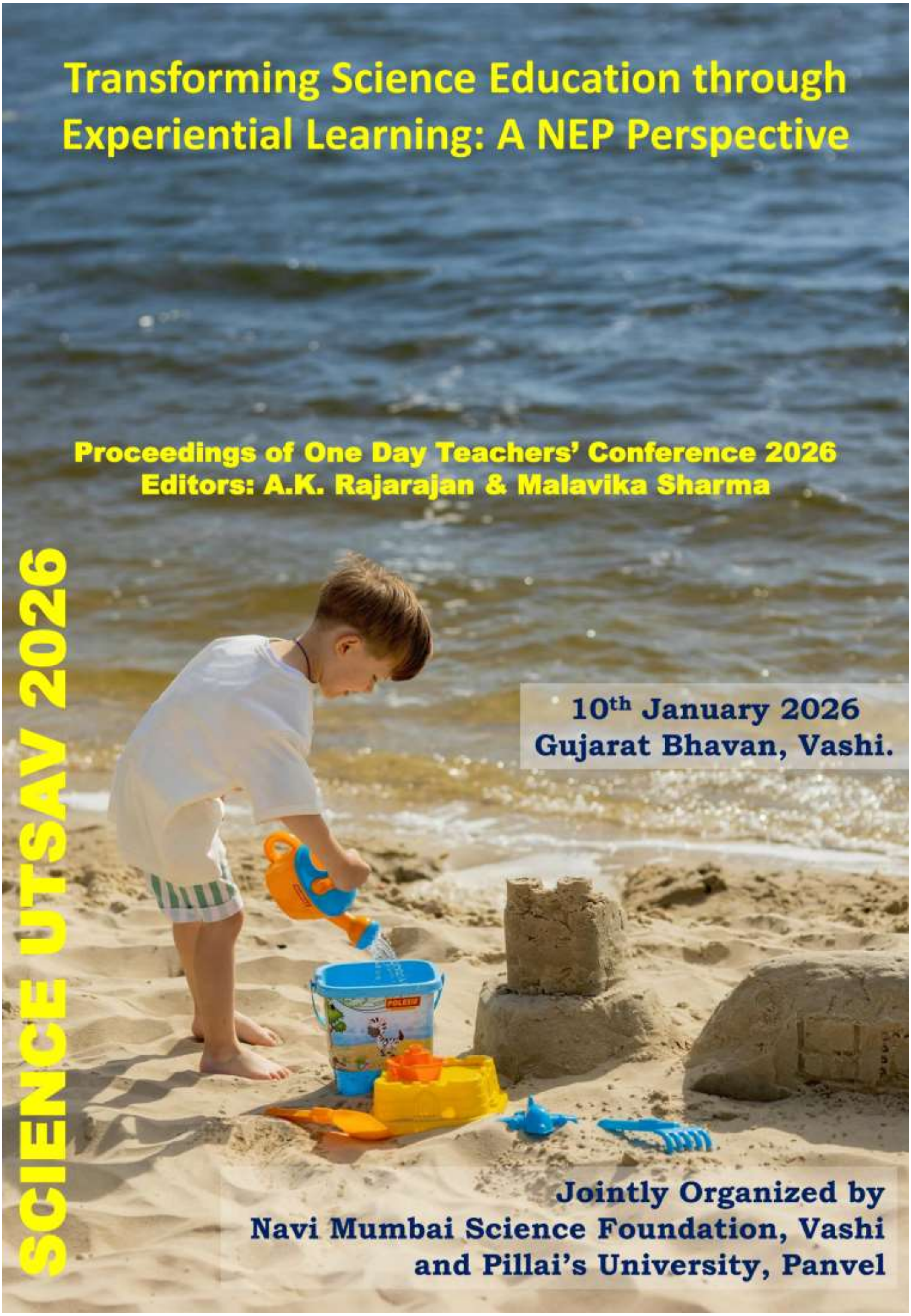

Transforming Science Education through Experiential Learning: A NEP Perspective

Proceedings of One Day Teachers' Conference 2026
Editors: A.K. Rajarajan & Malavika Sharma

SCIENCE UTSAV 2026

10th January 2026
Gujarat Bhavan, Vashi.

Jointly Organized by
Navi Mumbai Science Foundation, Vashi
and Pillai's University, Panvel

Science Utsav 2026

Proceedings of One Day Teachers' Conference on

Transforming Science Education through Experiential Learning: A NEP Perspective

Saturday 10th January, 2026

Venue:
Gujarat Bhavan, Sector 15, Vashi

Editors

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Organised Jointly by

Navi Mumbai Science Foundation
Vashi

Pillai University
Panvel

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About Navi Mumbai Science Foundation (NMSF)

(An NGO's portal for innovation in Education)

Navi Mumbai Science Foundation (NMSF) is a science led NGO in India. It is dedicated to development of “scientific culture" in the society in general & “scientific temper” in the student community in particular. This in turn contributes towards the holistic development of the nation & prepares it to face the challenges posed by a technologically advancing global environment without losing sight of its societal commitments. Its vision & mission may be summed up as under:

VISION

- ✓ Kindle and nurture scientific temperament in students;
- ✓ Enhance soft skills like problem-solving approach and communication skills;
- ✓ Promote ‘Pupil-centric’ approach in education;
- ✓ Create awareness in public about science and scientific issues;

MISSION

To advance, popularize and promote the cause of science through a defined action plan.

ACTION PLAN

- ➢ **Develop a network** of professionals and personalities to share their knowledge;
- ➢ **Provide multi-disciplinary environment** to students to understand their inter linkages;
- ➢ **Provide a platform** for interaction between leading educationists, teachers and students.

→ **The following activities are part of the present action plan:**

(Organized in each academic year)

(NMSF is an NGO's portal for innovation in Science Education)

I. “**Interactive Guidance Sessions with Scientists”** for "Homi Bhabha Bal Vaidnyanik Competition [HBBVC]".

II. **Essay Competition** on the topic “Nurturing Talent for Noble Laureatism”.

III. **“Fun with Science”** Programmes - as per request from schools & NGOs.
IV. **Special Event:** World Nuclear Energy Day celebration (on Dec. 2).
V. **Signature Event** of NMSF: Science Utsav (a two-day event, during January).
VI. **Judging at Science Exhibitions** in schools & colleges (as per request).
VII. **A Quarterly Science E-Magazine** for students of Std. VI to X, under the name “EduREKA”.
VIII. **Dr. Vikram Sarabhai Essay Competition** on the general topic “Space Exploration”.
IX. **“Teacher Training Program”** for Jilha Parishad School Teachers at

Patalganga - **A Recent addition.**

New scientific activities can be discussed & initiated as & when a proposal is received.

Our Website: *http://www.navimumbaisciencefoundation.org*

Why Navi Mumbai Science Foundation (NMSF)

The earlier sheet "About Navi Mumbai Science Foundation (NMSF)" gives a clear picture of its scientific activities designed to develop "**scientific culture**" in the society in general & "**scientific temper"** in the student community in particular. From this point of view, its activities are directed mainly towards the students of the **age group "10 - 20 years", which are the most formative years in the life of any individual. In due course, NMSF wishes to identify itself as an NGO's portal for innovation in Science Education which is accessible at "grass-roots" level.**

It is therefore essential to understand why NMSF thinks this way. In the beginning, we asked ourselves questions like i) a need for existence of an organisation like NMSF ii) specific role of NMSF and iii) how its activities will meet the societal needs of the day. While pondering over such questions, **we also reminded ourselves that India has become a parched country as far as the count of homegrown Nobel Laureates in science is concerned.** The last Indian Nobel Laureate in science stream was seen on the world stage in the year 1930. What happened thereafter?

Time was therefore ripe to review the scenario in retrospect, then introspect & come out with a feasible solution without getting lost in a blame game of any sort. While doing so, we kept in mind that India too had a rich past in scientific achievements in the fields like Mathematics, Astronomy, Medicine & Metallurgy which covered India with glory for more than two millennia before the 12th century AD. Revival of the past glory should not, therefore, prove to be an insurmountable task.

In the years after independence, emphasis in education was on lateral growth. The stress here was so intense that the vertical growth took a back seat – i. e. growth of **"centres of excellence"** in science & technology became a casualty. The real talent, therefore, started migrating in search of greener pastures & the trend still continues.

To reverse this trend, adequate world class R & D opportunities in basic sciences must become available in India too – sooner the better. It is this effort which will provide the real platform for sound societal growth and make India **"ATMANIRBHAR"** in due course. **It will also encourage some good students**

to stay back and join streams in basic sciences & basic engineering where more satisfaction prevails in the long run.

This is where the struggle of Navi Mumbai Science Foundation is expected to make an impact. The main plus point with NMSF is that it has been able to attract a few dedicated scientists from BARC who willingly interact with young students on a regular basis; the focal point of discussions being:

i) deal with that part of science also which lies beyond the four walls of the class room **and/or**
ii) that which is hidden in between any two lines of the text books.

This has emboldened NMSF to have a **VISION** of its own which is purely **"pupil-centric"** and focuses on **"hands-on / minds-on"** experience in science. The fortunate part of the entire exercise is that more & more parents are appreciating such efforts and are sending their children to take part in the activities being organised by NMSF.

Conference Organizers

Dr. A.M. Bhagwat – NMSF

Dr. Sandeep Joshi - Pillai University

Dr. Arun Pillai - Pillai University

Dr. Malavika Sharma – Pillai University

Dr. Jayant Joshi - UGC-DAE-CSR

Dr. A.K. Rajarajan – NMSF;

Dr. S.T. Mehetre – BARC, NMSF

Dr. Reni Francis, Pillai University

Concept Note:
Teachers' Conference (Science Utsav-2026)

Conference topic

"Transforming Science Education through Activity-based and Experiential Learning: A NEP Perspective."

Background

The aim of this year Teachers' Conference is to focus on the integration of **theory with practice** to make science education more engaging, inquiry-driven, and experiential. The aim is to move students beyond rote memorization towards a real understanding, where teachers transition themselves from *"leading from the front"* to *"guiding from behind"*. The National Education Policy (NEP), therefore, strongly advocates **activity-based learning**, making it imperative for teachers to rethink classroom practices.

Objectives

The conference seeks to bring together teachers, researchers, and leaders in education to explore innovative practices in science teaching.

Key objectives include:

1. Highlighting the importance of merging classroom teaching with experimentation.
2. Exploring strategies to bridge the gap between **rote learning and real understanding**.
3. Promoting **creativity, critical thinking, and scientific temperament** among students.
4. Demonstrating how science can be understood as a **way of life**, fostering rational and socially accepted attitudes.
5. Showcasing realistic case studies and classroom practices for middle and high school levels.

Themes

The conference will address a range of themes, including but not limited to:

1. **Inquiry-Driven Classrooms**: It focusses on students' curiosity and questioning, rather than their being passive recipients of information. It can include Learner-Centered Approach, Encouraging Curiosity, and Guiding Innovation.
2. **Activity-Based Learning**: It emphasizes learning by doing, wherein the students are involved in the process of learning. The teacher can do this by practical activities, demonstrations and case studies to enhance critical thinking - a key aspect of 21^{st} century skills.
3. **Bridging the Rote – Learning Gap**: Strategies to replace memorization with hands-on learning. Traditional rote memorization often leads to **superficial learning**, where students can recall facts but fail to apply them. Bridging this gap involves **connecting concepts to experiences**. This can be done with the help of concept mapping, problem-solving tasks, and peer teaching.

