Scientific Creativity of Middle-Stage School Students in Relation to Experiential Learning Enabling Environment of the Schools

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Abstract: Scientific creativity is a skill that enables students to think critically, solve real-world problems innovatively and apply scientific reasoning. This study examines the experiential learning enabling environment of schools and scientific creativity of its students. The study has employed mixed-method of research design, where both qualitative and quantitative approaches were adopted. The sample was selected by stratified random sampling technique of Ajmer city. The data was collected with the help of Verbal Test of Scientific Creativity (VTSC) by Dr. V.P. Sharma and Dr. J.P. Shukla (1985) and Observation Schedule based on Experiential Learning Enabling Environment developed by the researcher. The study reveals that there is average levels of scientific creativity of students. However, gender and socio-economic status do not influence the scientific creativity significantly. The results further indicated that the experiential learning enabling environment in schools plays a crucial role in fostering scientific creativity among students as significant difference was observed between both. Schools that provided interactive, hands-on learning experiences demonstrated higher levels of scientific creativity rather than those using traditional teaching methods. The study highlights the importance of promoting experiential learning environments in schools to enhance students' scientific creativity. It suggests that integrating inquiry-based and student-centered learning approaches into the curriculum can significantly improve students' engagement with science.

Keywords: *Scientific Creativity, Experiential Learning, Middle-Stage Students, Socio-Economic Status, Gender.*

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I. INTRODUCTION

NEP 2020 emphasizes a holistic and an interdisciplinary approach to education, which is foundational for nurturing scientific creativity among students. The ability to think creatively in science is crucial for developing scientific inquiry, critical thinking and technological advancements *(Hu & Adey, 2002)*. Middle-stage school students are at major developmental phase where fostering creativity can significantly impact their scientific reasoning abilities. Experiential learning environments emphasizes hands-on activities, inquiry-based learning and interactive teaching strategies which plays a crucial role in enhancing scientific creativity *(Kolb, 1984)*. Schools which provide well-equipped laboratories, ICT-mediated classes, and trained teachers can offer better opportunities for students to explore and develop their creative potential. This study aims to investigate experiential learning enabling environment of schools and scientific creativity of their students.

II. LITERATURE REVIEW

➢ *The Related Review of Literature is as Follows-*

Hu, W., & Adey, P. (2002), conducted study on developing and validating a Scientific Creativity Test for secondary school students using the Scientific Creativity Structure Model (SCSM). With the help of 7-item scale, inspired by the Torrance Tests of Creative Thinking the test was administered. Findings indicates that scientific creativity tends to increase with age, while science ability alone does not guarantee creativity.

Jiusto, S., & DiBiasio, D. (2006), assessed the Global Studies Program, an experiential interdisciplinary initiative, using three evaluation methods- IDEA evaluation system, an internal project quality assessment and the Self-Directed Learning Readiness Scale (SDLRS). Results showed significant improvement in lifelong learning (LLL) skills among program students compared to peers. While SDLRS showed moderate SDL gains, the study highlights experiential learning's role in enhancing SDL and LLL, emphasizing the need for diverse assessment approaches.

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Baer, j., & Kaufman, J. C. (2008), studied the gender differences in creativity along with test scores, achievements, and self-perceptions. Research indicates little to no gender disparity in creativity. However, the research gap in creative accomplishments between men and women suggests that environmental factors alone are not fully responsible for these differences.

Alkan, F. (2016), studied the impact of experiential learning on chemistry achievement and scientific process skills among 40 student teachers at Hacettepe University. Data were gathered using a chemistry achievement test and a scientific process skill test. Using a pretest-posttest design, the experimental group received experiential learning, while the control group followed a traditional method. Results showed that experiential learning enhanced academic performance and scientific skills, suggesting its potential for high school chemistry curriculum and in researches.

Raj, H.A.N.S., & Saxena, D. R. (2016), reviewed previous researches to offer insights for educators, researchers and administrators. The findings revealed that different teaching strategies and specialized programs can enhance scientific creativity. The findings on scientific creativity based on gender differences remained inconsistent. The review even highlighted existing research gaps and provides suggestions for future studies.

