



A COMPARATIVE STUDY OF THE EFFECTIVENESS OF DEMONSTRATION AND LABORATORY-BASED TEACHING METHODS IN SCIENCE AND TECHNOLOGY FOR 9TH-GRADE STUDENTS IN SECONDARY SCHOOLS OF LATUR TALUKA

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Paper Received On: 21 JUNE 2026

Peer Reviewed On: 25 JULY 2026

Published On: 01 AUG 2026

Abstract

This study, to compare the effectiveness of the demonstration and laboratory methods of teaching Science and Technology. The study was motivated by the need to promote scientific temper, experimental skills, observation, critical thinking, and active learning among students, as science teaching is often dominated by the lecture method. The main objective was to examine students' learning outcomes under the demonstration and laboratory teaching methods and to determine whether significant differences existed between boys and girls. An experimental research method with an equivalent-group design was adopted. A sample of 40 ninth-grade students (20 boys and 20 girls) was selected through random sampling from a school in Latur Taluka. The unit "Substances in Our Daily Use" was taught using the demonstration and laboratory methods, and a self-constructed unit test was administered to assess students' learning outcomes. Statistical techniques, particularly the 't'-test, were used to analyze the data. The findings revealed that students taught through the laboratory method performed significantly better than those taught through the demonstration method. Girls showed significantly higher achievement than boys under the laboratory method, whereas no significant gender difference was observed under the demonstration method. Significant differences were also found when comparing laboratory and demonstration learning outcomes among both boys and girls. Overall, the study established that the laboratory method was more effective than the demonstration method in improving students' achievement in Science and Technology. The study concludes that greater use of laboratory-based teaching can enhance students' learning outcomes and provide opportunities for direct experimentation, observation, active participation, and development of scientific temper. It therefore recommends that science teachers give greater emphasis to laboratory experiences alongside other instructional methods.

Interoduction

Science has held a significant place not only today but since ancient times. We cannot conceive of research without science. Whether in the realm of research or society at large, embracing science is essential. The study of science and technology fosters qualities such as an experimental spirit, observational skills, and a critical mindset among students. However, it is often observed that the lecture method is predominantly used to teach science. If teachers prioritize the laboratory method over the lecture method, the effectiveness of instruction

increases, and a scientific temper is better cultivated in students; this study was selected to evaluate that effectiveness.

To clarify the meaning of science, it is essential to understand how the concept itself evolved. The evolution of the concept of science can be explained by tracing human development from the primitive stage to the present day. When we consider the broad trajectory of human progress, the evolution of the scientific concept becomes clear. In the primitive stage, human life was entirely natural and dependent on nature. Humans learned many things through experience; indeed, these experiences were essentially experiments. Satisfying curiosity and engaging in innovation brought them joy, fueling a ceaseless journey of discovery. To ensure continuity in experimentation, a scientific discipline began to emerge. Science is a continuous, systematic process—one that fosters the development of scientific discipline and a scientific temper.

Objectives

To identify the difficulties students face in science and technology subjects, and to conduct a comparative study on the effectiveness of the demonstration method versus the laboratory method by assessing student interest in them.

Research Methodology

The experimental method has been employed for this research. Experimental research is defined as a method where the aim is not merely to test a hypothesis, but to observe the changes occurring in various factors during the experiment. Like other forms of educational research, the fundamental purpose here is to address dissatisfaction with a prevailing educational situation and attempt to resolve it through research. In experimental research, the researcher focuses on the future, constantly addressing questions such as: "What will happen, how will it happen, and why will it happen?" under carefully controlled conditions. This highly effective method, originally from the science laboratory, has been adapted for the classroom by the field of education, utilizing the control of variables. Additionally, the researcher should note the importance of conducting a small-scale pilot study (or exploratory study) after planning the experiment but before its actual commencement; this allows for necessary adjustments to the plan and execution, ensuring the experiment is conducted with greater perfection.

Research Design

Research design is a plan to control and thereby neutralize or minimize the impact of external variables and factors that could affect the validity of the study. This research utilizes the "equivalent-group design" (a type of experimental design). The schools and students for this study were selected using the convenience random sampling method.

Research Tools

For this research, the researcher utilized experimental materials to compare teaching methods (specifically the lecture method) and employed a unit test to assess effectiveness. The test was designed based on information regarding chemical substances used in daily life, along with their types and properties. A self-constructed unit test was used in this study; specifically, the test was designed based on the unit "Substances in Our Daily Use" after the material had been taught, and the test was subsequently administered.