4. **Building Scientific Temperament**: Encouraging rational thinking as a lifelong skill. Scientific temperament is about fostering **curiosity, questioning, objectivity, and rational thinking**. It goes beyond classroom learning to shape a mind-set for life. This can be encouraged by questioning assumptions and introducing evidence-based teaching and problem-solving mindset.
5. **Practical Innovations for Teachers**: Simple classroom-friendly experiments and methods that can be realistically implemented. This can be done using home-based experiments, interactive simulations, collaborative experiments, and **"Do-It-Yourself"** models.

Expected Outcomes

1. A shift from **"teach-and-test"** models to **"learn-and-practice"** approaches.
2. Increased student engagement through **concepts taught with demonstrations and experiments**.
3. Development of **creativity, curiosity, critical thinking and scientific thinking** among learners.
4. Improved **motivation and retention** through learning-by-doing.
5. Strengthened networks for teachers to share **case studies and best practices**.

Format:

The conference will feature a keynote address and a few invited talks by education experts, interactive workshops and case-study presentations. Teachers will also participate in hands-on sessions demonstrating low-cost, classroom-friendly experiments.

Target Audience:

- Middle and high school teachers
- School leaders and administrators
- Teacher training institutions
- Education researchers and curriculum developers
- Policymakers in education

Conclusion:

This conference provides a platform to reimagine science teaching as a **student-centered, experiential process**. By equipping teachers with practical strategies and case studies, it aims to foster a culture of **curiosity, creativity, critical thinking, and scientific temperament as envisaged in NEP.** It ensures that learning extends beyond classrooms into real life.

Dr. Chitra Natarajan Memorial Lecture 2026

Speaker: Alok Katdare
Advisor, Reliance Foundation Academic Council

Theme: Transforming Science Education through Experiential Learning: A NEP Perspective

Welcome and Acknowledgment:

Respected Dr. A. M. Bhagwat, Chairman, and Honourable Dr. Rajarajan, Secretary of the Navi Mumbai Science Foundation, distinguished guests, members of the NMSF, and fellow practitioners of science, a very good morning to you all.

Tribute to Dr. Chitra Natarajan:
It is a great honour and privilege for me to be standing in front of you to deliver the most coveted Dr. Chitra Natarajan Memorial Lecture 2026. I thank Dr. Bhagwat and Dr. Rajarajan for bestowing this honour upon me in this august gathering of scientists and science practitioners.

We gather today to honour the memory of Dr. Chitra Natarajan. As a stalwart of the Homi Bhabha Centre for Science Education (HBCSE), Dr. Natarajan was a pioneer who understood that technology and science education must be rooted in design, action, and social context. Her work was a lifelong argument against the 'passive' classroom; she believed that a student's hands must be as active as their mind if true learning is to occur.

Role of Navi Mumbai Science Foundation:
I have known Dr. Bhagwat and NMSF for more than two decades. I have seen Dr. Bhagwat taking pains to reach out to schools tirelessly to propagate science education.

Under his selfless devotion to the cause of science and the teaching of science, the Navi Mumbai Science Foundation has taken up this mantle with extraordinary dedication. NMSF is not merely an organization; it is a movement that has spent years demystifying science for the common student. Through its tireless teacher-training programs and the vibrant 'Science Utsav,' NMSF has created a bridge between complex scientific theory and the curiosity of a schoolchild. By fostering a culture of 'learning by doing' right here in our community, specifically through the Science Exhibition by students as part of Science Utsav every year, NMSF is ensuring that the spirit of inquiry remains a living, breathing reality in schools. My salutes to NMSF in general and Dr. Bhagwat in particular.

Personal Journey with Science and Mathematics:

I have been a student of Mathematics. I had frequent encounters with science during my school and college days, which actually were attempts at my encounter by science and science teachers, as most of the time science remained Greek and Latin for me.

The fear was such that in Class 9, I scored 98 out of 100 in mathematics but was not even closer to passing marks in science; perhaps I was the only one to hold such a dubious distinction.

In my initial days of teaching, I was assigned the teaching of science in addition to my subject, mathematics, which I accepted reluctantly. The fear of failure while standing before a young audience forced me to go deeper into the concepts and explore the "why" and "how" rather than just the "what" and "where." Slowly, I started loving the subject and began exploring it more. In the process, I have gathered two types of experiences – one as a student and the other as a teacher. The experience as a teacher made me a lifelong student of science and also strengthened my roots in mathematics.

Why Experiential Learning Matters:

These experiences shaped my conviction that science must be lived, not memorized. And that is why it is very important that we join our students in seeking science in everything around us and guide them, handhold them. It is very important that science is allowed to step out from the textbooks and stroll with young students. What is needed is to create a safe space for children to experience what they do, to express what they see while doing, to try experimenting and fail, to explore further to find the right way, and finally, to consolidate what they have learnt in this complete cycle.

The transformation of science education will happen only if my fellow science practitioners from schools and colleges transform their approach.

Some time ago, I was interacting with a physics teacher when I noticed screw gauges, Vernier callipers, and spherometers neatly stored in an almirah. Out of curiosity, I asked a simple question: "Why should students learn to identify the zero error of these instruments and apply the correction?" The teacher replied, "Because in the practical examination, they need to get the correct answer."

Her response reflected a familiar perspective, so I gently probed further: "Even if a student's answer is off by a few decimals, nothing catastrophic happens. So, what makes zero-error correction essential?" She reiterated her point, but the deeper purpose remained unarticulated.

The true educational value lies not merely in arriving at the 'right' numerical answer but in nurturing a scientific habit of mind. Zero-error correction trains students to think critically, to observe carefully, and to appreciate that precision is the discipline that distinguishes science from other subjects. It conveys that every scientific measurement carries responsibility, rigour, and respect for accuracy. When students consistently practise such habits, they begin to internalise the idea that excellence, in science or in life, emerges from attention to detail and mastery of foundational skills.

Seen through this lens, even a simple act like determining the zero error becomes a meaningful competency—one that blends conceptual clarity, procedural skill, and scientific temperament. When we approach practical work with this purpose, laboratories transform from assessment spaces into vibrant learning ecosystems that cultivate the next generation of thinkers, innovators, and knowledge creators.

NEP's Call for Experiential Learning:
Instead of viewing the curriculum as a checklist, the NEP invites us to create learning environments where students question, explore, design, experiment, and innovate. Inquiry-based learning, project-based learning, and experiential learning are no longer add-ons—they are central to nurturing an innovation mindset, one that values curiosity, systematic thinking, and problem-solving.

Understanding Competency:
What is a Competency? In simple words, competence is the holistic ability to use the skills—along with knowledge and attitude to achieve a successful outcome in a real-world environment. Competence is a broader concept that describes a person's overall capacity to meet the demands of a specific role or situation. When we teach a child about the "zero error" of a screw gauge, the Knowledge is understanding that instruments can be imperfect. The Skill is the physical ability to calibrate it. But the Attitude—which is the most important part—is the "Scientific Temperament."

Cross-Curricular Linkage:
As a science teacher, once I demonstrated to students about burning of a wooden chip as against a log of the same wood. A wooden chip ignites almost instantly when touched by a matchstick because it has a high surface-area-to-volume ratio, requiring less heat to reach its ignition temperature. In contrast, a thick wooden log takes longer to burn because it requires substantially more heat to raise its internal temperature to the ignition point. This demonstration by using wood of various thicknesses. The students were asked to share their observations and find reasons for these different behaviours. This approach helped them consolidate the concept of ignition temperature while understanding the importance of the surface-area-to-volume ratio and the amount of heat required to attain the ignition temperature. Such activity promoted enquiry-based learning, experiential learning and activity-oriented learning.
When a student sees that a thin wood chip burns faster than a log, they have discovered a "Big Idea." This can be applied elsewhere. They will understand why our lungs have millions of tiny alveoli instead of two big balloons—it's the same ratio at work! This is what the NEP calls Cross-Curricular Linkage. We aren't forcing them to run a marathon of chapters; we are teaching them how to walk, observe, analyse and infer.

Primary Stage: Building Curiosity and Conceptual Clarity:
The primary school—encompassing what the NEP calls the Foundational and Preparatory stages—is all about building concepts, developing curiosity, and nurturing an enquiry mindset. Teachers here have a vast "playfield" to experiment with the curriculum and lead students through the fascinating "streets of science" by breaking conventional boundaries. Traditionally, across all curricula, we find 'germination of seed' as a redundant, "tick-box" experiment.

But this can be done differently to align with the NEP's vision of Experiential Learning. Students can be divided into groups and asked to bring seeds of different types—ones that become creepers, plants, or trees; or ones that germinate during different seasons.
The kitchen garden concept works so well here for the schools to deal with this model of experiential learning. The concept can run through the year and be revisited as the seasons change, creating a Cross-Curricular Linkage between Biology and Geography.

Now, the children have a variety of seeds germinating in different ways. They learn growth patterns and life cycles first hand, shifting the focus from rote memorization to Conceptual Clarity. Encourage them to see what stays the same (the constants) versus what changes (the variables). They can record their observations against the name of each seed and draw an "n-number" of insights, turning a simple activity into a Formative Assessment of their scientific temper. Here instead of grading children simply on whether their seed grew, the grading is done on the quality of their observations and their ability to explain why a certain seed might have failed to germinate. We must empower children to ask the Right Question rather than merely providing the Right Answer.

Middle Stage – Moving from Learning to Doing Science:
Middle school, or the Middle Stage of the NEP, is where knowledge builds upon the concepts and skills developed in the primary years. This is the right time to move from "learning science" to "doing science," further promoting the habit of experimentation, even though the curriculum becomes more "time-bound." I have seen many teachers who are afraid of handing simple instruments to students, fearing damage. If an instrument is lost or damaged, let us weigh the cost: is the learning more valuable, or is the equipment? This is the time where a "Laboratory on Wheels" can be created to democratize access to tools.

These examples underscore why NEP 2020 emphasizes experiential learning as a cornerstone of science education. The NEP emphasizes Vocational exposure and Hands-on learning; issuing simple pendulums for students to take home is a perfect example. Let them use strings of different lengths, record observations, and infer the relationship between time period and length of the pendulum. This experiential learning helps them "optimize" the concept, ensuring that by the time they reach secondary school, they aren't just consumers of information, but practitioners of the scientific method.

Innovation and Reflective Practice for Teachers:
The innovations in classroom teaching happen in two ways—one is a planned one, and the other is reflecting upon your day and discussing it with peers. You will realize that on many occasions you had innovated or scripted a "best practice." We have options that we feel elated and leave it there, or we document the whole process with evidence and share it with the larger community. Write case studies on some of the identified practices and discuss in the department meetings or a meeting of all the teachers. This not only builds competence in the teachers and students simultaneously but also promotes a culture of experimentation in classroom teaching and together we all create newer benchmarks for us.

Innovation is not about the cost of the equipment; it is about the cost of the thought. When a teacher documents these small daily wins, they are building their own professional competence. The NEP envisions a teacher who is a "Reflective Practitioner"—one who doesn't just repeat the same lesson for thirty years, but one who learns from their students every day, every moment and then realign our teaching and resources to set higher benchmark for the next time. These are the moments where innovations take root and best practices evolve.

NEP Framework and 5-E Model:
The NEP is not merely a shift in what we teach; it represents a transformative re-imagining of how learning should happen. For many years, our education system has focused on completing chapters and ticking off experiments. While that approach served a purpose in its time, NEP 2020—through the National Curriculum Framework—encourages us to move from syllabus completion to competency cultivation.