The review of literature highlights that there are only few studies on experiential learning enabling environment therefore, the gap in existing researches motivates the researcher to conduct the study on the given topic.

➢ *Objectives:*

The objectives of the study are as follows-

- To find out the scientific creativity of middle stage school students.
- To find out the scientific creativity of middle-staged level students in relation to their gender and socio-economic status.
- To find out the experiential learning enabling environment of middle stage schools.
- To find out the scientific creativity of middle students in relation to experiential learning enabling environment of schools.

➢ *Hypotheses:*

The hypotheses of the study are as follows-

- There is difference in scientific creativity of middle-staged level students in relation to their gender and socio-economic status.
- There is difference in scientific creativity based on experiential learning enabling environment of schools.

III. METHODOLOGY

➢ *Research Design*

Mixed method research has been followed in the study. In the quantitative approach, data was collected using the standardised VTSC tool by Dr. V.P. Sharma and Dr. J.P. Shukla (1985) while experiential learning enabling environment of schools is assessed with the help of observation schedule based on experiential learning enabling environment developed by the researcher.

➢ *Population and Sample*

In the present study, middle-stage school students of Ajmer city comprises the population of the study. The sample was selected by stratified random sampling technique. Four schools were selected from two strata of central government and private schools. A total of 85 students of these schools were chosen for the study.

➢ *Tools*

The tools used for the study are as follows –

- Verbal Test of Scientific Creativity (VTSC) by Dr. V.P. Sharma and Dr. J.P. Shukla (1985) to be used for analyzing scientific creativity. The dimensions of the tool are Fluency, Flexibility and Originality. The validity of the standardized tool is 0.98 and reliability is 0.73.
- Observation schedule for assessing the Experiential Learning Enabling Environment of the schools developed by the researcher. The dimensions of the tool are- School infrastructure and resources, Pedagogical and assessment approach, Students' engagement, Reflections on experiences and creativity, Teacher training and professional development and School culture and environment.

➢ *Data Collection and Analysis*

The data was collected quantitatively using VTSC tool by Dr. V.P. Sharma and Dr. J.P Shukla (1985) and qualitatively by observation schedule for assessing the experiential learning enabling environment of the schools developed by the researcher. The data obtained from the sample was subjected to descriptive statistics (mean, mode, median standard deviation, skewness, kurtosis, etc.) and then inferential statistics was used for drawing inferences about the population.

IV. RESULTS

➢ *Objective 1:*

To find out the scientific creativity of middle stage school students.

Table 1 Basic Statistics of Scientific Creativity for Total Sample

Basic Statistic	**Value**
N	85
Mean	107.34
Median	110

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Mode	110
SD	35.47
Skewness	-0.16
Kurtosis	-0.35
Range	167
Minimum	27
Maximum	194

The basic descriptive statistics shows that the mean (107.34) represents the average value of the dataset. The median and mode (both 110) suggest that most data points are around this value. The standard deviation (35.47) indicates the extent of variation from the mean—this dataset has a moderate spread. The Kurtosis (-0.35) suggests a slightly flatter distribution. The Skewness (-0.16) shows that the distribution is nearly symmetrical. The range (167) shows a wide spread between the minimum (27) and maximum (194).

To study the levels of scientific creativity of the total sample, the scores were divided into 3 levels of scientific creativity- Low, Average and High according to the manual and frequencies in each level were determined.