Statistical Tools

The study primarily employed statistical tools such as standard error, Chi-square test, analysis of variance (ANOVA) and covariance (ANCOVA), bivariate correlation, factor analysis, and the 't'-test.

Population, Sampling, and Sample

To conduct the research titled "A Comparative Study of the Effectiveness of Demonstration and Laboratory Teaching Methods in Science and Technology for 9th-grade Students in Latur Taluka," the researcher selected Saraswati Vidya Mandir in Latur. A

sample of 40 ninth-grade students (20 boys and 20 girls) was selected from the school using the simple random sampling method. The unit "Substances in Our Daily Use" (from the Science and Technology curriculum) was taught to them first using the demonstration method and subsequently using the laboratory method. A questionnaire/test based on the content was then administered. Data were collected and interpreted in this manner.

Statistical Analysis and Interpretation of Data

1) Testing the significance of the difference in effectiveness of the laboratory method between girls and boys:

Table No. 1: Table comparing the scores of girls and boys in the final test based on the laboratory method

Students	Student s	Mea n	Standar d Deviation	Standar d Error	Mean Differenc e	Calculate d Value	Degrees of Freedo m	Tabl e 't' Valu e
Laborator y Method (Girls)	20	14.75	2.67	0.65	1.78	2.72	38	2.05
Laborator y Method (Boys)	20	13.07	2.53					2.76

From Table No. 1 above, it is observed that for the group of 20 girls from a school in Latur Taluka, the mean learning outcome using the laboratory teaching method is 14.75 with a standard deviation of 2.67; whereas for the group of 20 boys from a school in Latur Taluka, the mean learning outcome using the laboratory teaching method is 13.07 with a standard deviation of 2.53. The standard error between them is 0.65, and the difference in means is 1.78. The resulting calculated value is 2.72.

The degrees of freedom are 38; the table value at the 0.05 level of significance is 2.05, and at the 0.01 level of significance, it is 2.76. However, since the calculated 't' value of 2.72 is lower than the table value, the hypothesis has been accepted at the 0.05 level.

Interpretation

Since the hypothesis regarding the laboratory teaching method for boys and girls is significant, it is found that girls have performed better in learning through the laboratory teaching method.

2) Examining the significance of the effectiveness of the demonstration method for boys and girls:

Table No. Table 2: Comparison of scores obtained by girls and boys in the final test for the demonstration method

Students	Student s	Mea n	Standar d Deviation	Standar d Error	Mean Differenc e	Calculate d Value	Degrees of Freedo m	Tabl e 't' Valu e
Demonstratio n (Girls)	20	8.98	1.80	0.47	0.44	0.89	38	2.05
Demonstratio n (Boys)	20	8.54	1.72					2.76

From Table 2 above, it is observed that for the group of 20 students (girls) from the school in Latur Taluka, the learning outcome scores for the demonstration teaching method show a mean of 8.98 and a standard deviation of 1.80; whereas for the group of 20 students (boys) from the school in Pusad Taluka, the learning outcome scores for the demonstration

method show a mean of 8.54 and a standard deviation of 1.72. The standard error is 0.47, the difference between means is 0.44, and the resulting calculated 't' value is 0.89.

The degrees of freedom are 38; the table value is 2.05 at the 0.05 level of significance and 2.76 at the 0.01 level of significance. However, since the calculated 't' value (0.89) is lower than the table values, the hypothesis was rejected at both levels.

Interpretation

Since the hypothesis regarding the demonstration teaching method for girls and boys was rejected, it was found that the scores obtained by girls and boys using this method were nearly identical. Consequently, the rejection of the hypothesis indicates that there is no significant difference worth noting in the effectiveness of the demonstration method between boys and girls.

3) Examining the significance of effectiveness among students learning via the laboratory method versus the demonstration method:

Table No. 3: Table showing the comparison of final test scores of students learning through the laboratory method and the demonstration method.

Students	Students	Mean	Standard Deviation	Standard Error	Mean Difference	Calculated 't' Value	Degree of Freedom	Table 't' Value
Laboratory Student	20	13.07	2.53	0.92	4.53	4.61	38	2.05
Demonstration Student	20	8.54	1.72					2.76

Table No. 3 indicates that for the group of 20 students in Latur Taluka using the laboratory method, the learning outcome showed a mean of 13.07 and a standard deviation of 2.53; whereas for the group of 20 students using the demonstration method, the learning outcome showed a mean of 8.54 and a standard deviation of 1.72. The standard error is 0.92, the difference in means is 4.53, and the resulting 't' value is 4.61.

The degrees of freedom are 38; the table value is 2.05 at the 0.05 significance level and 2.76 at the 0.01 significance level. Since the obtained 't' value of 4.61 exceeds the table values, the hypothesis is accepted at both levels.