Instead of viewing the curriculum as a checklist, the NEP invites us to create learning environments where students question, explore, design, experiment, and innovate. Inquiry-based learning, project-based learning, and experiential learning are no longer add-ons—they are central to nurturing an innovation mindset, one that values curiosity, systematic thinking, and problem-solving.

The National Education Policy (NEP) 2020 shifts the focus from "what to think" to "how to think." It advocates for a holistic, integrated, and learner-centered approach that transforms the classroom from a space of passive listening to one of active discovery. The 5-E framework—Engage, Explore, Explain, Elaborate, and Evaluate—ensures that "Enquiry-Driven" learning is purposefully structured.

Reliance Foundation Schools – Translating Vision into Practice:
Education is at the heart of Reliance Foundation's vision for India and is critical to the country's social and economic progress. Reliance Foundation uses a two-pronged approach to accelerate India's educational quotient, through initiatives spanning primary, secondary and tertiary education:

Developing world-class institutions that serve as models to transform and strengthen the country's education system nurturing India's youth and future global leaders to develop solutions to India's challenges and, in parallel, ensuring equitable access to education for all.

At Reliance Foundation Schools, we have embraced this vision wholeheartedly in a deeply meaningful way. Across our 12 RF Schools, each has established a School Innovation Council (SIC) registered with the Ministry of Science and Technology. We have more than 150 teachers who are trained as Innovation Ambassadors by the Ministry of Science and Technology, equipping them to mentor students in ideation, design thinking, prototyping, and research.

The SICs across our schools are nurturing students to develop project ideas that are socially relevant, environmentally responsive, or even helpful in enhancing classroom teaching and learning. In last three years a total of 206 project proposals were submitted to prestigious forums such as INSPIRE MANAK, CBSE Science Exhibition, NCERT PRAYAAS, CBSE Skill Expo, CSIR JIGYASA, Youth Ideathon, HCL Jigsaw, Vikasit Bharat Buildathon, and many others. 50 projects qualified for State/Regional Level.

Further, 31 project proposals qualified for National Level of which 19 projects have won at the national level winning research grants, scholarships, cash awards totalling to Rs 6,60,000, while this year's many of the results are still awaited and with that the numbers will be even higher.

Achievements and National Aspirations:

These are not just awards, but they are testimonies to what happens when students are provided with the right ecosystem—an ecosystem aligned with NEP 2020's call for hands-on, minds-on, hearts-on learning with focus on research and innovation mindset. They reflect a future-ready education model where students are not just absorbing knowledge but actively creating solutions for the world around them.

These achievements are not isolated milestones; they are stepping stones toward a much larger national aspiration. When we nurture innovation today, we are laying the foundation for the India of tomorrow. The competencies we build in our classrooms will shape the capabilities of our nation in the decades to come.

Vision 2047 and Role of Teachers:

As we look ahead, let us remember that transformation begins in our classrooms, with each small innovation shaping a larger future. India is committed to the Honourable Prime Minister's call for a Vikasit Bharat and Vision 2047. The students who are in Nursery this year, they will be in their college years by that time. The students of middle school of today will be contributing in shaping this vision, the students in secondary and senior secondary schools today will be leading the vision and by then many of us will be sitting and reaping the fruits of this shift in the education system of Bharat. The implementation of NEP 2020 in its spirit with devotion and dedication of our teachers will make this dream come reality.

Closing Remarks and Call to Action:

The teachers' conference today is a platform to share these innovations generously, talk about our best practices with sense of pride and not with sense of competition, but with a duty to our fellow teachers so that these are propagated across institutions. This is where the Navi Mumbai Science Foundation contributed to the cause of education by bringing the practitioners of science on a common platform and share their best practices and innovations through paper presentation.

With this, I stop here, hoping I have done justice to the responsibility thrust upon me. Once again, my sincere thanks to Dr. Bhagwat, Dr. Rajarajan, and NMSF for this invitation, and my thanks to the audience for hearing me patiently. My best wishes to my colleague teachers with an advice, Marriages take place on auspicious days at an auspicious time, but best practices keep evolving and innovations in the classroom happen daily; without waiting for an auspicious moment. So, let us keep our eyes open, ears open and brain analysing these and capture that Aaha moment which you realised when you retire in bed in the night.

So be innovators, be creators of best practices, wait for NMSF to announce for the next edition of Science Utsav and meet again to share and grow together. Wishing you all a day full of learning, sharing, and growing together as we work toward Viksit Bharat – Vision 2047.

Thank you!

Invited Talks

Teaching for Understanding: Practical Ways to Replace Rote Learning

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Abstract

The shift from rote memorisation to meaningful, experience-based learning has become an essential priority in modern classrooms. In alignment with the principles of the National Curriculum Framework (NCF 2023), this workshop, *will* equip teachers with classroom-ready strategies that promote deeper comprehension, learner autonomy, and active engagement. Designed as an experiential session, the workshop will help teachers move beyond “teaching for recall” and introduce “teaching for understanding,” ensuring long-term retention and conceptual clarity among students.

The session introduces teachers to practical, hands-on learning techniques that are easy to implement within existing school constraints. It also helps teachers understand how experiential learning cycles concrete experience, reflection, conceptualisation, and application, can be seamlessly integrated into everyday lessons. Through guided activities, demonstrations, and collaborative tasks, participants will explore effective ways to reduce dependence on memorisation and increase student participation, curiosity, and critical thinking.

In addition, teachers will gain practical insights into how hands-on engagement helps students understand concepts more effectively than memorisation. By the end of the session, participants will be equipped with ready-to-use strategies that can transform their classrooms into spaces where learning becomes meaningful, enjoyable, and lasting.

Practical Innovations in Physics Education: Bridging Core Domains through Experiential Learning and Data Analysis

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Abstract

Traditional physics instruction often relies on teacher-led demonstrations and memorized formulas, leaving students disconnected from the experimental processes that define scientific inquiry. This paper presents practical innovations for transforming physics education by integrating three hands-on experiments from core physics domains—optics, mechanics, and electromagnetism—combined with accessible data analysis techniques.

The proposed approach spans three complementary experiential learning activities: (1) optical interferometry using wedge-shaped air films to determine elastic constants of polymeric materials; (2) catapult design and optimization where students construct mechanical systems and analyse performance data to understand key parameters; and (3) electric motor construction where students design motors for maximum efficiency and examine how design variables influence performance through data analysis.

Each experiment advances beyond traditional methods by embedding three critical elements: hands-on construction using minimal, readily available resources (glass slides, rubber bands, ice-cream sticks); systematic measurement and data collection; and evidence-based analysis where students refine designs based on experimental data rather than intuition alone. This approach directly addresses the National Education Policy (NEP) 2020 emphasis on moving from rote memorization to inquiry-driven learning.

The framework is deliberately designed for feasibility in school and pre-college environments. Simple apparatus, everyday materials, and straightforward data analysis techniques ensure that teachers without specialized infrastructure can implement these activities.

By demonstrating how hands-on experiments across physics' fundamental domains can be enriched through careful observation and data analysis, this work provides teachers with replicable, low-cost models for practical innovation aligned with NEP principles, enhanced scientific temperament, and deeper conceptual understanding.

Keywords: Experiential Learning, Physics Education, Optics, Mechanics, Electromagnetism, Student-Centred Learning, Hands-On Experiments, Data Analysis, NEP Alignment, Teacher Innovation

Immersive Learning Through AR/VR:
A Framework for Experiential Education in Schools

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Abstract

Immersive learning technologies such as Augmented Reality (AR) and Virtual Reality (VR) are reshaping educational practices by enabling learners to visualize and interact with complex concepts in intuitive and experiential ways. For school-level education, where foundational understanding is built, immersive environments offer unique advantages: they simplify abstract ideas, enhance curiosity-driven exploration, and create safe, realistic simulations that would otherwise be difficult or impossible to conduct in physical classrooms. This is particularly impactful in subjects such as Biology, Chemistry, and Environmental Science, where students can observe microscopic processes, perform virtual experiments, and engage with 3D models that strengthen conceptual learning.The development of effective immersive experiences relies on two key domains: CAD-based 3D asset design, which ensures accurate and pedagogically meaningful visual models, and application development, which integrates these assets into interactive AR/VR environments. Establishing collaborations between schools and technical institutes can accelerate the adoption of immersive learning by providing access to specialized skills, infrastructure, and interdisciplinary expertise—ultimately enabling schools to integrate modern learning tools without steep technological barriers.

As AR/VR technologies become embedded in daily life—through virtual product previews, home visualization tools, retail try-ons, and interactive digital experiences—their inclusion in school education becomes essential for preparing future-ready learners. Familiarity with immersive technologies not only enhances academic learning but also cultivates digital literacy, creativity, and problem-solving skills that are increasingly relevant in a technology-driven society. The societal implications are significant: early exposure to immersive learning fosters a generation capable of leveraging advanced technologies ethically, innovatively, and inclusively, contributing to a more informed and technologically empowered future.

Contributed Papers

From Ideas to Impact

Bhavini Veera
Arya Vidya Mandir, Bandra West; Subject Head – Biology and EVS

Abstract

The National Education Policy (NEP) 2020 emphasizes experiential, inquiry-based, and learner-centred education to nurture a scientific temper and 21st-century skills. This paper presents practical strategies for implementing experiential learning in science classrooms using simple, low-cost innovations, including DIY models, home-based experiments, AI-enabled simulations, visible thinking routines, CORT tools, interdisciplinary integration, and outdoor learning. Classroom examples, student engagement, and feedback demonstrate that these approaches foster curiosity, critical thinking, and conceptual understanding, making science meaningful, enjoyable, and memorable for learners of all ages and abilities.

Introduction

Traditional science teaching in the classroom often focuses on memorization rather than understanding, leading to passive learning, an exam-centric approach, and a lack of conceptual clarity among students. The National Education Policy (NEP) 2020 advocates a shift towards experiential learning, where students actively engage through observation, questioning, experimentation, and reflection. It promotes learning by doing, inquiry-based methods, collaboration, and multidisciplinary approaches. NEP 2020 also encourages teachers to move beyond textbooks and design meaningful learning experiences that nurture the 5 Cs—curiosity, critical thinking, creativity, communication and collaboration along with scientific thinking in learners.

Role of the Teacher

In an experiential classroom, the teacher acts as a guide by the side rather than a sage on the stage. A shift is from “teach-and-test” models to “learn-and-practice” approaches.

Practical Innovations Within and Beyond the Classroom

Teachers implement practical innovations within and beyond the classroom by engaging students in hands-on, real-life learning through simple experiments, collaborative activities, varied pedagogies, and everyday observations that meaningfully connect scientific concepts to the real world. A few examples are listed below:

1. Home-Based Experiments- Learning Beyond the Classroom
Home-based experiments use simple household materials to demonstrate scientific concepts,

● **Physics:** Reflection with mirrors; static electricity using plastic scales.

● **Chemistry:** Acid-base testing with turmeric or hibiscus; balloon inflation with baking soda and vinegar.

● **Biology:** Transpiration in plants; diffusion with food colour; osmosis in seeds.

Outcome: Enhances observation skills, connects science to daily life, and boosts student confidence and ownership of learning.

