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Enhancing Science Education Through Art Integration: A Study of Post COVID-19 Pedagogical Strategies

1Jyoti Mavadia, 2Bharat Mavadia, 3Dr. Lakshmi Sripada
1Educator, 2Ass. Director, 3Principal
1BAPS SWAMINARAYAN VMSG RES. SCHOOL,
2BAPS SWAMINARAYAN VMSG RES. SCHOOL,
3BAPS SWAMINARAYAN VMSG RES. SCHOOL

Abstract

The COVID-19 pandemic significantly affected traditional educational methods, leading to a notable decline in student interest and engagement in learning. In standard 11 and 12, the students are focused on preparation of competitive examination like NEET and Engineering Entrance Test while preparing for Board Exam. In these circumstances, chalk-and-talk method is highly preferred mode by students, teachers and parents alike. This preference leads to loss of interest and understanding among diverse learners, causing under-development of cognitive competence. Lack of innovative methods to teach sciences in these grades, the resistance of students and parents into anything other than competitive examination preparation, combined with societal pressure for high grades leads to dry environment and high drop-out ratio from schools.

This research studies the 1) effectiveness of Art-Integration as process of teaching learning science to rekindle student interest and enhance understanding of basic scientific concepts, specifically among the students of Class 11 and 12. Also 2) effectiveness of Art-Integration into final product of better scores in standard 12 Secondary Board examination as well as competitive exams such as GujCET (Gujarat Common Entrance Test – taken for entry to Professional Courses like Pharmacy) and NEET (National Eligibility cum Entrance Test for various Medical Courses).

Observational data (and other qualitative data sets) and test scores (quantitative data) indicate remarkable improvement in students' understanding of scientific concepts, while classroom participation and final exam scores demonstrate increased motivation and academic achievement. These methods significantly enhance student engagement and interest, thereby improving their performance and preparedness for competitive exams.

This study emphasizes the potential of art integration as a valuable pedagogical strategy in post-pandemic education, and competitive-exam-intensive environment. These methods are effective learning styles, which enhance retention capacity, and concentration span while supporting students in their academic development and competitive exam readiness. The insights gained from this research provide a foundation for consolidating Art-Integrated educational practices in schools, that boost student learning and engagement in science education.

Keywords: Art-integration, Pedagogical Strategy, Academic achievements, Post-COVID challenges, scientific concepts, Student engagement, Competitive exams, Assessment methods, Learning outcomes.

Introduction: (review previous work, gap, why new research)

The COVID-19 pandemic posed formidable challenges to conventional educational paradigms, resulting in a noticeable decline in student engagement and interest in learning (UNESCO, 2020). By capitalizing on students' natural inclination towards artistic expression, as evidenced by their engagement with social media platforms, this research aims to cultivate a renewed sense of curiosity and involvement in scientific principles. Through the implementation of a diverse array of art-infused activities, students are encouraged to explore intricate scientific concepts in dynamic and interactive formats, thus fostering enhanced understanding and retention of critical subject matter (Zembylas & Schutz, 2020). This paper also seeks to provide solution to educators who grappled with formidable task of reigniting student interest and enthusiasm for learning, in aftermath of COVID-19, particularly within science, which traditionally demand heightened levels of engagement and comprehension.

Parallel to this timeframe of post-COVID-19 period, 2021 to 2024 – saw the rise of coaching centres across the countries in Tier 1 and 2 cities – a topic that needs authentic research and data gathering but is observed on the ground and substantiated by several news reports. Students and parents are drawn to these centres through their marketing campaigns showcasing academic success and promising the same for everyone. This phenomenon has promoted students' mistrust on the academic efficacy of schools to produce results. A parallel mechanism has been fuelled to allow the students to attend the school as well as coaching classes, which is seen widely as unethical practice. Additionally, in these coaching centres, chalk-and-talk method is the preferred mode. This preference leads to loss of interest and understanding among diverse learners, causing under-development of cognitive competence. Given the widespread focus on rote memorization and test preparation in the Indian education system, particularly for competitive exams, traditional methods often fail to engage students or foster deep understanding. Through this study, we seek to prove that art-integration leads to equally good academic success thus providing a strategic response to this challenge. Art integration offers a solution by making abstract scientific concepts more tangible and relatable through creative expression. All the CBSE (Central Board of Secondary Education, India) school PGTs (Post Graduate Teachers) possess necessary skills to carry out Art Integrated Projects due to Training Programs by CoEs (Centre of Excellence). The mandatory facilities at every CBSE schools, mean that they possess adequate resources and time to carry out the activities as listed here.

