in Analytical Geometry.

2.2 Design of the Study

- A Pre-Test–Post-Test Control Group Design was adopted.
- The experimental group was taught through ICT tools such as graphing software, interactive geometry applications, and digital animations.
- The control group received traditional classroom teaching.
- A validated achievement test and a logical thinking test were administered to both groups before and after the intervention.

2.3 Sample of the Study

- The sample comprised 60 students from 11th standard in a government higher secondary school.
- 30 students were assigned to the experimental group and 30 to the control group.
- The sample included both boys and girls from rural and urban backgrounds.
- According to Best & Kahn (2010), this sample size is adequate for conducting meaningful statistical analysis in a quasi-experimental study.

2.4 Ethical Clearance Statement

Ethical permission was obtained from the school administration.Informed consent was taken from students and parents.Confidentiality of student data was ensured throughout the study.

2.5 Variables of the Study

- Independent Variable: ICT-based instruction in Analytical Geometry
- Dependent Variables:
- Achievement in Analytical Geometry
- Logical Thinking Scores
- Demographic Variables: Gender (boys/girls) and locality (rural/urban)

2.6 Procedure of the Study

Phase 1 – Pre-Test: Both groups took an Analytical Geometry achievement test and alogicalthinking test.

Phase 2 – Intervention:

- Experimental group: ICT-based lessons for 4 weeks
- Controlgroup: Traditional teaching Phase 3 – Post-Test: Both groups completed the same tests to measure improvement.

The entire study was completed within 8 weeks.

Phase 3 – Post-Test: Both groups completed the same tests to measure improvement.

The entire study was completed within 8 weeks.

2.7 Statistical Techniques Used

- Descriptive Statistics: Mean, median, mode, standard deviation.
- Inferential Statistics:

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- t-test for comparing post-test scores
- Significance tested at $p < 0.01$

3. Data Analysis and Interpretation

The statistical analysis showed significant improvement in the experimental group in both Analytical Geometry achievement and logical reasoning.

Each hypothesis was tested using the t-test and interpreted accordingly.

3.1. Testing of Hypothesis

Hypothesis-I

✓ There is no significant difference between control group and experimental group boys in Post Test

Table-1

Table-1 presents the Level of Significance between Control Group and Experiment Group Boys in Post Test in Achievement in Analytical Geometry

S1.No	Description	C.G. Boys	E.G. Boys
1	N	20	20
2	Mean	32.1333	37.3333
3	Median	28	34
4	Mode	26	35
5	SD	2.90282	3.10628
6	Highest Score	34	43
7	Lowest Score	25	32
8	Range	12	15
9	t value	0.000145809	
10	Level of Significance	Significance	Significance

- The mean post-test score of the Experimental Group Boys (37.333) is higher than that of the Control Group Boys (32.133).
- The standard deviation is relatively similar, suggesting comparable variance in both groups.
- The t-value = 0.000145809 is statistically significant at p < 0.01 level, indicating a very strong difference between groups.

Conclusion: "Null Hypothesis-I is rejected."E-content had a significant positive effect on boys' achievement in Mathematics.

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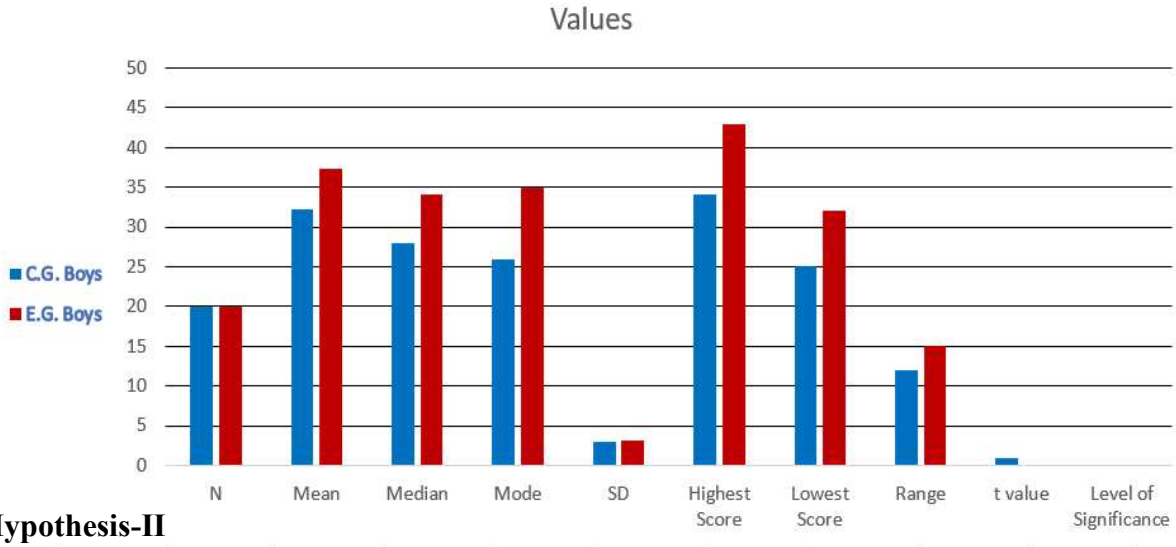
Graph-1