Interpretation

A significant difference in means was observed between students learning via the laboratory teaching method and those learning via the demonstration method. Furthermore, as the obtained 't' value exceeded the table values at both levels, the hypothesis was accepted. In other words, it was observed that students learning through the laboratory method performed better in terms of scores compared to those learning through the demonstration method.

4) Examining the significance of the difference in effectiveness between girls learning via the laboratory method and the demonstration method:

From Table No. 4 above, it is evident that for the group of 20 girls in Latur Taluka learning via the laboratory method, the mean learning outcome score is 14.75 with a standard deviation of 2.67; whereas for the group of 20 girls learning via the demonstration method, the mean learning outcome score is 8.98 with a standard deviation of 1.80. The standard error is 0.69, the difference between the means is 5.77, and the resulting 't' value is 7.78.

Table No. 4: Table comparing the final test scores of girls learning through the laboratory and demonstration methods.

Students	Student s	Mea n	Standar d Deviation	Standar d Error	Mean Differenc e	Calculate d 't' Value	Degrees of Freedom	Tabl e 't' Valu e
Laboratory (Girls)	20	14.75	2.67	0.69	5.77	7.78	38	2.05
Demonstratio n (Girls)	20	8.98	1.80					2.76

The degrees of freedom are 38; the table 't' value is 2.05 at the 0.05 significance level and 2.76 at the 0.01 significance level. Since the calculated 't' value of 7.78 exceeds the table values, the hypothesis has been accepted at both levels.

Interpretation

Girls learning through the laboratory teaching method compared to the demonstration method, a significant difference in the mean scores was observed between the two groups of girls. Furthermore, since the obtained 't' value exceeded the table values at both levels of significance, the hypothesis was accepted. This indicates that girls studying via the laboratory method achieved better scores than those studying via the demonstration method.

5) Examining the significance of the difference in effectiveness between students studying via the demonstration method and the laboratory method:

Table No. 5: Table comparing final test scores of students studying via demonstration and laboratory methods

Students	Student s	Mea n	Standar d Deviation	Standar d Error	Mean Differenc e	Calculate d 't' Value	Degrees of Freedom	Tabl e 't' Valu e
Demonstratio n Student	20	14.25	2.18	7.60	4.25	6.19	38	2.05
Laboratory Student	20	18.05	2.79					2.76

Table No. 5 reveals that for the group of 40 students in the Latur taluka school using the demonstration method, the mean learning outcome score was 14.25 with a standard deviation of 2.18; whereas for the group of 40 students using the laboratory method, the mean learning outcome score was 18.05 with a standard deviation of 2.79. The standard error was 7.60, the difference in means was 4.25, and the resulting 't' value was 6.19.

The degrees of freedom were 78; the table value at the 0.05 significance level was 2.05, and at the 0.01 significance level, it was 2.76. However, since the obtained 't' value of 6.19 exceeded the table values, the hypothesis was accepted at both levels of significance.

Interpretation of Results

The difference in mean scores between students learning via the laboratory method and those learning via the demonstration method is significant. This implies that students achieved better scores under the laboratory method compared to the demonstration method. In other words, instruction using the laboratory method resulted in a positive change in student performance compared to instruction using the demonstration method.

Conclusions

- 1) Regarding the laboratory teaching method, the hypothesis was found to be significant; consequently, girls outperformed boys in learning through this experimental method.

- 2) Regarding the demonstration teaching method, the hypothesis was rejected; the scores obtained by girls and boys were found to be nearly identical. Thus, due to the rejection of the hypothesis, no significant difference was observed in the effectiveness of the demonstration method between boys and girls.
- 3) A significant difference in mean scores was observed between boys learning via the laboratory method and those learning via the demonstration method. Furthermore, as the obtained 't' value exceeded the table 't' value at both levels, the hypothesis was accepted. This indicates that boys learning through the laboratory method outperformed those learning through the demonstration method in terms of scores.
- 4) A significant difference in mean scores was observed between girls learning via the laboratory method and those learning via the demonstration method. Additionally, as the obtained 't' value exceeded the table value at both levels, the hypothesis was accepted. In other words, it was observed that girls who learned using the laboratory method outperformed those who learned using the demonstration method in terms of scores.
- 5) There is a significant difference between the mean scores of students who learned via the laboratory method and those who learned via the demonstration method. Consequently, it was found that students achieved better marks through the laboratory method of learning compared to the demonstration method. This indicates that instruction using the laboratory method led to a positive change in student performance compared to instruction using the demonstration method.

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