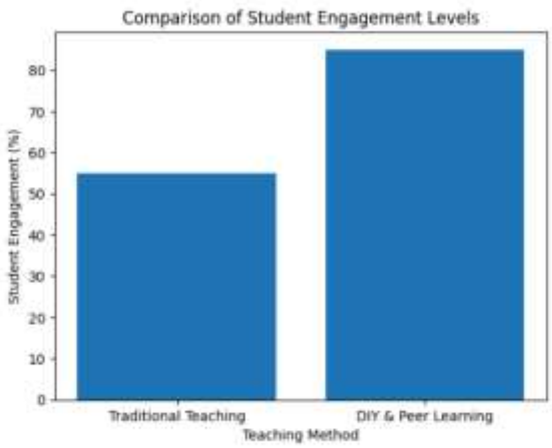
2. DIY Models: Building Conceptual Understanding through peer learning
DIY models encourage creativity and deeper understanding by learning by doing. This could be done collaboratively through peer learning.

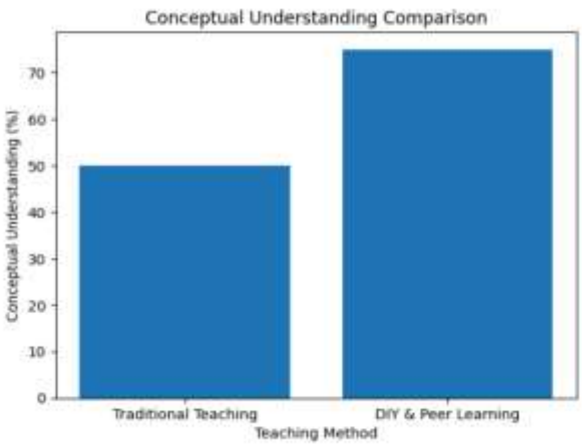
● **Physics:** Electric circuits, pinhole camera.

● **Chemistry:** Paper chromatography, invisible ink.

● **Biology:** Working lung model, cell models from recycled materials.

Outcome: While teaching the grade VII topic, The Cell, almost 82–85% of students participated actively, and 70–75% could explain the functions of organelles in their own words, showing improved engagement and conceptual clarity.





3. Interactive Simulations and Virtual Tools (AI-Enabled Learning)
When physical experiments are limited by safety, time, or resources, AI-enabled interactive simulations help students visualize complex processes, and observe outcomes in real time.

● **Physics:** Virtual circuits with adjustable voltage and resistance.

● **Chemistry:** Chemical reactions and separation techniques.

● **Biology:** Blood flow circulation in the heart, photosynthesis visualization

Impact: Strengthens scientific reasoning, digital literacy, and critical thinking.

4. Design Thinking in Science -From Problems to Practical Solutions- Design thinking encourages students to identify real-life problems, think creatively, and develop practical solutions. In the classroom, an activity focused on creating awareness about plastic pollution was done.

Steps: Students begin by observing the problem in their surroundings → Empathize with its impact on living beings and the environment → Define the issue → Ideate possible solutions, collect plastic waste, and donate to an NGO for recycling → Prototype. Few students make decorative pen stands.

Impact: Promotes sustainability, environmental responsibility, and awareness aligned with SDG Goal 12 – Responsible Consumption and Production

5. Integrating Visible Thinking Routines and CORT Tools: Unlocking Critical Thinking

The use of Visible Thinking Routines and CORT tools supports students in developing structured reasoning, engaging in meaningful discussions, and approaching scientific concepts with a critical mindset. In the classroom, these allow teachers to quickly identify and address gaps in understanding.

● **Visible Thinking Routines:** See–Think–Wonder, Claim–Support–Question,

Connect–Extend–Challenge.

● **CORT Tools:** CAF (Consider All Factors), PMI (Plus–Minus–Interesting).

Outcome: Students develop critical thinking, structured reasoning, and the ability to articulate and reflect on their scientific understanding during discussions held in the classroom.

6. Interdisciplinary Connections in Learning

Students explored the integration of multiple subjects through hands-on activities:

● **Science + Art:** Skeletal systems from clay, ear buds.
● **Science + Language:** Writing reflections explaining bone functions.
● **Science + Mathematics:** Counting and classifying bones into axial and appendicular skeleton.

Evidence: Student-made models and reflections showcase successful interdisciplinary integration.



7. Outdoor and Activity-Based Learning
Outdoor learning was used extensively to make science concepts tangible. Examples from Biology and Physics illustrate this approach:

● **Biology** (Circulatory System): The heart model drawn on the ground transformed the school campus into a learning space. Students physically move through the model to understand complex processes of the flow of oxygenated and deoxygenated blood through the chambers of the heart.
● **Physics (**Types of Motion): Rotational, linear, circular, and periodic motions demonstrated using balls, hula hoops, and other props.
Student Feedback:
● Biology: “I understood blood circulation better because I became a part of the heart.”
● Physics: “I could see and feel how objects move in different ways; it was so much fun.”



Assessment: Exit tickets where the teacher asked students to answer the questions- showed 75–80% of students were more confident in answering questions.

Conclusion

Experiential learning transforms science classrooms into spaces of curiosity, creativity, and deep understanding. Using low-cost innovations—DIY models, home-based experiments, AI-enabled simulations, visible thinking routines, CORT tools, interdisciplinary projects, and outdoor activities—students of all ages actively construct knowledge and develop essential 21st-century skills. These strategies align with NEP 2020, proving that effective science education relies on thoughtful planning and innovation rather than expensive resources.

Classroom evidence confirms that experiential approaches enhance conceptual clarity, foster curiosity, and make learning engaging and memorable, cultivating scientific temper and lifelong learning habits for all learners.

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Experiential Learning and Practical Innovations for Teachers

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Abstract

Experiential learning and practical innovations are significantly reshaping contemporary teacher education by effectively bridging the long-standing gap between theory and practice. This research paper explores how experiential learning principles, when supported by practical and pedagogical innovations, empower teacher trainees to become reflective, adaptive, and creative educators. The study highlights major experiential learning models, the role of innovative teaching practices, benefits for teacher trainees, challenges in implementation, and strategies for effective integration. The findings suggest that teacher trainees who actively engage in hands-on, reflective, and transformative learning experiences supported by innovative tools and methods demonstrate higher professional competence, confidence, and classroom readiness. The paper emphasizes that experiential learning and practical innovations go hand in hand in preparing future teachers for the dynamic demands of 21st-century classrooms.

Introduction

Teaching cannot be learned only from books or lectures. Teaching is a professional skill that develops through experience, reflection, and continuous practice. In recent years, teacher education has moved away from traditional, lecture-based approaches towards experiential learning supported by practical innovations. This shift has become essential in preparing teacher trainees to meet the real challenges of today's classrooms.

Experiential learning allows teacher trainees to learn by doing, while practical innovations provide effective methods and tools to support this learning. Together, they play a vital role in shaping confident, reflective, and competent future teachers.

Experiential Learning in Teacher Education

Experiential learning is a process in which learning takes place through direct experience followed by reflection. In teacher education, experiential learning means engaging trainees in real teaching situations rather than limiting them to theoretical discussions.

Experiential learning opportunities provided by the teacher educators are:

- Micro-teaching sessions
- Practice teaching in schools
- Classroom observations
- Role plays and simulations
- Action research and case studies

These experiences help teacher trainees understand how educational theories work in real classrooms. They also help trainees develop teaching skills, classroom management strategies, and communication abilities.

Role of Practical Innovations in Teacher Preparation

Practical innovations are creative and effective approaches that make teaching and learning more meaningful. In teacher education, innovations help teacher trainees adapt to modern classrooms and diverse learners.

Project-Based Learning

Teacher trainees are encouraged to design lesson plans, teaching aids, and assessments as projects. This helps them understand curriculum planning, implementation, and evaluation in a practical manner.

Technology-Enabled Teaching

The use of smart boards, digital presentations, online resources, and learning management systems has become an essential part of teacher preparation. Integrating technology helps trainees become confident in using digital tools for teaching and assessment.

Reflective Practices

Reflection is at the heart of experiential learning. Teacher educators guide trainees to maintain reflective journals and teaching portfolios. These reflections help trainees identify their strengths, challenges, and areas for improvement.

Collaborative Learning

Group discussions, peer teaching, and team lesson planning promote collaboration among trainees. Such activities help them learn from each other and develop professional attitudes.

Experiential Learning and Practical Innovations

Experiential learning and practical innovations are closely connected. Experiential learning provides real teaching experiences, while innovations offer structured ways to plan, implement, and reflect on these experiences.

For example:

- Practice teaching becomes more meaningful when followed by reflective writing and peer feedback.
- Classroom simulations are more effective when supported by audio-visual tools.
- Action research projects help trainees solve real classroom problems using innovative strategies.

Together, experiential learning and innovations ensure that teacher trainees develop not only content knowledge but also pedagogical skills, professional attitudes, and reflective abilities.

Benefits

The integration of experiential learning and innovations leads to several positive outcomes:

- **Enhanced Professional Competence:** Trainees develop strong teaching, classroom management, and assessment skills.
- **Improved Reflective Ability:** Continuous reflection leads to self-awareness and professional growth.
- **Increased Confidence:** Hands-on teaching experiences reduce anxiety and build confidence.
- **Adaptability and Creativity:** Exposure to innovative practices encourages flexibility and creative problem-solving.
- **Better Classroom Readiness:** Trainees are better prepared to handle diverse learners and real-life classroom challenges.

Teacher trainees become more prepared to face classroom realities and professional responsibilities.

Role of the Teacher Educator

Teacher educators act as facilitators, mentors, and reflective guides rather than mere content deliverers. These include:

- Designing meaningful experiential activities
- Encouraging reflective thinking
- Providing constructive feedback
- Modelling innovative teaching practices
- Creating a supportive learning environment

Conclusion

Experiential learning and practical innovations are essential components of effective teacher education. From the perspective of a teacher educator, these approaches help bridge the gap between theory and practice and prepare teacher trainees for real classroom challenges. When trainees actively participate in teaching experiences supported by innovative strategies, they develop confidence, competence, and professional commitment. Therefore, teacher education programmes must continue to strengthen experiential learning and encourage practical innovations to develop capable and future-ready teachers.

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Hands and minds on the periodic table using AsanVigyan card games: Progressing from fun-play to functional protocol

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Introduction: Chemistry is challenging for new students due to the numerous unfamiliar names, terms and symbols right in the beginning. The AsanVigyan Valency Card of Elements (VaCE) has been for the past five years been helping students grasp the information of periodic table effectively right at young age [1]. The main goal is to make the periodic table learnable at the Foundational Literacy and Numeracy (FLN) stage. The philosophy behind is as follows; there is nothing more foundational in the world of materials than the knowledge of atoms and if there is anything which follows the sequence of natural numbers with perfection, it's the number of protons in the nucleus, aka the atomic number. The work is in line with National Education Policy (NEP-2020), and here we present the results of our bold but successful attempt in introducing the periodic table as part of foundational literacy and numeracy (FLN) with special emphasis on inclusion of students from socio-economically disadvantaged groups (SEDGs) [2]. The targeted community schools were Special Education Zones like Hydrogen Paathshala of Anand Nagar, Navi Mumbai and Astytva Learning Centre, Pune. Students from community education centres, of age group 6 to 12, were introduced to the world of atoms and the periodic table as part of foundational curriculum using the card game based methods.

The Starting Problem: Educators lacked a guided way to introduce periodic trends and basically faced the issue of "where to begin with"? There was a need for a structured, engaging game framework that makes it easy for all to start the learning process in a standard format for large scale curriculum level implementation. It has to be such that no prior learning should be required.