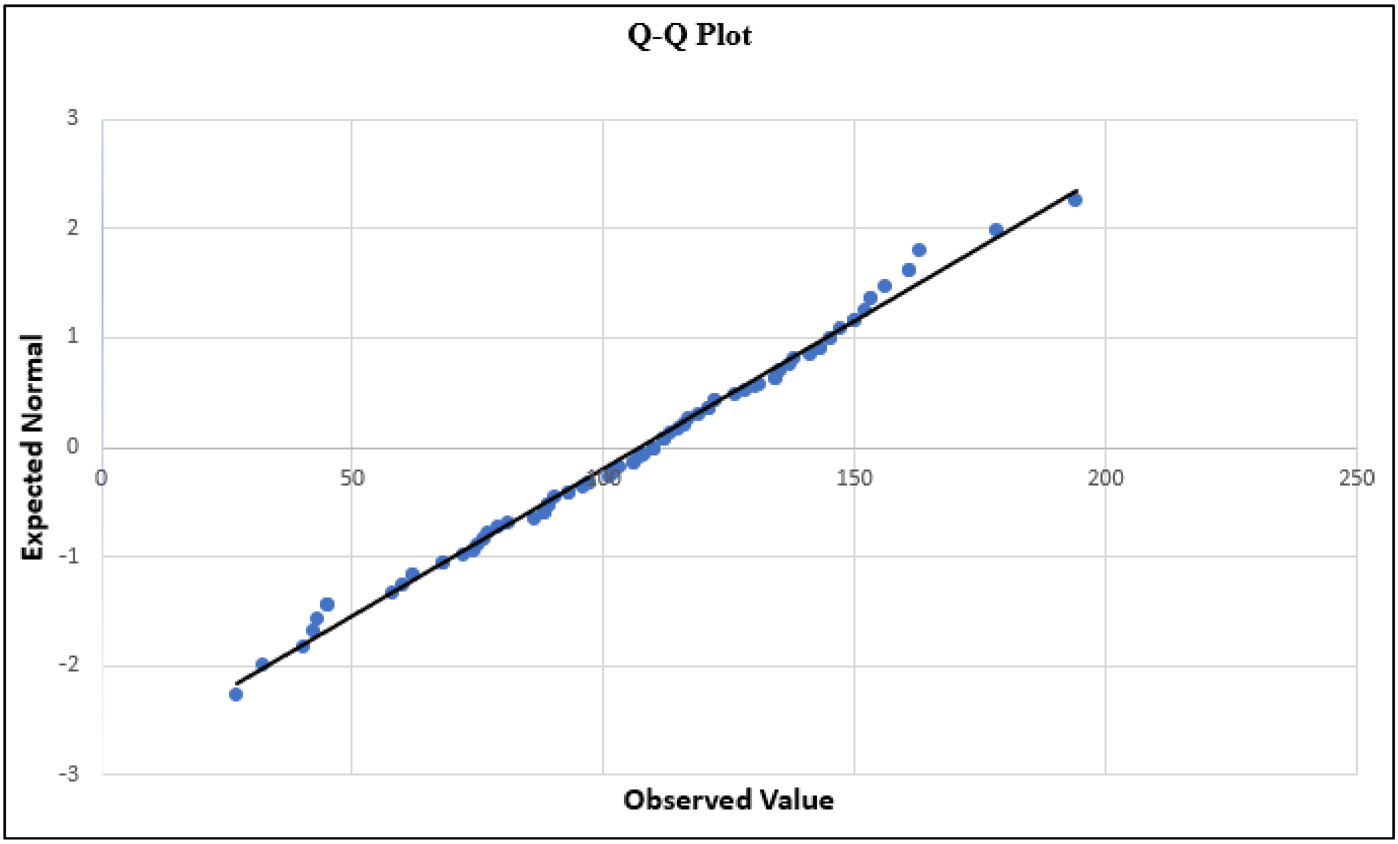

Fig 1 Q-Q Plot

The normal Q-Q plot of scientific creativity scores shown in the figure 1, compares the observed values of the scores to expected normal distribution. The majority of the data points closely follow the diagonal reference line, indicating that the data mostly follows a normal distribution. Overall, the data appears to be normally distributed based on this plot.