To begin with, we drew inspiration from student preferences, notably their inclination towards social media-driven activities, to incorporate diverse artistic techniques aimed at explaining complex scientific concepts, such as biological classification (Ritter & Mostert, 2020). Theoretical framework of this study is grounded In Howard Gardner's theory of Multiple Intelligences, which explains diverse kinds of intelligences to learn. The diversity requires variety in instructional methods. Art integration engages students who learn better with visual-spatial intelligence, kinaesthetic intelligence and visual intelligence for sure. We decided to provide students with opportunities to actively interact with scientific content in innovative and imaginative manners (Martin, 2020). The research endeavours to comprehensively assess the impact of these Art-Integrated pedagogical approaches on student motivation and learning outcomes (Bamford & Gibbons, 2018). The above 3 researches form another basis for this study, where we seek to enhance student engagement, creativity and retention of complex concepts through Art-Integration.

Interestingly, this approach not only addresses the cognitive aspects of learning but also engages students emotionally and physically, which is crucial for maintaining interest and motivation in subjects like Biology. By incorporating artistic activities, such as clay modelling and role-play, students can explore scientific concepts in a more interactive and meaningful way, leading to improved retention and understanding.

Research questions:

1. How does the integration of art into science education impact student engagement and interest in learning scientific concepts among Class 11 and 12 students?
2. In what ways does art integration influence the performance of Class 11 and 12 science students in competitive exams such as GujCET and NEET?
3. How do observational learning, classroom participation, and regular assessments contribute to the effectiveness of Art-Integrated teaching methods in science education?

Method and Research Sample:

The research adopts a mixed-methods approach, incorporating both qualitative and quantitative methodologies to investigate the implementation and effects of Art-Integrated science instruction. The study participants were the eleventh-grade students for academic year 2022-23 and same cohort in twelfth-grade. The students were tracked for fifteen months from November 2022 to January 2024. All the students of the class were included for research. It would be noted that this study gains more grounding from the fact that these students were in a residential campus, without any other support or coaching. The academic scores are purely result of classroom interaction and student's own efforts. The students did not have access to digital or physical substitute to classroom teaching.

The decision to employ art-integrated teaching methods in this study is particularly relevant in the Indian educational context, where there is intense pressure on students to excel in competitive exams like NEET and GujCET. This pressure often leads to a narrow focus on memorization, leaving little room for creative or exploratory learning. By integrating art into the science curriculum, this study seeks to provide an alternative pedagogical approach that not only aligns with Gardner's theory but also addresses the specific needs of Indian students who are navigating a highly competitive academic landscape.

Moreover, the post-pandemic shift towards hybrid and online learning has further highlighted the need for innovative teaching strategies that can engage students. Art integration, with its emphasis on visual and **hands-on learning**, offers a versatile approach that can be effectively adapted to both in-person and virtual classrooms, making it particularly suitable for the current educational climate in India.

Firstly, The students were given a questionnaire before they started with their Art-Integrated activities in Biology. Data collection encompasses a range of methodologies to capture the aspects of student engagement, comprehension, and motivation in science learning.

This was followed by observations of classroom activities and student participation during Art-Integrated lessons. The lesson plan and activities were mapped to rubrics. Total 7 Activities were conducted (Table 1). These were meticulously designed to meet the criteria of art integration as method, and knowledge construction, 21st century skills and skill acquisition as outcomes.

The effectiveness of Art-Integrated teaching methods in science education is significantly enhanced through regular assessments. Regular assessments ensure that learning is continuously monitored and reinforced through creative and reflective tasks. Regular assessments, including formative assessments and summative assessments are essential for measuring student progress and guiding instruction.