Solution: The ZARVEN Learning Game! A functional protocol

Each card represents one of the elements in periodic table. Properties compared:

Z – Atomic Number; **A** – Atomic Mass; **R** – Atomic Radius;

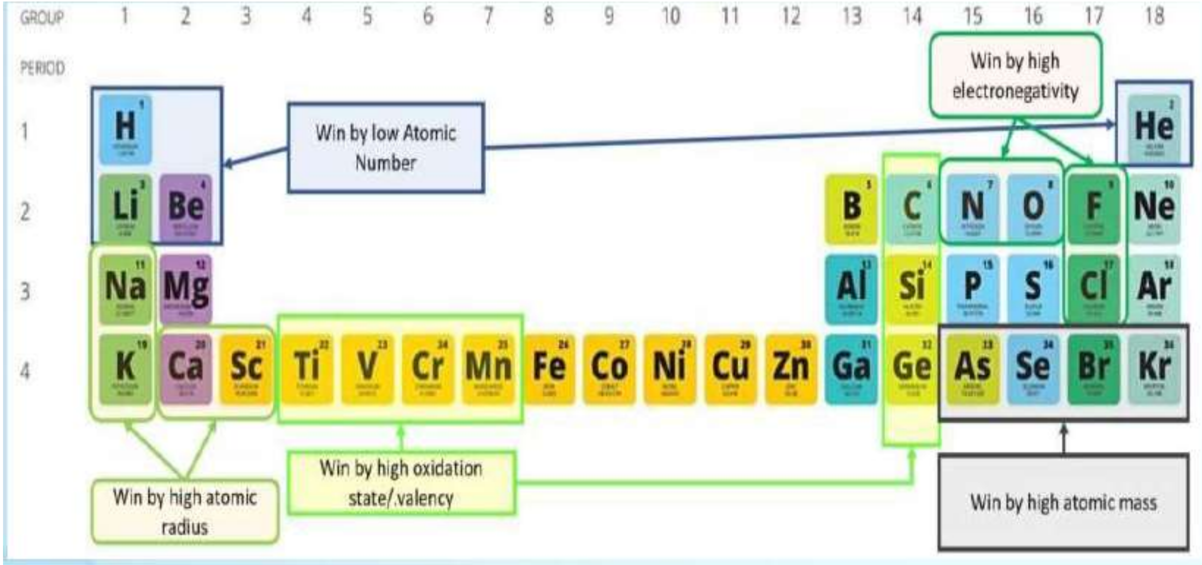
V – Valency; **EN** – Electronegativity

Rules: "Less is more" for Z, More the merrier for A, R, V, and EN. Let us see some examples.

Sym	Score	**Ne**	Vs	**Mg**	Score
Z (LIM)	**1**	**10**	Vs	12	0
A (MTM)	0	20.2	Vs	**24.3**	**1**
R (MTM)	0	38	Vs	**145**	**1**
V (MTM)	0	0	Vs	**2**	**1**
En (MTM)	0	0	Vs	**1.31**	**1**
Zarven (MTM)	**1**		Vs		**4**

Sym	Score	**Cl**	Vs	**Ar**	Score
Z (LIM)	**1**	**17**	Vs	18	0
A (MTM)	0	35.5	Vs	**40**	**1**
R (MTM)	**1**	**79**	Vs	71	0
V (MTM)	1	-1	Vs	0	0
En (MTM)	1	**3.16**	Vs	0	0
Zarven (MTM)	**4**		Vs		**1**

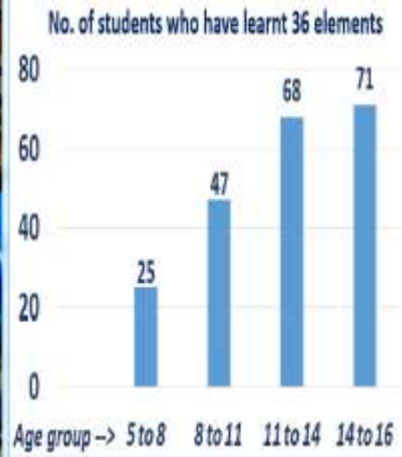
The enhancing role of Data Science: More data the merrier! Each element was made to "compete" with each other like league format. A league table of all 18 elements was created with 153 pairwise comparisons. Scoring was used to visualize periodic trends and support understanding of relationships between properties and get an idea of "winning cards" in each property category. Since the methodology is the same for any two cards, and so are the results, ZARVEN thus is an ideal learning game as one does not need to think much as to where to begin, but they need to just keep pen and paper to note for the scores to learn the trends.



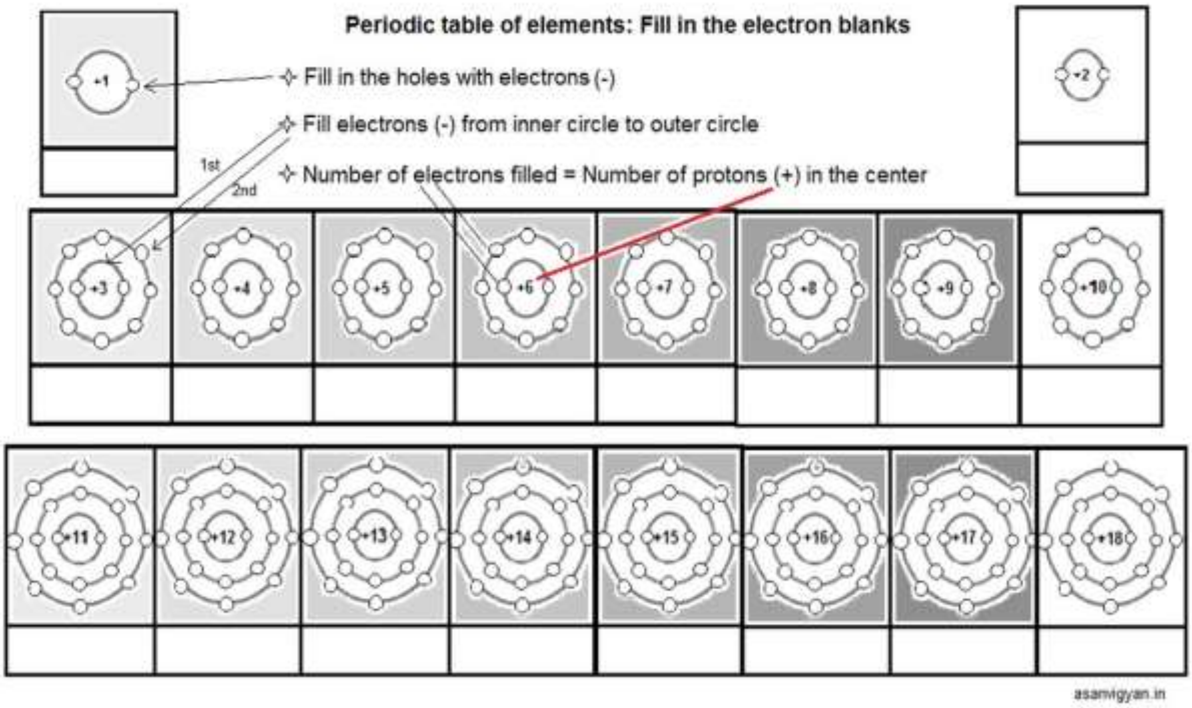
	H	He	Li	Be	B	C	N	O	F	Ne	Na	Mg	Al	Si	P	S	Cl	Ar
H	null	4-1	2-2	2-3	2-3	1-4	2-3	3-2	2-3	4-1	2-2	2-3	2-3	2-3	3-2	1-4	2-3	3-2
He	1-4	null	1-4	1-4	1-4	1-4	2-3	2-3	2-3	1-2	1-4	1-4	1-4	1-4	2-3	2-3	2-3	1-2
Li	2-2	4-1	null	2-3	2-3	2-3	3-2	3-2	3-2	4-1	2-2	2-3	2-3	2-3	3-2	3-2	3-2	4-1
Be	3-2	4-1	3-2	null	2-3	2-3	3-2	3-2	3-2	4-1	3-2	2-2	1-4	2-2	3-2	3-2	3-2	4-1
B	3-2	4-1	3-2	3-2	null	2-3	3-2	3-2	3-2	4-1	3-2	3-2	2-2	2-3	2-3	2-3	3-2	4-1
C	4-1	4-1	3-2	3-2	3-2	null	3-2	3-2	3-2	4-1	3-2	3-2	3-2	2-2	3-2	2-3	2-3	3-2
N	2-3	3-2	2-3	2-3	2-3	2-3	null	2-3	2-3	3-2	2-3	2-3	2-3	2-3	2-2	2-3	1-4	2-3
O	2-3	3-2	2-3	2-3	2-3	2-3	3-2	null	2-3	3-2	2-3	2-3	2-3	2-3	3-2	2-3	2-3	2-3
F	2-3	3-2	2-3	2-3	2-3	2-3	3-2	3-2	null	3-2	2-3	2-3	2-3	2-3	3-2	3-2	2-2	2-3
Ne	1-4	2-1	1-4	1-4	1-4	1-4	2-3	2-3	2-3	null	1-4	1-4	1-4	1-4	2-3	2-3	2-3	1-2
Na	2-2	4-1	2-2	2-3	2-3	2-3	3-2	3-2	3-2	4-1	null	2-3	2-3	2-3	3-2	3-2	3-2	4-1
Mg	3-2	4-1	3-2	2-2	2-3	2-3	3-2	3-2	3-2	4-1	3-2	null	2-3	2-3	3-2	3-2	3-2	4-1
Al	3-2	4-1	3-2	4-1	2-2	2-3	3-2	3-2	3-2	4-1	3-2	3-2	null	2-3	3-2	3-2	3-2	4-1
Si	3-2	4-1	3-2	3-2	3-2	2-2	3-2	3-2	3-2	4-1	3-2	3-2	3-2	null	3-2	3-2	3-2	4-1
P	2-3	3-2	2-3	2-3	3-2	2-3	2-2	2-3	2-3	3-2	2-3	2-3	2-3	2-3	null	2-3	2-3	3-2
S	4-1	3-2	2-3	2-3	3-2	3-2	3-2	2-3	2-3	3-2	2-3	2-3	2-3	2-3	3-2	null	2-3	3-2
Cl	3-2	3-2	2-3	2-3	2-3	3-2	4-1	3-2	2-2	3-2	2-3	2-3	2-3	2-3	3-2	3-2	null	4-1
Ar	2-3	2-1	1-4	1-4	1-4	2-3	3-2	3-2	3-2	2-1	1-4	1-4	1-4	1-4	2-3	2-3	1-4	null

Elements	Win	Draw	Lose	Points
H	5	4	8	19
He	0	0	17	0
Li	9	2	6	29
Be	12	2	3	38
B	12	0	5	36
C	14	1	2	43
N	2	2	13	8
O	4	0	13	12
F	6	2	9	20
Ne	1	0	16	3
Na	9	2	6	29
Mg	12	0	5	36
Al	14	0	3	42
Si	16	1	0	49
P	4	1	12	13
S	8	0	9	24
Cl	9	1	7	28
Ar	5	0	12	15

Results & Discussion: The gamified approach proved to be very effective in making students learn the difficult content, not via rote memorization, but via comparison of the important chemical properties like atomic number, atomic mass, atomic radii, valency and electronegativity. Gamification when empowered by data science input ensured a quick feedback mechanism wherein the learners were self-motivated to progress, accelerating their learning of the central science with the aim of 'synthesizing' chemists from communities. Students quickly recognized periodic trends through simple comparisons. The "starting problem" for teachers was eliminated — they could begin anywhere and still guide learning. Children showed improved understanding and memory retention due to repetition via a standard protocol. The league format made learning interactive and measurable. Some success stories from the ground level and novel approaches by the Gen-Z educators are presented



To complement the card game part, an online game was also developed to test the skill in recognizing the elements of same group. From there as well, we get the data of how much time the learner took to find all 8 pairs in the memory game format along with the number of flips. Another simple yet effective addition to the card game was using “fill up the electron blanks” worksheet which helps in slowing down the process of learning and giving enough residence time for the important content of valency concept to be well ingrained in the minds of the learner.