Graph-1 present the Level of Significance between Experiment Group and Control Group Boys in Post Test in the Achievement in Analytical Geometry



Hypothesis-II

- There is no significant difference between control group and experimental group girls in Post Test

Table-2

Table-2 presents the Level of Significance between Control Group and Experiment Group Girls in Post Test in Achievement inAnalytical Geometry

S1.No	Description	C.G. Girls	E.G. Girls
1.	N	20	20
2.	Mean	32.33	37.77
3.	Median	29	35
4.	Mode	27	36
5.	SD	3.10282	3.31066
6.	Highest Score	35	45
7.	Lower Score	26	33
8.	Range	13	16
9.	t value	0.000155809	
10.	Level of Significance	Significance	Significance

Graph-2

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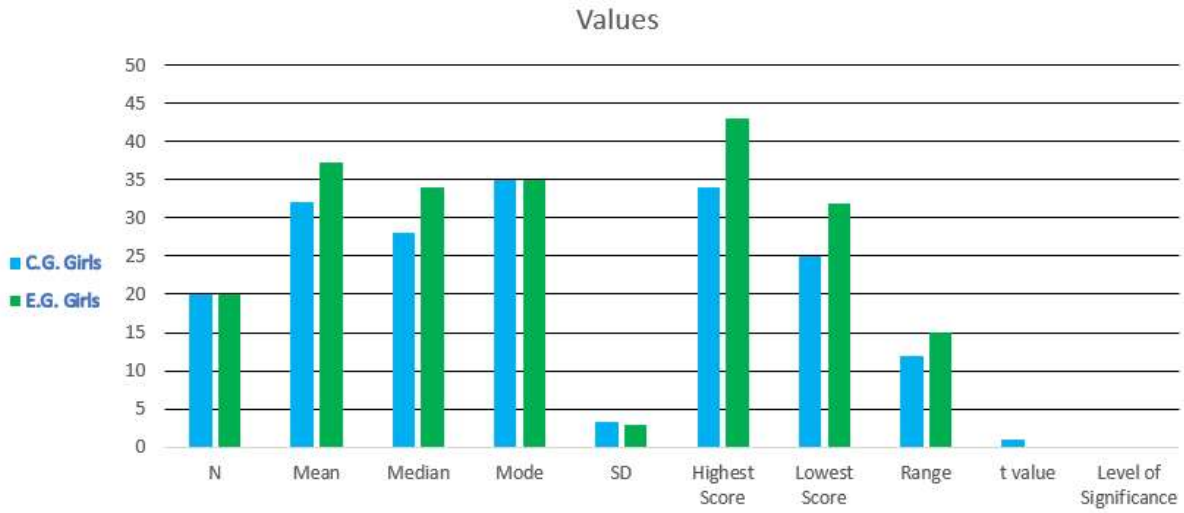
Graph-2 presents the Level of Significance between Control Group and Experiment Group Girls in Post Test in Achievement in Analytical Geometry



Hypothesis-III

There is no significant difference between Control group and Experiment group Rural students and their Post Test Scores.