For statistical confirmation of normality of data, the Kolmogorov-Smirnov (K-S) test was also conducted on the sample based on scientific creativity scores. The K-S test showed a statistic value of 0.050 at df 85. The p-value (sig.) is 0.200 > 0.05, this means we fail to reject the null hypothesis, suggesting that the data follows a normal distribution at the 5% significance level. Therefore, the data of scientific creativity scores is normally distributed which further infers that parametric testing methods will be used for analysis.

➢ *Objective 2:*

To find out the scientific creativity of middle-staged level students in relation to their gender and socio-economic status.

- H_{01}: There is no significant difference in scientific creativity of middle-staged level students in relation to their gender.

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Table 2 T-Test for Difference in Scientific Creativity Scores of Middle-Staged Level Students in Relation to Their Gender

Gender	N	Mean	SD	t-value	df	t-critical	P	Significance
Male	45	104.13	39.93	0.898	81	1.989	0.37	Not significant
Female	40	110.95	29.75					

The t-test results from Table 2 indicates that there is no statistically significant difference in scientific creativity scores between males (N = 45, Mean = 104.13, SD = 39.93) and females (N = 40, Mean = 110.95, SD = 29.75) as t-value (0.898) < t-critical (1.989) at df 81, also the p-value (0.37) > 0.05, thus fails to reject the null hypothesis, suggesting that gender does not have a significant impact on scientific creativity.

- H_{02}: There is no significant difference in scientific creativity of middle-staged level students in relation to their socio-economic status.

The socio-economic status is based on the category itself. One way ANOVA is applied to test the difference.

Table 3 ANOVA to Check Scientific Creativity of Middle-Staged Level Students in Relation to Their Socio-Economic Status

Source of variation	SS	df	MS	F	P	F-critical	Significance
Between groups	1688.882	2	844.4409	0.66	0.51	3.10	Not significant
Within groups	103998.2	82	1268.271				
Total	105687.1	84					

The calculated F-value (0.66) < F-critical value (3.10) at df 2, 82 thus, suggesting that the variation between the group means is not large enough to be considered statistically significant. Also, the calculated p-value (0.51) > 0.05, therefore fails to reject the null hypothesis suggesting that there is no significant difference in scientific creativity of middle-staged level students in relation to their socio-economic status.

➢ *Objective 3:*

To study the Experiential Learning Enabling Environment of schools.

The schools were classified into three categories—Good, Average, and Low—based on their Experiential Learning Enabling Environment scores, determined using the observation schedule. Two schools received a good rating (Scores: 20, 21), indicating strong support through resources, teaching methods and students' engagement. One school scored average (Score: 14), showing moderate support, while another fell into the low category (Score: 9), suggesting limited experiential learning opportunities due to insufficient resources or ineffective experiential enabling environment. Higher scores reflect a well-developed learning environment, whereas lower scores indicate the need for enhancements in infrastructure, pedagogy, and engagement.

Dimension wise scores of schools were also determined as per the dimensions of the observation schedule developed by the researcher. The graphical representation based on the different dimensions of experiential learning environment of schools is mentioned in Figure 2.