Conclusion:

ZARVEN simplifies complex topic of periodic table trends through gamification and comparative data analysis. Combining inputs from data science into the pedagogical design made the AsanVigyan cards even more accessible. Our work supports NEP 2020's vision of foundational conceptual learning through play and innovation. **Gamification is a serious candidate specially to deal with vast content which cannot be catered via experimentation. The pioneering work to make periodic table super accessible via gamification hopes to stir an educational movement which shifts focus from blackboard to scoreboard. This can only be done when "games" are not seen just for fun and play but develops into a functional protocol where rules of the game and the scoring system aligns with the pedagogical objectives.**

Future work: Further scaling up of league game is in progress by including 36 elements to get the basic dataset ready. A football world cup type implementation format is also to be tested at schools during learning sessions. Further data science enhancement by calculating the probability of win for each element overall and for each property too is being pursued to get further the idea of the periodic trends. Chemi-olympics is also in pipeline where these card games take the shape of competitive sports between universities. Currently this work is taken up as undergraduate projects in KREA university, Tirupati & KJ Somaiya University, Mumbai with emphasis on interwoven curriculum, giving us platform for further testing and outreach. In parallel, inputs from educational psychology, cognitive sciences & neuroscience are also being taken into consideration to scientifically prove that card games are effective in improving learning in an unambiguous way via disruption of default mode network and activation of “flow-state” of higher concentration and engagement.

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A Practical Framework to Reduce Rote Learning Using Daily-Life Observations

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Abstract

Science education becomes truly effective when students are able to relate classroom concepts to their everyday experiences. However, middle-school science teaching often relies heavily on rote memorisation, resulting in limited conceptual understanding and poor application skills. This paper presents a practical framework for transforming middle-school science classrooms by integrating enquiry-based and activity-based learning rooted in daily-life observations. The framework includes innovative practices such as five-minute micro-labs, QR-coded learning trails, science storyboarding, student-led mini exhibitions, and an error-analysis corner. Simple hands-on experiments using easily available household materials enable students to replace memorisation with meaningful learning. The approach is aligned with the National Education Policy (NEP) 2020 and is suitable for diverse school contexts, including low-resource settings. A classroom-based case study further demonstrates the effectiveness of connecting scientific concepts with students' lived experiences.

1. Introduction

Middle-school science education often becomes memory-oriented when concepts are taught in isolation from real-life contexts. As a result, students tend to memorise definitions and formulas without developing a clear understanding or the ability to apply knowledge. The National Education Policy (NEP) 2020 strongly emphasizes experiential learning, enquiry-based pedagogy, and contextual learning rooted in the learner's environment.

Daily-life observations—such as why clothes dry faster on windy days, why metal objects feel colder than wooden ones, or why shadows change during the day—serve as powerful entry points for scientific enquiry. When science teaching is connected to familiar experiences, students become more curious, engaged, and motivated to learn. This paper proposes a simple, practical, and innovative approach to transform middle-school science learning through enquiry-based and activity-based strategies grounded in everyday observations.

2. Enquiry-Based Learning through Daily-Life Observations

Enquiry-based learning begins when students observe a phenomenon and ask questions such as "Why does this happen?" or "How does this work?". Everyday experiences naturally stimulate such curiosity and encourage students to think scientifically.

Examples of Daily-Life Enquiry

- Why does a pressure cooker whistle? → Heat, pressure, and steam
- Why do vehicles slow down on sandy roads? → Friction
- Why does a rainbow appear after rainfall? → Refraction and dispersion of light
- Why do we sweat more in humid weather? → Evaporation
- Why does milk overflow while boiling but water does not? → Surface tension

When students explore these familiar phenomena through classroom activities, they develop deeper conceptual understanding and analytical thinking skills.

Benefits of Enquiry-Based Learning

- Encourages careful observation
- Promotes questioning and curiosity
- Develops logical reasoning
- Enables application of knowledge beyond the classroom

3. Activity-Based Learning Connected to Real Life

Activity-based learning becomes meaningful when activities reflect students' real-life experiences. Using simple, low-cost materials allows students to learn through direct involvement rather than passive listening.

Low-Cost Activities Linked to Daily Life

1. **Heat Transfer**
   Daily-life context: Metal pans heat faster than wooden spoons. *Activity:* Compare temperature changes in metal and plastic spoons placed in warm water.
2. **Air Pressure**
   Daily-life context: A plastic bottle dents after cooling. *Activity:* Conduct a heat-and-cool bottle experiment.
3. **Evaporation**
   Daily-life context: Clothes dry slowly on rainy days. *Activity:* Compare drying rates of wet cloth pieces placed under a fan and in still air.
4. **Light and Shadow**
   Daily-life context: Shadows are longer in the morning and evening. *Activity:* Measure the shadow of a stick at different times of the day.
5. **Acids and Bases**
   Daily-life context: Lemon tastes sour and soap feels slippery. *Activity:* Prepare natural indicators using turmeric, hibiscus, or beetroot.

Connecting abstract concepts to familiar experiences significantly improves retention and understanding.

4. Reducing Rote Learning through Hands-On Experiences

Replacing memorisation with experiential learning enables students to construct knowledge independently.

Step-by-Step Learning Process

- Present a real-life situation
- Encourage students to make predictions
- Perform a simple activity or experiment
- Record observations
- Discuss outcomes and discrepancies
- Connect findings to textbook concepts

Subject-Based Examples

Physics – Motion

Context: Buses require longer distances to stop at higher speeds. *ctivity:* Roll a ball at different speeds and measure stopping distances.

Chemistry – Solubility

Context: Sugar dissolves faster in hot tea. *Activity:* Compare solubility of sugar in hot and cold water.

Biology – Photosynthesis

Context: Plants near windows grow better. *Activity:* Observe plant growth under sunlight and shade.

5. Developing Scientific Temperament through Daily Experiences

Scientific temperament develops when students habitually observe, question, and reason based on evidence.

Effective Classroom Practices

- Daily "Why does this happen?" questions
- Home-based observation tasks (e.g., moon phases)
- Prediction-based discussions
- Real-life problem-solving activities

Such practices nurture curiosity, critical thinking, and rational decision-making.

6. Innovative Classroom Practices Linked to Daily Life

i. Five-Minute Micro Labs

Short activities that introduce concepts quickly:

- Perfume spreading in air (Diffusion)
- Salt clumping during monsoon (Moisture absorption)
- Paper falling slower than a stone (Air resistance)

ii. Science Storyboarding
Students visually represent processes such as digestion, electricity supply, and cloud formation through illustrated story frames.

iii. QR-Coded Learning Trails
QR codes lead students to short videos, guiding questions, or home-based challenges related to daily observations.

iv. Monthly Mini Science Exhibitions
Themes include Kitchen Chemistry, Science in Sports, and Science Behind Toys using household materials.

v. Error Analysis Corner
Students identify and test misconceptions, promoting conceptual clarity.

vi. "Ask Me Anything" Science Badge
Encourages peer discussion through everyday science questions.

vii. DIY Take-Home Science Kits
Simple kits allow students to perform activities at home and record observations.

viii. Interactive Science Wall
Displays real-life objects such as soil samples, leaves, seeds, and magnets for exploration.

7. Case Study: Teaching Air Pressure through Daily-Life Observation

Observation

A student observed that a plastic bottle dents after hot water is poured out and the bottle is closed.

Enquiry Question

"Why does the bottle get crushed without any external force?"

Activity

- Fill the bottle with hot water
- Empty and close it
- Pour cold water on the outside
- Observe deformation

Findings

Students explained the role of external air pressure and reduced internal pressure.

Impact

- Improved conceptual understanding
- Increased student questioning
- Greater connection between home experiences and classroom learning

8. Conclusion

Connecting science education to daily-life experiences transforms learning into a meaningful, engaging, and lasting process. Enquiry-based and activity-based approaches grounded in real-world observations significantly reduce rote memorisation and strengthen conceptual understanding. The innovative practices discussed—such as micro labs, QR learning trails, storyboarding, and student exhibitions—align strongly with NEP 2020 and are feasible even in low-resource school settings. This framework empowers teachers to create dynamic science classrooms that foster curiosity, reasoning, and scientific temperament.

Scientific Temperament and Rational Thinking:
An Experiential Classroom Approach under NEP 2020

(Focused Classroom Practices: Connecting Science to Daily Life & Assessing Reasoning over Answers)

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Abstract

Scientific temperament is the foundation of rational thinking, curiosity, and evidence-based decision-making. In school classrooms, however, science learning often becomes exam-centric, leading students to memorise formulas and procedures without understanding their relevance. This paper presents two classroom practices consciously implemented to build scientific temperament as a lifelong skill:

(1) connecting science concepts to daily life, and

(2) assessing reasoning rather than only final answers.

Using real classroom anecdotes, the paper demonstrates how these strategies reduce fear, improve conceptual clarity, and foster rational thinking, in alignment with the vision of NEP 2020 and experiential learning.

Introduction

Scientific temperament goes beyond acquiring scientific knowledge; it shapes how learners observe the world, question information, and make decisions. The National Education Policy (NEP) 2020 emphasises a shift from rote memorisation to experiential and inquiry-driven learning, where students actively construct understanding. In this context, classrooms must move from asking “What is the correct answer?” to “Why and how does this happen?”

In my classroom practice, I observed that students often struggled not because concepts were difficult, but because learning was disconnected from real life and assessments rewarded answers over thinking. To address this, I focused on two pedagogical shifts that significantly influenced students’ mindset and engagement.

A. Connecting Science to Daily Life

1) Starting with Familiar Experiences Instead of Definitions Lessons are introduced through everyday observations before formal terminology. Students are encouraged to share personal experiences related to the concept, reducing abstraction and increasing relevance.

Anecdote:

While introducing acids and bases, students first shared everyday experiences with sour and bitter substances such as lemon juice and soap. These familiar examples helped them understand the concept before formal definitions were introduced, making learning more meaningful.

2) Encouraging Students to See Science Beyond Textbooks

Real-world examples are used consistently, encouraging students to identify scientific principles operating in their surroundings. This reinforces the idea that science is a way of life.

Anecdote:

To move beyond textbook definitions, students were divided into four groups and asked to observe oxidation reactions at home:

- Group 1: An unpainted bicycle rusted faster than a painted one in rain, highlighting the role of oxygen, moisture, and protective coatings.
- Group 2: Cut apples turned brown on exposure to air, showing oxidation affecting food quality.
- Group 3: Silver jewellery tarnished over time, demonstrating slow oxidation.
- Group 4: Oil kept uncovered developed a foul smell, explaining oxidation of fats (rancidity).

This activity helped students recognise oxidation as a real-life chemical process rather than a textbook reaction.

3) Using Daily-Life Problems as Learning Triggers

Instead of hypothetical problems, real situations are used, enabling students to analyse cause–effect relationships logically.

