IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

"Impact Of Stem-Based Instructional Strategies On The Academic Achievement Of Science Students In Upper Middle School"

Zia Fatima Khan*

*Research scholar, DTE, Sam Higginbottom University of Agriculture Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh, 211007, India

Dr. Syeda Sara Aziz**

**Assistance Professor, DTE, Sam Higginbottom University of Agriculture Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh, 21007, India

Abstract : This study investigates the impact of STEM-based instructional strategies, with a particular focus on hands-on learning, on the academic achievement of upper middle school science students. Applying a quasi-experimental one-group pre-test and post-test design, the research involved Class 7 science students studying the topic *"Acids and Bases."* The same group of students was assessed before and after incorporating STEM-based instruction that emphasized hands-on activities, real-world problem solving, and interdisciplinary integration. The hands-on component involved active experimentation and collaborative tasks that encouraged students to directly interact with scientific concepts. Results reveals significant improvements in academic performance following the STEM intervention, reflecting enhanced conceptual understanding as well as improved application and problem-solving skills. These findings bring out the crucial role of hands-on learning within STEM education and support its amalgamation into standard middle school science curricula to promote deeper and more meaningful learning outcomes.

Keywords: STEM education, STEM instructional strategies, Hands-on learning, Academic achievement, Science education, Middle school students, Pre-test post-test design.

INTRODUCTION:

In the rapidly evolving aspects of global education, the demand for learners equipped with intellectual thinking, creativity, and problem-solving skills has led to a growing emphasis on interdisciplinary teaching approaches. STEM education integrating Science, Technology, Engineering, and Mathematics has emerged as a visionary and creative framework designed to prepare students for real-world challenges by connecting classroom learning with practical application.

Traditional science instruction in middle school classrooms often relies on lecture-based methods and textbook-driven content, which may limit the students engagement and conceptual understanding. On the other hand, STEM-integrated instructional strategies emphasize active learning through inquiry, exploration, and experimentation. These strategies motivate students to apply scientific knowledge in technological and engineering contexts while reinforcing mathematical reasoning.

STEM integration moves beyond teaching individual subjects in isolation; it promotes a balanced learning model where students solve actual problems through hands-on tasks, collaborative learning, and project-based activities. By simulating real-world scenarios, STEM instruction helps bridge the gap between theoretical science content and practical application, thereby making learning more meaningful and effective.

Upper middle school represents a critical stage in students' intellectual thinking and academic path. At this level, promote interest in science through innovative teaching approaches can significantly influence students' future choices and achievements in STEM-related fields. This study explores the impact of STEM-

integrated instructional strategies on the academic performance of middle school science students, focusing on the topic "Acids and Bases." The research investigates whether such strategies improve students' understanding, retention, and ability to apply scientific concepts, compared to conventional methods of instruction.

Objective of the study:

To compare the academic achievement of upper middle school science students before and after the implementation of hands-on STEM-based instructional strategies.

Hypothesis of the study:

There is no significant difference in science achievement among upper middle school students following the implementation of hands-on STEM-based instructional strategies.

Research design:

The present study employs one-group pre-test and post-test design to assess the impact of hands-on STEM-based instructional strategies on science achievement among upper middle school students.

Population and Sample:

The sample of present study consists of 50 science students of upper middle school. The sample is selected by using purposive sampling method for collection of data.

Tools used:

A Structured Questionnaire (Self constructed by the researcher) was used as the primary research instrument.

Result and Discussion

The study aimed to evaluate the academic achievement of science students by analyzing their performance on a pre-test and post-test. The pre-test was administered prior to the instructional intervention, while the post-test was conducted following a four-week period of STEM-based instruction.

Objectives: To compare the academic achievement of upper middle school science students before and after the implementation of hands-on STEM-based instructional strategies.

Hypothesis: There is no significant difference in science achievement among upper middle school students following the implementation of hands-on STEM-based instructional strategies.

The results are given below-

Table 1

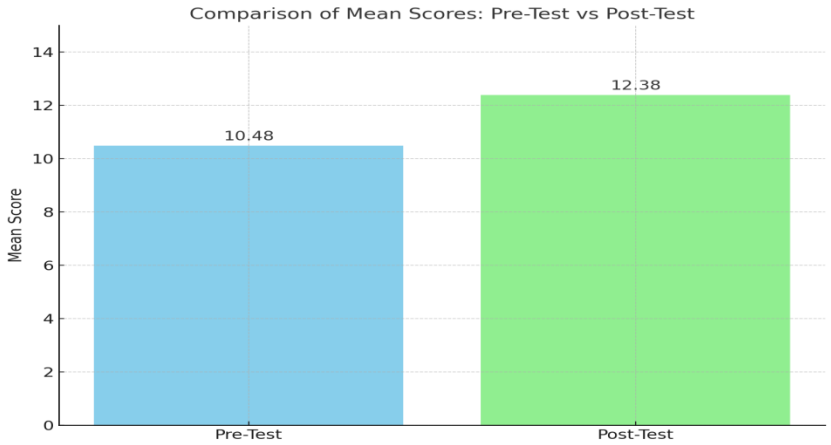
TEST	SAMPLE	MEAN	SD	t-test
PRE-TEST	50	10.62	2.36	5.27
POST-TEST	50	12.54	2.04	

*Significant at 0.05 level

table 1 show mean, s.d and t-test value of pre test and post test achievement test of science students in upper middle school.

This indicates that calculated t-value is 5.27. The mean score in the pre-test was 10.62, while the mean score in the post-test increase to 12.54, indicating an overall improvement in student performance. The standard deviations for the pre-test and post-test were 2.36 and 2.04, respectively. A paired sample t-test is conducted to determine whether the difference in means was statistically significant. The calculated t-value was 5.27, which is greater than the critical t-value at the 0.05 level of significance. This shows that there will be no significant difference in science achievement before and after the intervention. Therefore, the hypothesis rejected.

Figure 1



the bar graph showing comparing of the mean scores of pre-test and post-test. it visually demonstrates the improvement in science achievement after implementing hands –on learning through stem approaches, with the post-test mean score clearly higher than the pre-test mean.

A similar study by Bicer, Capraro, and Capraro (2015) investigated the effects of STEM project-based learning on middle school students' achievement in science and mathematics. The findings suggest that students exposed to STEM-based activities demonstrated higher academic performance as compared to those taught through conventional methods. These results support the statement that interactive and applied learning environments are more effective in promoting comprehension and retention.

Conclusion:

After the study of pre-test and post-test scores, the findings indicate a clear improvement in the students academic achievement by the implementation of STEM-based instructional strategies. The post-intervention results suggest that hands-on, experiential learning approaches effectively enhanced students' understanding of scientific concepts, demonstrating the positive impact of STEM integration in middle school science education.

References:

Beers, S. Z. (2011). 21st-century skills: Preparing students for their future. *Kappa Delta Pi Record, 47*(3), 121–123. https://doi.org/10.1080/00228958.2011.10516575

Bicer, A., Capraro, R. M., & Capraro, M. M. (2015). The effects of STEM project-based learning on students' achievement in mathematics and science. *The Journal of Educational Research, 108*(6), 575–588. https://doi.org/10.1080/00220671.2014.979911

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science, 24*(2), 97–140. https://doi.org/10.1080/10888691.2018.1537791

Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education, 3*(1), 11. https://doi.org/10.1186/s40594-016-0046-z

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice-Hall.

Sanders, M. E. (2009). STEM, STEM education, STEM mania. *The Technology Teacher, 68*(4), 20–26.