Table 1 Detail of all 7 activities conducted in the study

Projects	**Herbarium making by imprinting specimens on clay:** *Morphology of Plants, Biological Classification*	**Role play for a** *deeper understanding of biodiversity & Conservation, Anatomy*	**Clay art jewellery to** *learn the structure of cell anatomy of Protista, Cell Cycle, DNA & RNA*	**Poster Making:** *Environmental Issues*	**Paper Art:** *Body fluids & Circulation, Human Health & Disease*	**Dance:** *Organisms & Population, Microbes in Human welfare*	**Theatre:** *Ecosystem, Biodiversity*
Content	**Chapter 3 (Class 11): Plant Kingdom Concepts:** Morphology of plants, plant parts, Modifications of Root, Stem, Leaves. Classification of organisms based on their characteristics, and the role of herbarium in taxonomy.	**Chapter 13 (Class 11): Anatomy of Plants, (Class 12): Biodiversity & Conservation Concepts:** Vascular bundles, stomata, secondary growth, biodiversity, and need of conservation.	**Chapter 8 (Class 11): Cell: The Unit of Life, Biological Classification, Biomolecules (DNA, RNA, Protein) Concepts:** Cell structure, cell cycle, DNA, RNA, and Protista anatomy.	**Chapter 14 (Class 12): Ecosystem Concepts:** Environmental issues, ecosystem services, conservation efforts, and ecological impact.	**Chapter 18 (Class 11): Body Fluids and Circulation Concepts:** Blood, heart, blood vessels, lymph, and the role of these fluids in maintaining health and homeostasis.	**Chapter 8 (Class 12): Microbes in Human welfare Concepts:** Population dynamics, organisms, microbes, and their role in human welfare.	**Chapter 15 (Class 12): Organisms and Population Biodiversity and Conservation. Concepts:** Organism and its environment , Species diversity, conservation strategies, and the importance of biodiversity.
Make Learning Fun	Engagement and enjoyment in the task (Individual)	Active participation and enthusiasm (Group)	Engagement and interest in crafting (Individual)	Interest and effort in creating the poster (Individual)	Enjoyment and enthusiasm in paper art (Individual)	Engagement and energy in performance (Group)	Engagement and enthusiasm in the performance (Group)
Aptitude for Innovation	Innovation in specimen arrangement and clay design (Individual)	Innovative portrayal of roles and concepts (Group)	Innovative use of shapes, colours in design (Individual)	Creativity in addressing environmental issues (Individual)	Innovative representation of biological concepts (Individual)	Creative interpretation of biological themes through dance (Group)	Innovative approach to portraying ecosystems (Group)
Developing Cognitive	Understanding of plant morphology and	Depth of understanding demonstrate	Understanding of cell structure and related	Understanding of environmental	Understanding of body fluids and related	Understanding of organisms and	Depth of understanding shown through

Ability	classification (Individual)	d through role-play (Group)	concepts (Individual)	issues presented (Individual)	systems (Individual)	their interactions (Group)	performance (Group)
Communication	Ability to explain the process and result (Individual)	Clarity and effectiveness of dialogue delivery (Group)	Clarity in explaining the design and its scientific basis (Individual)	Effectiveness of message conveyed through the poster (Individual)	Clarity in explaining the paper art and its scientific context (Individual)	Expression and clarity in conveying the theme (Group)	Effectiveness in communicating the message (Group)
Collaboration	N/A	Team coordination and contribution (Group)	N/A	N/A	N/A	Coordination and teamwork (Group)	Collaboration and collective effort (Group)
Creativity	Creativity in choosing specimens and design (Individual)	Creative interpretation of roles (Group)	Originality in jewellery design (Individual)	Innovative use of visuals and text (Individual)	Creativity in paper art representation (Individual)	Original choreography and use of space (Group)	Originality in script and presentation (Group)
Academic Performance	Accuracy and neatness of final herbarium (Individual)	Accuracy in portraying biological concepts (Group)	Precision and attention to detail (Individual)	Clarity and organization of content (Individual)	Quality and precision of final artwork (Individual)	Execution and overall impact of performance (Group)	Overall impact and execution of the play (Group)
Conceptual Clarity	Clear demonstration of key concepts (Individual)	Understanding and accurate depiction of concepts (Group)	Accurate representation of biological structures (Individual)	Accurate representation of the issue (Individual)	Accurate depiction of biological systems (Individual)	Clear representation of biological concepts (Group)	Accurate and clear depiction of ecosystem concepts (Group)

As follow up to the activities a viva was conducted at end of activity where the work of student during the Art-Integrated science lessons, such as herbariums, posters, and clay models, were evaluated. Additionally, viva and presentation would assess the depth of understanding the underlying concept linked to curriculum.