Anecdote:

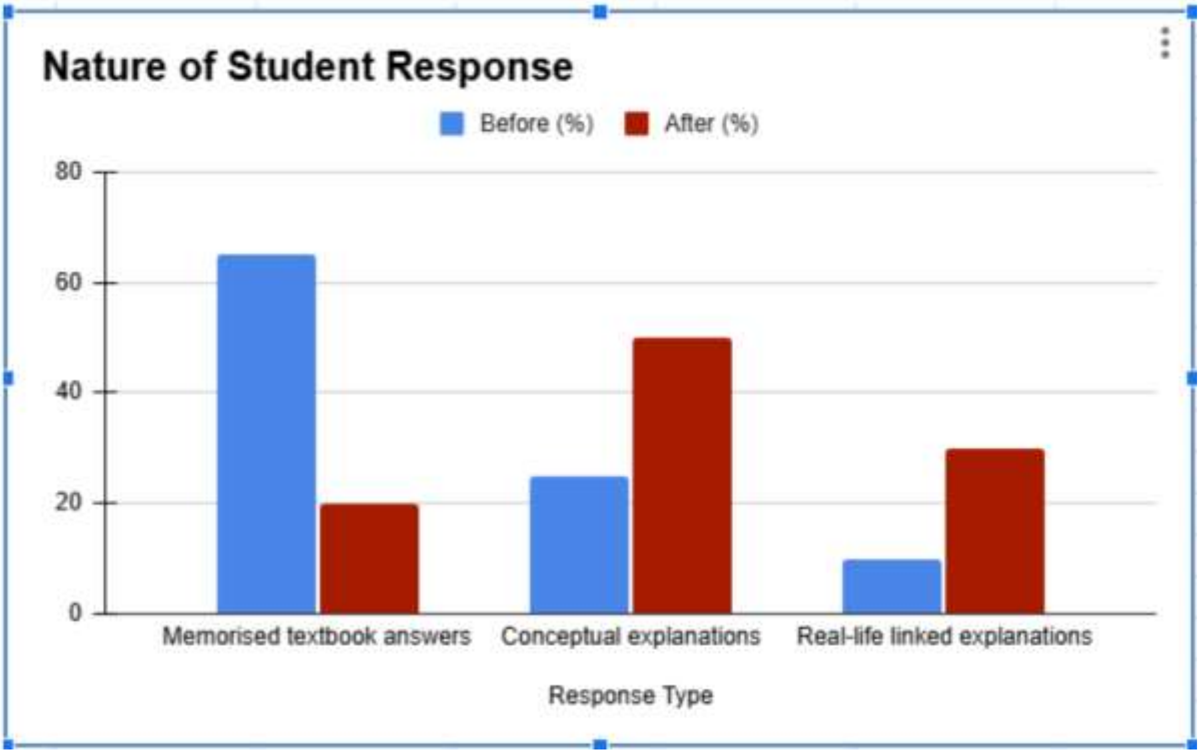
While teaching neutralisation reactions, students were asked why they are advised to brush their teeth before going to bed. Guiding questions such as “What is present in toothpaste?” and “What damages our teeth?” led students to reason that acids from food affect enamel and that toothpaste, being basic, neutralises these acids. This daily-life context helped students understand neutralisation before learning the chemical equation.

4) Impact on Student Mindset

Students began asking “Why does this happen in real life?” Learning became meaningful rather than mechanical, and students started connecting concepts across chapters.

Anecdote:

After repeated exposure to daily-life examples, students shifted from exam-oriented questions to curiosity-driven ones. Many independently linked Oxidation in rusting to browning of fruits and acids in food to corrosion and neutralisation, reflecting developing scientific thinking.



B. Assessing Reasoning, Not Just Answers

5) Shifting Assessment Focus from Answers to Thinking

Marks are allocated for explanation, logic, and method. Partial reasoning is acknowledged even if the final answer is incorrect.

Anecdote:

A student remarked, "Now I don't remember formulas first—I try to understand what is happening." This reflected a shift from memorisation to conceptual thinking.

6) Treating Errors as Learning Opportunities

Incorrect answers are analysed instead of being immediately corrected, helping students identify faulty assumptions.

Anecdote:

In a numerical problem, an incorrect unit assumption led to a wrong answer. Analysing the reasoning helped students understand the importance of dimensional analysis.

7) Reducing Fear of Word Problems through Reverse Thinking

To reduce anxiety, students were given only data and asked to frame their own word problems.

Anecdote:

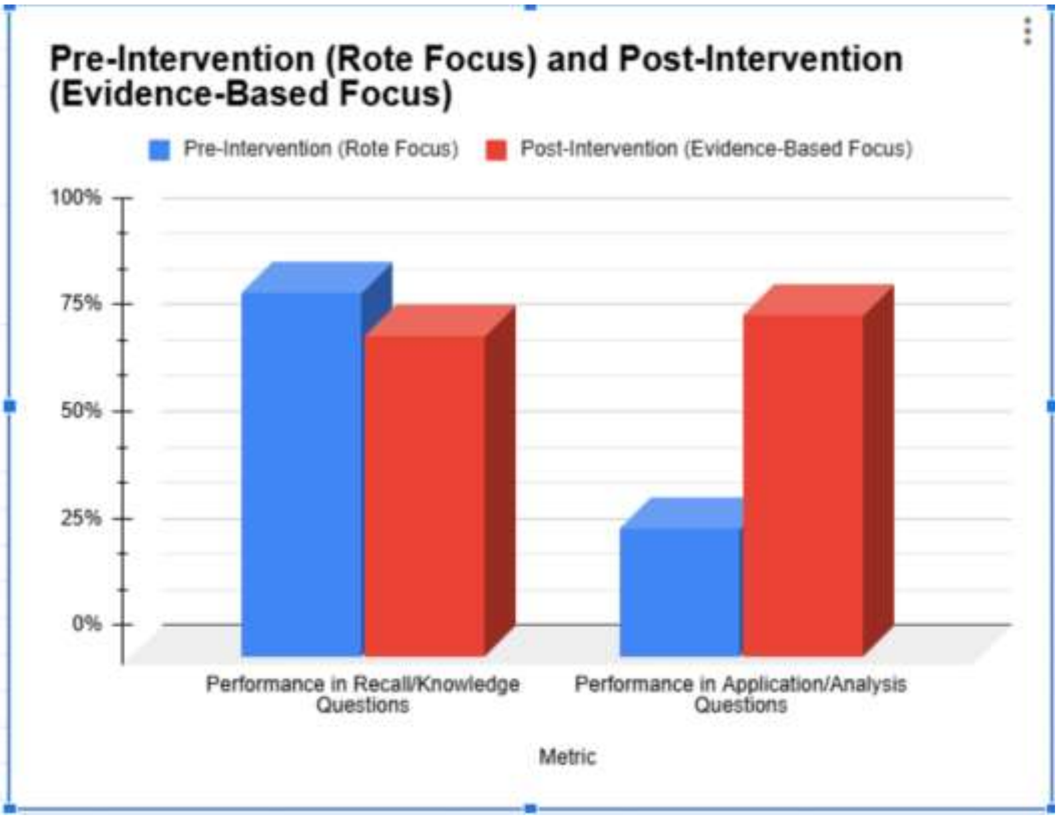
Initially hesitant, students gradually became confident in framing multiple problems from the same data, realising that word problems follow logical structures.

8) Observable Outcomes in Student Learning

- Increased confidence in explaining answers
- Improved performance in application-based questions
- Reduced dependence on memorisation
- Greater willingness to question and analyse

Anecdote:

While teaching the metal activity series, students observed an iron nail placed in copper sulphate solution. Instead of stating reactivity from the textbook, they justified their answers using colour change, copper deposition, and labelled diagrams, demonstrating evidence-based reasoning.



Alignment with NEP 2020 and Conference Theme

- ❖ Shift from teach-and-test to learn-and-practice
- ❖ Promotion of inquiry-driven and experiential learning
- ❖ Development of critical thinking and scientific temperament
- ❖ Teacher as facilitator rather than information provider

- ❖ Science viewed as a lifelong skill

Conclusion

- ❖ Building scientific temperament requires intentional classroom practices that prioritise thinking, reasoning, and real-life application over rote memorisation.
- ❖ Connecting science concepts to daily life helps students see relevance and meaning in their learning, making science a way of life rather than a subject.
- ❖ Assessing reasoning instead of only final answers encourages logical thinking, curiosity, and confidence among learners.
- ❖ Such practices help students move beyond fear of failure towards inquiry, reflection, and evidence-based decision-making.
- ❖ In an era of rapid technological advancement and the growing influence of Artificial Intelligence, developing strong conceptual understanding and rational thinking is essential to prepare students for future challenges.
- ❖ Scientific temperament equips students with the ability to question, analyse, and adapt, skills that remain valuable even as tools and technologies evolve.
- ❖ I express my sincere gratitude for this opportunity to share my classroom experiences and perspectives through this paper, as it reinforces the importance of preparing learners to be future-ready, conceptually strong, and intellectually resilient, in alignment with the vision of NEP 2020.

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Enhancing Conceptual Understanding in Class 9 Science 1 through experiential and Play-Based Learning.

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Abstract

The National Education Policy (NEP) 2020 highlights the need to move away from rote memorisation towards experiential, joyful, and learner-centred education. However, in many Class 9 Science 1 classrooms, which include Physics and Chemistry, teaching still focuses largely on textbook explanations, formulas, laws, and definitions. As a result, students often memorise content for examinations without developing clear conceptual understanding or the ability to relate science to everyday life. This classroom-based study explores whether a combination of hands-on experiential activities and play-based strategies such as mnemonics, rhythmic chants, and simple songs can improve conceptual understanding, interest, and participation in Class 9 Science 1. The study involved 40 students divided into two groups: one taught through traditional methods and the other through experiential and play-based learning. Data collected through tests, classroom observation, and student feedback indicate that students exposed to activity-based strategies showed better understanding, stronger recall, and greater confidence. The study supports the implementation of NEP 2020 principles in regular Science 1 classrooms.

Keywords: Experiential learning, play-based learning, Science 1, Physics and Chemistry, NEP 2020, conceptual understanding

1. Introduction

The secondary stage marks an important transition in **Science 1**, as students are gradually introduced to more abstract ideas in both **Physics and Chemistry.** Topics such as motion, force, acids, bases, and chemical reactions require logical reasoning and a clear understanding of underlying concepts. However, classroom teaching in many schools continues to follow a fixed pattern, where the teacher explains content from the textbook, writes formulas or definitions on the board, and expects students to memorise them for examinations.

Teachers often observe that while students are able to reproduce formulas or definitions during tests, they struggle to explain these concepts in their own words or apply them to everyday situations. For example, students may recall the formula for speed but find it difficult to explain why a moving object eventually slows down. Similarly, many can define acids and bases but fail to recognise them in common household substances. This gap between learning and understanding often causes science to be perceived as difficult and stressful rather than meaningful and interesting.

In reality, scientific concepts are closely connected to daily experiences such as walking, travelling, cooking, cleaning, rusting of metals, and the use of common materials at home. This study developed from classroom experiences where students showed greater interest and understanding whenever lessons included simple activities, demonstrations, mnemonics, and group interaction. It therefore examines whether combining **experiential learning** with **play-based methods** can reduce rote learning and support deeper conceptual understanding in Science 1.