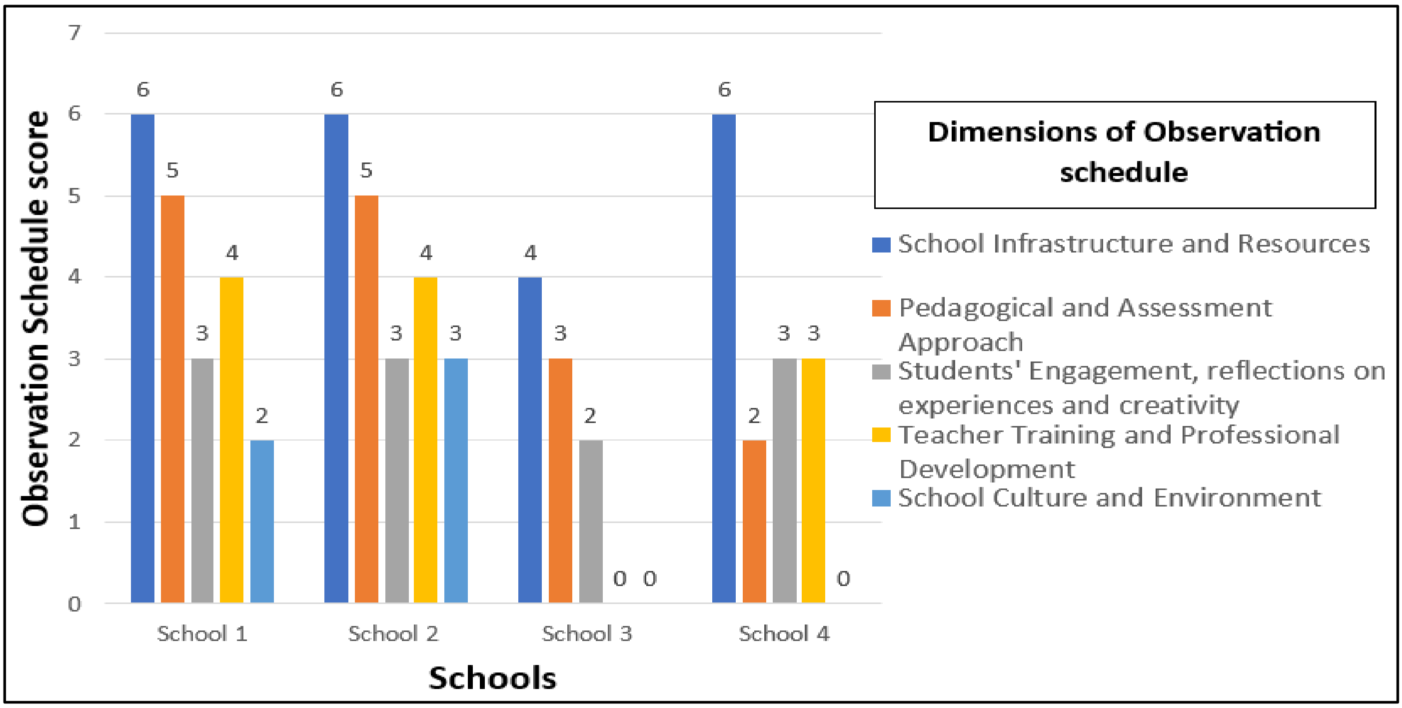

Fig 2 Dimension Wise Graphical Representation

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The Figure 2 shows graphical representation of Experiential Learning Enabling Environment and proves that there are wide differences among the schools based on different dimensions.

- School Infrastructure and Resources: Schools 1, 2, and 4 have the highest score (6), indicating strong infrastructure and resource availability while School 3 has the lowest score (4), suggesting comparatively weaker infrastructure.
- Pedagogical and assessment approach: Schools 1 and 2 performed well (5 each), showing effective teaching and assessment methods while school 3 has a moderate score (3), whereas school 4 has the lowest score (2), indicating weaker pedagogical strategies.
- Students' Engagement, reflections on experiences and creativity: Schools 1, 2, and 4 have similar engagement levels (3), while school 3 has the lowest (2). This suggests that students in school 3 may have fewer opportunities to reflect on experiences and develop creativity.
- Teacher training and Professional Development: Schools 1 and 2 have the highest scores (4), regarding teacher training programs while school 3 has the lowest score (0), indicating a lack of professional development opportunities for teachers.
- School Culture and Environment: Schools 1 and 2 have relatively higher scores (2 and 3, respectively) whereas schools 3 and 4 score 0, indicating poor or non-existent school culture and environment.

Overall, School 1 and 2 generally performed well across most dimensions, showing strong infrastructure, pedagogy and teacher training. School 3 performed poorly in teacher training (0) and school culture (0), which affects students' engagement and creativity. School Culture and Environment is the weakest dimension across all schools, with two schools scoring 0.

➢ *Objective 4:*

To find out the scientific creativity of middle students in relation to experiential learning enabling environment of schools.

- H_0: There is no difference in scientific creativity based on experiential learning enabling environment of schools.