In support of the qualitative data, we collected quantitative data through analysis of Class test scores and final exam score *(Rubrics in table 2)*. This data validates the efficacy of Art-Integrated teaching into scores of boards and competitive exam.

Student activity photos:

Figure 1 Images of the classroom activities.

Overall, this detailed mixed-methods approach ensures a comprehensive scrutiny of the efficacy and implications of Art-Integrated science instruction in current situation, offering valuable insights for educators, policymakers, and researchers alike.

Tools and Techniques:

According to Gardner's theory of Multiple Intelligences, incorporating diverse teaching methods, such as art, caters to various learning styles and can lead to better student engagement and understanding (Gardner, 1983). The data provided tracks the engagement based on rubrics as given below. This demonstrates how the pedagogical approach has positively influenced student engagement and interest in the subject. Towards the end of study, most students displayed a steady increase in their scores, with minimal fluctuations, underscoring the consistently positive impact of the Art-Integrated approach.

1) **Engagement and Interest Scores**: Qualitative Data Collection

Rubrics:

Table 2 Rubrics and Weightage for each Activity

Area	Criteria	Weightage
Engagement & Interest	Classroom Participation (observation based)	30
	Activity Participation (observation based)	20
	Activity Viva	25
Academic Performance	Class/Weekly Test (20 marks)	15
	Monthly Test (40 marks)	15
	Total	100
	Conversion	100/20=5

2) **Data Collection**

Improvement in students Engagement and interest through Art Integrated Teaching Pedagogies *(detail table attached as annexure 1)*. In the execution stage, the students observation was carried out in various aspects.

Class Participation was monitored and recorded after every class and was summarized for every month. Positive participation earned them 1 mark in each class, thus it brings us to 30 marks in each month. Activity Participation marks were awarded for their pro-activeness (2.5 marks), their involvement (2.5 marks), curiosity (2.5 marks), and intent shown (2.5 marks). This was supplemented with the final output which carried another 10 marks for impact.

Activity viva was a crucial phase that was aimed at finding if the student had comprehended the activity (5 marks), the concept (10 marks) and the work flow had proper thought process (10 marks).

Every week, a small class test was carried out that was part of their formative assessment as well. The purpose of these test was to identify the over-all impact on studies and its gradual progression. In total, 40 weekly class tests were conducted before completion of syllabus in December 2023. Those marks were converted to assigned weightage of 15 marks in rubrics. These tests followed Board Pattern on even numbered week of month and Competitive examination pattern on odd numbered weeks of month.

The monthly tests were a little more rigorous. They had 20 marks MCQs mimicking NEET examination questions and 20 marks subjective questions following CBSE Board examination pattern. This provided them enough writing practice in real-time scenarios. These 40 marks were converted to 15 marks for weighted average in the Interest and Engagement Score.

This mix of qualitative and quantitative data ensured that the conceptual clarity and academic achievement practice went hand-in-hand. Thus, the desired outcome was generated.

Result and Discussion

The summary of the data (Fig. 2) is as follows:

Statistical Summary of Monthly Assessment of students

- The scores reflect the level of engagement and interest each student had in the class each month.
- Initial total Engagement Score in Month 1 was 52 which improved to a whopping 107 in 15th month, at time of final reading.
- Total increase over the period: 55 points

Average monthly improvement per student - 55/15 ≈ 3.67

Improvement Trends:

- Initial average score per student in Month 1 - 52/23 ≈ 2.26
- Final average score per student in Month 15 - 107/23 ≈ 4.65
- Average improvement per student - 4.65- 2.26 = 2.39

Comparative Analysis of Monthly Trends

- The engagement scores show a gradual and consistent improvement over the months.
- Noticeable jumps in scores occur between Month 1 and Month 2 (from 52 to 56) and between Month 8 and Month 9 (from 92 to 103).