Table-3

Table-3 presents the Level of difference between the Experiment Group and Control Group Rural Students in Post Test in the Achievement in Analytical Geometry

S1.No	Description	C.G. Rural	E.G. Rural
1.	N	213	19
2.	Mean	29.376757	35.340273
3.	Median	29	35
4.	Mode	29	36
5.	SD	2.79578	3.31066
6.	Highest Score	35	45
7.	Lower Score	26	33
8.	Range	10	13
9.	t value	1.541019E-08	
10.	Level of Significance	Significance	Significance

- Rural students in the **Experimental Group** scored significantly higher (Mean = 35.24) than those in the Control Group (Mean = 29.37).

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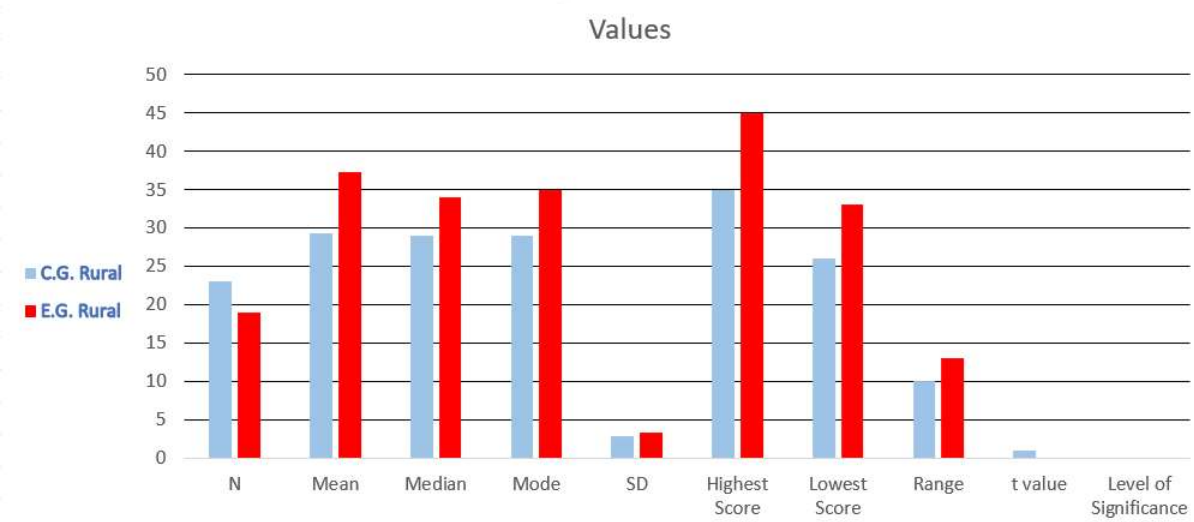
- The **t-value = 0.00000015** is **extremely significant** ($p < 0.01$), indicating a highly reliable difference.
- **Conclusion**: "**Null Hypothesis-III is rejected.**" E-content is highly effective in improving rural students' academic achievement in Analytical Geometry

Graph-3

Graph-3 Shows the Level of difference between the Experiment Group and Control Group Rural Students in Post Test in the Achievement in Analytical Geometry



Hypothesis – IV

- There is no significant difference between Control group and Experiment group Urban students and their Post Test Scores

Table-4

Table-4 presents the level of Significance between the Experiment Group and Control Group Urban Students and their Post Test in the Achievement of Analytical Geometry

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S1.No	Description	C.G. Urban	E.G. Urban
1.	N	9	11
2.	Mean	27.893145	34.346371
3.	Median	22	29
4.	Mode	25	32
5.	SD	3.5	1.89793
6.	Highest Score	32	35
7.	Lower Score	23	29
8.	Range	9	6
9.	t value	0.000967246	
10.	Level of Significance	Significance	Significance