To find out the difference in scientific creativity based on experiential learning enabling environment of schools ANOVA was applied. The results are summarized in Table 4.

Table 4 ANOVA for Differences in Scientific Creativity Scores Based on Experiential Learning Enabling Environment of Schools

Source of variation	SS	df	MS	F	P	F-critical	Significance
Between groups	13333.53	2	6666.765	5.91	0.003	3.10	Significant
Within groups	92353.58	82	1126.263				
Total	105687.1	84					

From Table 4, it is conferred that the calculated F-value (5.91) > F-critical value (3.10) at df 2, 82 thus, suggesting that the variation between the group means is large enough to be considered statistically significant. Also, the calculated p-value (0.003) < 0.05, therefore rejecting the null hypothesis suggesting that there is significant difference in scientific creativity of middle-staged level students based on experiential learning enabling environment of schools.

V. DISCUSSION

The mean of scientific creativity of the combined data was found to be 107.34. The mean scores suggest that middle-stage school students possess average level of scientific creativity. This finding indicates that while students have creative potential, it can be further developed with the right educational approaches and learning experiences.

t-test was applied to study difference in scientific creativity scores based on gender. The t-value (0.898) < t-critical (1.989) at df 81 of males and females, also the p-value (0.37) > 0.05, fails to reject the null hypothesis, suggesting that gender does not have a significant effect on scientific creativity. This breaks the gender stereotypes of the society. Both boys and girls can develop similar levels of creativity, if given equal learning opportunities. This reinforces the idea that in order to foster creativity among students, teaching methods and learning experiences are important over gender differences.

ANOVA was applied to study differences in scientific creativity of middle-staged level students in relation to their socio-economic status. The results showed that the calculated F-value (0.66) < F-critical value (3.10) at df 2, 82, suggesting that the variation between the group means is not large enough to be considered statistically significant. Also, the calculated p-value (0.51) > 0.05, therefore failing to reject the null hypothesis suggesting that there is no significant difference. This indicates that social status and caste categories do not necessarily determine a student's scientific creativity, which further breaks the stereotypes of the society.

Based on dimensions of experiential learning enabling environment of the two schools scored good, while one scored low and other one scored average. Based on the tool also, school 2 scored highest (21) while school 3 scored lowest (9). This highlights the need for schools to create more hands-on learning experiences, interactive and inquiry-based learning environments that encourages students to think creatively and apply scientific concepts in real-life situations.

ANOVA was calculated to find out the differences in scientific creativity scores based on experiential learning enabling environment of schools. It shows that the calculated F-value (5.91) > F-critical value (3.10) at df 2, 82 thus, suggesting that the variation between the group means is large enough to be considered statistically significant. Also, the calculated p-value (0.003) < 0.05, therefore rejecting the null hypothesis suggesting that there is significant difference in

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scientific creativity of middle-staged level students based on experiential learning enabling environment of schools.

This suggests that schools which offer more hands-on activities, real-world problem-solving tasks and interactive learning opportunities help students develop stronger creative thinking skills. Encouraging practical learning experiences can play a crucial role in fostering scientific creativity among middle-stage school students.

VI. CONCLUSION

This study examined the scientific creativity of middle-stage school students and its relationship with gender, socio-economic status, school type and the experiential learning environment in schools. The study revealed that gender and socio-economic status do not have an effect on scientific creativity, meaning that creativity is not directly dependent on these factors but rather on the learning environment and exposure to creative experiences.

However, school type and experiential learning environments were found to significantly influence scientific creativity. Additionally, schools that provided experiential learning enabling environment, helped students to develop scientific creativity. The reasons to support the study could be well equipped science labs, ICT mediated classes along with well qualified teachers (professionally and subject expert) with experiential learning enabled conditions. The study further highlights the importance of creating an engaging and interactive learning environment to foster scientific creativity among students. By fostering a learning platform that nurtures creativity, schools can help develop strong problem-solving and critical thinking-skills in science.

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