3) Key observations in Academic Improvement

Quicker improvement:

Students D, S, and C consistently performed well, showing high engagement and interest throughout the 15 months.

These students demonstrated a strong affinity towards the Art-Integrated pedagogical approach from the start.

Slow Starters with Significant Growth:

Students A, B, and J started with lower scores but showed significant improvement over the months, indicating that Art-Integrated education had a positive long-term impact on their engagement.

Consistency and Fluctuation:

Most students displayed a steady increase in their scores, with minimal fluctuations. Student K, while having the lowest total score, did show improvements but at a slower pace compared to peers.

Impact of Art Integrated Education:

The data indicates (Fig. 2) a clear overall improvement in engagement and interest in biology due to the Art-Integrated approach. The steady upward trend across all students suggests that integrating art into the curriculum fosters a more engaging and enjoyable learning environment.

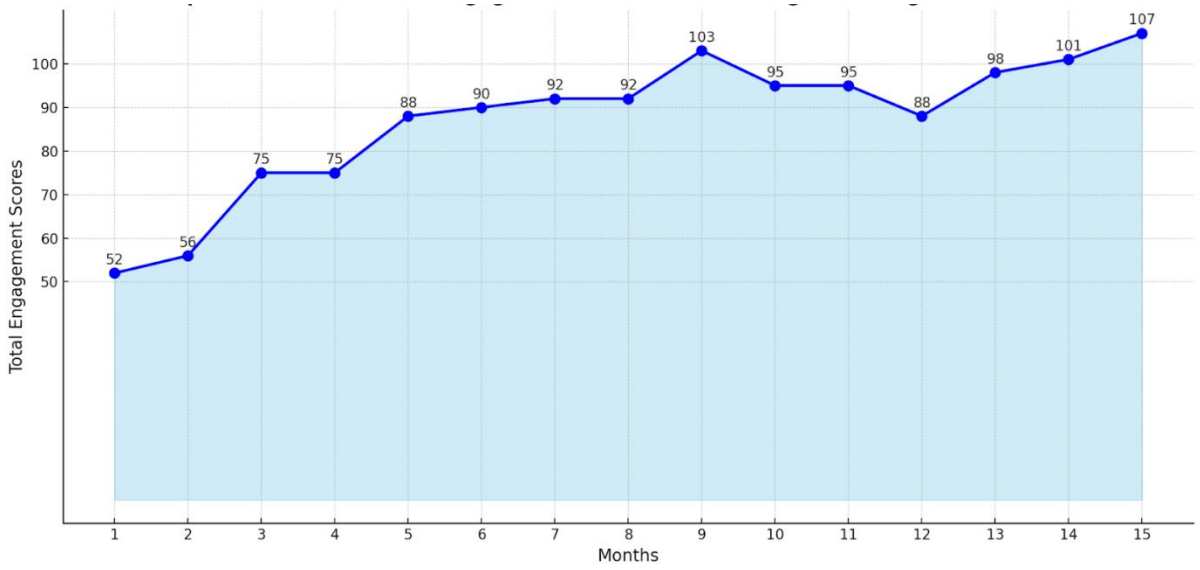

Figure 2 Month wise improvement in the students' engagement and interest through Art Integration Teaching Method (reference Annexure1)

The data strongly supports the hypothesis that Art-Integrated education significantly improves student engagement and interest in science biology classes. The average improvement per student and the overall increase in engagement scores highlight the effectiveness of this pedagogical approach.

4) Enhance Academic performance in Competitive Exams (NEET & GujCET) and Boards:

Art-Integrated teaching in biology has shown significant positive outcomes in student performance, particularly in standardized assessments such as the CBSE board exams. The study involves 23 students who initially showed low motivation, particularly towards competitive exams like NEET and GujCET. Art-Integrated teaching in biology improved their class test and monthly test scores and significantly boosted their motivation levels, resulting in 19 out of these 23 students appearing for competitive exams and performing well.

Statistical Summary:

- Participation Rate = 19/23×100 ≈ 82.6% in NEET and GujCET .