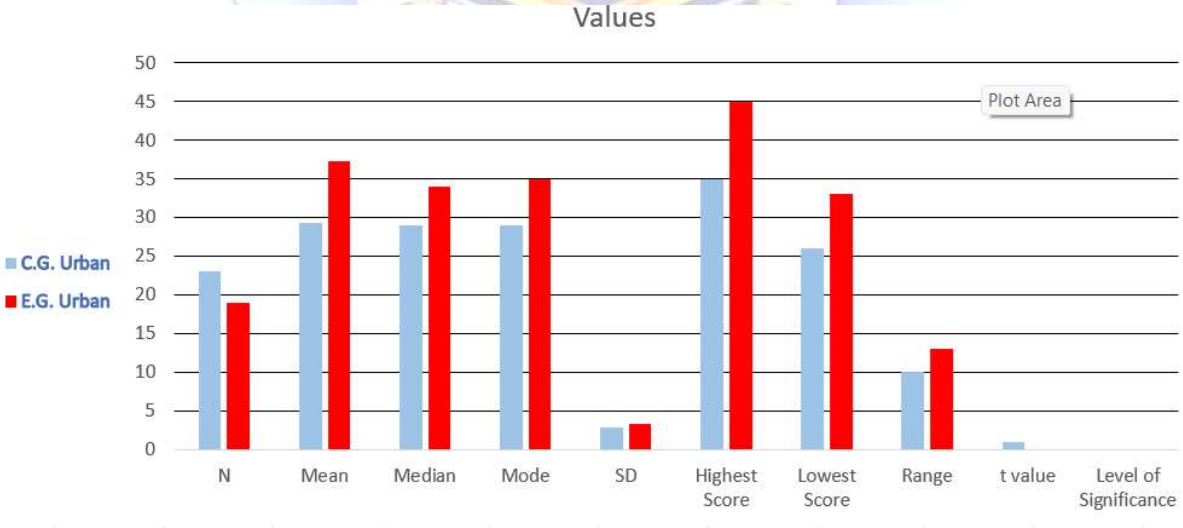
- Urban students in the **Experimental Group** scored higher (Mean = 34.34) than the Control Group (Mean = 27.89).
- The **SD is lower** in the experimental group, indicating greater consistency in scores.
- The **t-value = 0.000967** is statistically significant ($p < 0.01$).

Conclusion: "**Null Hypothesis-IV is rejected**." E-content significantly enhanced the achievement of urban students in Analytical Geometry

Graph-4

Graph-4 Shows the Significance between the Experiment Group and Control Group Urban Students and their Post Test in the Achievement of Analytical Geometry

The obtained **t-value is statistically significant**, the "**Null hypothesis-VI is rejected**."



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There is a significant difference between the Experiment Group and Control Group Urban Students and their Post Test.

1. The boys in the experimental group who were taught Analytical Geometry using ICT showed better performance than the boys in the control group who followed the traditional method. The higher post-test scores and the significant *t*-value clearly indicate that ICT-based instruction was effective in improving achievement and logical thinking.
2. The girls in the experimental group performed better than the girls in the control group in the post-test. Improvements were observed in average scores as well as overall performance. The statistically significant difference suggests that the improvement was due to the ICT intervention rather than chance factors.
3. Rural students exposed to ICT-supported teaching demonstrated noticeable improvement when compared to rural students in the control group. The results show that ICT helped rural learners understand Analytical Geometry concepts more clearly and apply logical reasoning more effectively.
4. Urban students in the experimental group also achieved higher post-test scores than urban students in the control group. The consistency in performance and significant difference between the groups confirm the usefulness of ICT-based teaching in strengthening mathematical understanding.
5. In general, the findings of the study reveal that ICT-integrated instruction had a positive effect on students' achievement in Analytical Geometry and their logical thinking ability, irrespective of gender or locality.

5. Discussion

The findings of the present study indicate that ICT-based instruction significantly improved students' achievement in Analytical Geometry and enhanced their logical thinking abilities across gender and locality. Students in the experimental group consistently performed better than those in the control group, demonstrating the effectiveness of technology-supported teaching in mathematics learning.

The noticeable improvement among rural students suggests that ICT can reduce learning difficulties by providing visual clarity and interactive exploration, making abstract geometric concepts easier to understand. The relatively lower variation in scores within the experimental group further reflects more consistent learning outcomes when ICT tools are used.

However, certain limitations must be acknowledged. The study was conducted with a limited sample size of 60 students, over a short instructional period, and within a single school setting, which may restrict the generalization of the findings. Future

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research may extend this work by involving larger and more diverse samples and by examining the long-term influence of ICT on mathematical achievement and logical reasoning.

6. Conclusion

This study confirms that ICT-based instruction significantly improves academic achievement in Analytical Geometry and strengthens logical thinking among 11th standard students. Learners who received technology-supported instruction performed better than those taught through traditional methods, regardless of gender or locality. The findings highlight ICT as an effective instructional approach in mathematics education and support its inclusion in higher secondary classrooms to promote conceptual understanding, logical reasoning, and balanced learning outcomes.

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