Students' achievements in NEET (Reference Fig. 3)

- 1 student scored more than 600
- 4 students scored more than 500
- 3 students scored more than 400

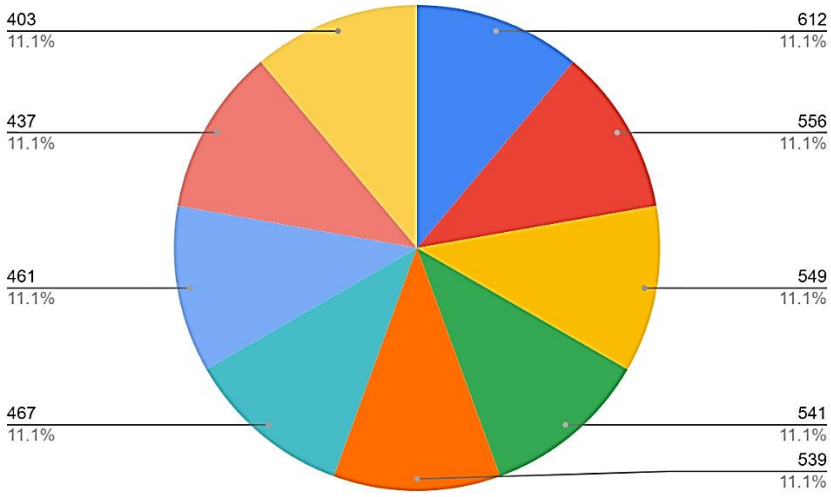

Figure 3 Students' achievements in NEET

Students’ achievements in GujCET

- 1 Student scored 95 PR
- 2 Students scored 94 PR

In CBSE boards 2024 total 9 students scored more than 90 marks in the CBSE board exams (Fig. 4, *detail table attached as annexure 2*). The average score in the CBSE board exams was 83.9, showing a significant improvement from school practice exams. The average Improvement of the students was ≈ 14.58. This analysis examines the comparative improvement of students' scores from school practice exams to the CBSE board exams, demonstrating the effectiveness of art integration in enhancing academic achievement.

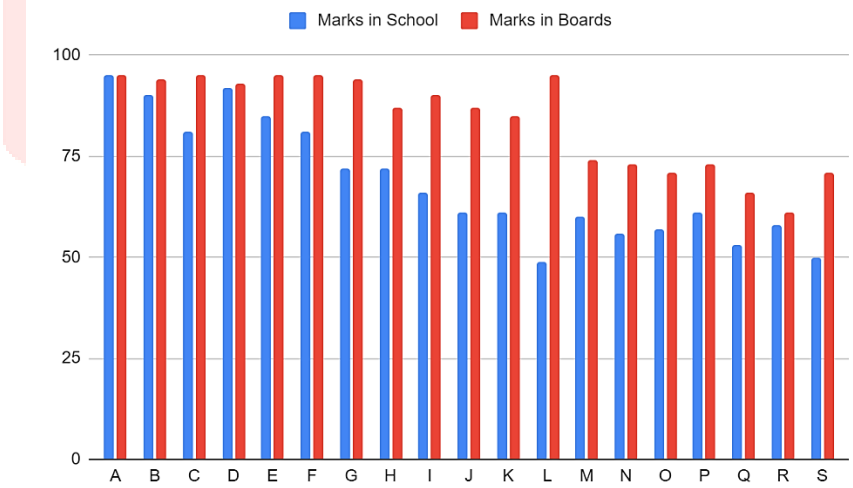

Figure 4 Comparative improvement of students' scores from school practice exams to the CBSE board exams (Reference Annexure 2).

Students maintained or improved their scores, suggesting that art integration does not only benefit struggling students but also enhances the learning experience for high achievers. The study clearly demonstrates that Art-Integrated teaching in biology significantly boosts students' academic performance and motivation levels. The engaging and creative approach helps students better understand and retain biological concepts, leading to improved scores in both regular and competitive exams. The transformation in students' attitudes towards learning and their subsequent success in NEET and GujCET exams underscores the effectiveness of this pedagogical strategy.

External factors such as societal pressure, motivation of students through regular sessions, personalized counselling and mentoring of students may have impacted the results, the effect of which is little difficult to be measured.

Conclusion:

The effectiveness of Art-Integrated teaching methods.

Previous research has highlighted the potential of art integration as a pedagogical strategy to enhance student learning outcomes and motivation across various academic disciplines (Smith et al., 2019). Studies have shown that incorporating artistic elements into science education can stimulate creativity, critical thinking, and interdisciplinary connections (Hansen et al., 2020). Art integration has been found to cater to diverse learning styles and interests, thereby promoting inclusive and engaging learning environments (Meyer & Sutman, 2018). Also, students who participated in art-based learning activities showed improved retention and understanding of complex scientific concepts compared to those who learned through traditional methods (Rinne et al., 2011). Furthermore, the post-COVID-19 educational landscape underscores the importance of innovative teaching approaches that harness students' digital literacy and creative instincts (European Commission, 2021).

We would strongly like to assert that this approach has significantly enhanced 5 competences in students namely Aptitude for innovation, Development of cognitive ability, Communication, Collaboration, Creativity as mentioned in the rubrics above, as by-product of motivation, interest, conceptual clarity and finally higher scores. However, the detailing warrants another research paper.

The findings in this research show that students improved their periodic test scores, performed well in CBSE Board Examination, and performed exceptionally well in competitive exams like NEET and GujCET. Contrary to popular belief, the Art-Integrated approach has led to enhanced learning and test score. Regular assessments integrated with art projects likely contributed to this success by providing continuous feedback and reinforcing learning through creative expression.

These elements collectively contribute to the remarkable improvement in students' academic performance and motivation levels, as evidenced by the data from the research. By integrating art into science education, students not only achieve higher test scores but also develop a deeper understanding and appreciation of scientific concepts.

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Annexure 1

Improvement in students Engagement and interest through Art Integrated Teaching Pedagogies

Students	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	
A	2	1	2	3	4	4	4	4	4	5	5	4	5	5	5	57
B	1	2	2	3	4	3	4	5	5	4	5	5	5	4	5	57
C	2	2	3	4	5	5	5	4	5	4	5	5	5	4	5	63
D	4	3	4	4	4	5	5	4	5	4	5	5	5	4	4	65
E	3	3	2	4	5	5	4	4	5	4	4	3	5	4	4	59
F	2	3	4	3	3	4	5	4	2	5	3	3	4	4	5	54
G	3	2	3	2	3	4	5	4	5	5	4	3	5	5	4	57
H	3	1	2	3	4	3	4	3	5	5	4	5	4	5	4	55
I	2	1	3	3	4	4	4	5	5	5	4	4	5	4	5	58
J	2	2	3	3	2	3	3	5	5	5	4	4	3	5	5	54
K	1	2	3	2	1	2	4	5	3	4	2	4	3	5	5	46
L	1	3	4	2	3	4	4	2	4	5	4	4	4	3	5	52
M	2	3	4	3	3	3	3	5	5	3	4	3	4	5	5	55
N	2	3	2	4	5	4	4	5	5	4	4	4	4	5	5	60
O	1	2	3	5	5	4	4	4	5	4	4	4	4	5	5	59
P	2	2	3	3	5	5	3	4	5	4	4	4	4	4	5	57
Q	2	2	3	3	3	4	3	4	2	4	4	3	4	4	4	49
R	2	3	4	4	4	4	4	4	5	4	4	2	4	5	4	57
S	4	4	5	5	4	5	5	4	5	1	4	3	4	5	5	63
T	4	2	3	3	5	4	5	3	5	4	5	3	5	4	4	59
U	3	4	4	3	4	3	4	4	5	4	5	4	4	4	4	59
V	2	3	5	2	4	4	2	2	5	4	4	4	4	4	5	54
W	2	3	4	4	4	4	4	4	3	4	4	5	4	4	5	58
Total	52	56	75	75	88	90	92	92	103	95	95	88	98	101	107	1307

Annexure 2

Comparative improvement of students' scores from school practice exams to the CBSE board exams

Students	Marks in School	Marks in CBSE
A	95	95
B	90	94
C	81	95
D	92	93
E	85	95
F	81	95
G	72	94
H	72	87
I	66	90
J	61	87
K	61	85
L	49	95
M	60	74
N	56	73
O	57	71
P	61	73
Q	53	66
R	58	61
S	50	71