2.Importance of the Study

Learning based solely on memorisation often leads to temporary retention, with students struggling to recall or apply concepts beyond examinations. NEP 2020 encourages learning experiences that involve active participation, inquiry, and enjoyment. However, many teachers are hesitant to implement activity-based methods due to syllabus demands, limited time, and lack of laboratory resources.

This study highlights the value of using simple, low-cost classroom activities along with mnemonics and rhythmic recall techniques that can be easily incorporated into regular teaching periods. It demonstrates that meaningful learning in both Physics and Chemistry can be achieved without requiring extensive resources or additional instructional time.

3.Objectives of the Study

The objectives of the present study were:

1. To compare traditional teaching methods with experiential and play-based learning in Class 9 Science 1 (Physics and Chemistry).
2. To study the effect of hands-on activities, mnemonics, and rhythmic recall on conceptual understanding.
3. To observe changes in students' confidence, participation, and interest in Science.
4. To document practical classroom strategies aligned with NEP 2020.

4.Methodology

The study followed a comparative experimental design and was conducted with 40 Class 9 students over one week. The students were divided into two groups:

Group A – Traditional Method:

Taught using chalk-and-talk, textbook explanation, and numerical problem-solving.

Group B – Experiential and Play-Based Method:

Taught using simple hands-on activities, demonstrations, mnemonics, rhythmic chants, and group discussions.

Topics Covered

• Physics: Motion, speed, force
• Chemistry: Acids, bases, indicators, basic reactions

5. Data Collection Tools

The impact of the two teaching methods was studied using the following tools:

5.1 Pre-test and Post-test: Both groups were given a 10-mark test before the intervention and another after one week to measure learning improvement.
5.2 Classroom Observation: Students participation, confidence, attentiveness, and willingness to answer questions were observed and noted during lessons.
5.3 Student Feedback: Students from the play-based group shared written feedback about their learning experience, difficulties, and interest levels.

6. Description of Activities and Their Educational Value

In Physics, students measured distance and time to calculate speed, observed motion in everyday objects, and discussed push-and-pull activities to understand force. Mnemonics and rhythmic lines were used to remember formulas and laws.

In Chemistry, students tested household substances such as lemon juice, soap solution, and baking soda using natural indicators like turmeric. They observed colour changes and discussed acidity and basicity. Mnemonics and songs were used to reinforce definitions and reactions.

Group recall activities encouraged students to explain concepts in their own words, helping them link theory with real-life experience.

7. Learning Outcomes

The learning outcomes were analysed by comparing test results, classroom observations, and student feedback from both groups. Improved conceptual understanding:

Students who learned through experiential and play-based activities demonstrated a clearer understanding of concepts in both Physics and Chemistry. They were able to explain ideas such as motion, force, acids, and bases in their own words rather than only recalling definitions or formulas.

Better recall and application:

Students in the activity-based group remembered formulas, laws, and reactions more easily and were able to apply them to new and unfamiliar situations. They showed less confusion while solving problems and answering oral questions.

Increased participation and confidence:
There was a noticeable increase in student participation during lessons. Students were more willing to answer questions, share observations, and discuss their ideas without fear of making mistakes.

Greater curiosity and interest:
The use of hands-on activities, mnemonics, and group work made lessons more engaging. Many students showed curiosity by asking "why" and "how" questions and expressed greater interest in learning science.

Improved collaboration and responsibility:
Group activities encouraged students to work together, share tasks, and listen to one another. This helped develop cooperation, responsibility, and respect for different viewpoints during learning.

Overall, the learning outcomes suggest that experiential and play-based strategies helped students move beyond rote memorisation and supported meaningful understanding in Science 1, in line with the objectives of NEP 2020.

8. Findings and Discussion

The analysis of test scores, classroom observations, and student feedback showed improvement in both groups; however, students taught using experiential and play-based strategies demonstrated noticeably stronger learning outcomes. These students displayed a clearer understanding of scientific concepts and were better able to explain ideas in their own words.

Compared to the traditionally taught group, students in the activity-based group participated more actively during lessons and asked a greater number of questions. They showed increased confidence while answering oral questions and engaging in discussions. The use of hands-on activities and memory aids appeared to reduce hesitation and fear of making mistakes.

The findings suggest that experiential and play-based learning approaches are more effective than rote-based methods in developing conceptual clarity in Science 1. By actively involving students in the learning process, these strategies help bridge the gap between theoretical knowledge and real-life application.

9. Conclusion

The present study demonstrates that learning Science 1 at the Class 9 level becomes more effective and meaningful when students are actively engaged through experiential and play-based teaching methods. Activities, demonstrations, mnemonics, and rhythmic recall techniques supported better understanding and longer retention of concepts in both Physics and Chemistry.

These strategies are practical, economical, and easy to incorporate into regular classroom instruction without requiring advanced laboratory facilities. When applied consistently, experiential and play-based approaches can help shift science education away from memorisation towards deeper understanding, in accordance with the broader educational goals outlined in NEP 2020.

10. References

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4. Sharma, P. (2019). Activity-based learning in science classrooms. Chemistry Education Research and Practice, 20(3), 456–470.

PROJECT BASED LEARNING
Hands on activity

Parbati Roy, Yatendra Pal Singh, Radha Srinivasan

Abstract

Project-Based Learning (PBL) is an activity-based, student-centered pedagogical approach that bridges the gap between theoretical knowledge and real-life applications through experiential learning. This paper presents a classroom-based case study demonstrating the implementation of PBL in senior secondary physics education, with a focus on the topic Current Electricity and DC Circuits. The PBL framework enabled students to engage in inquiry, experimental design, data collection, analysis, reflection, and peer observation within a structured 120-minute laboratory session.

Project based learning-hands on activity

Project based learning (PBL) is activity-based student-cantered method to teaching and learning that helps students to connect theoretical concepts to real-life situations. Instead of learning through textbooks, diagrams & study materials available online & offline, PBL encourages students to explore interesting questions, investigate real-life problems and arrive at practical solutions through hands-on activities.

In PBL, students can work individually or in groups to research, plan & design experiment, collect & analyse data and evaluate & present their ideas. In the process learners acquire various ATL (approaches to learning) skills like critical thinking, research skills which enhances creativity, communication skills, social skills which enhances collaboration and time management skills. These skills are essential not only for academic success but also for future careers and to become responsible citizens.

There is a famous saying by **Confucius,** “I hear and I forget. I see and I remember. I do and I understand”. If students are involved in their learning through activities, the outcome is better as education becomes student centric and experience lasts lifelong.

PBL allows students to learn by doing. Students can ask questions, make decisions, learn from their mistakes & reflect on their learning, use improvised techniques & arrive at better result. Teacher acts as a guide supporting students to develop deeper understanding and apply their knowledge to practical situations.

Following is a case study of implementing the above method.

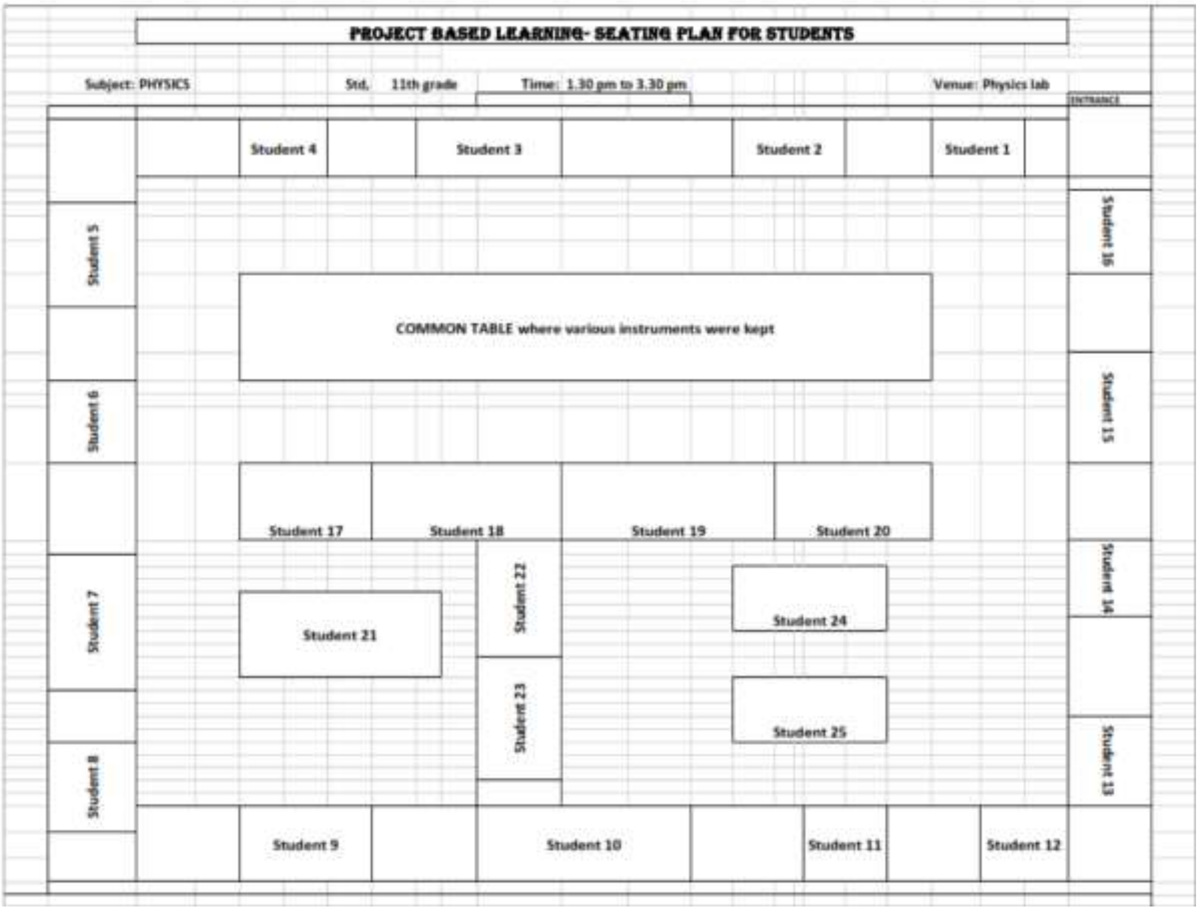
Sample size: 25, Source: Private international school with privileged students, grade 11th (AS level, Cambridge)

Project topic was '**Current Electricity & DC Circuits'** and project title was **'Circuit innovations & applications**. Each student was given a list of 15 experiments to choose their own experiment from (Choice board ref: page 3). Also, it was mentioned they could choose any other relevant experiment on electricity and electronics of their own interest. This gave students a broader scope of study to enhance their knowledge and understanding and connect it to real life applications.

Each student was assigned a separate place and a work station in the physics lab with their names labelled. Common apparatus for electricity like DC power supply, dry cells, connecting wires, ammeter and voltmeter were kept on each table beforehand. Specific apparatus required for individual experiments were kept on a large common area from where students could collect their apparatus for their own experiment suitable for their individual experimental design. Learning objective and driving question was clearly mentioned**--- How are electrical circuits useful through real life applications and experiments?**

Suggested tools and resources were enlisted and an assessment rubric (ref: page 4) was also shared with students beforehand. Students were asked to first design their own experiment after choosing the topic and then, connect the circuit and note down the readings, analyse data and wite their conclusion from their experiments. Time allotted was 120 minutes (block period). Students were also asked to write their reflections---**what challenges they faced and how it could be improved further.** Also, students were asked do peer observation in last fifteen minutes. Differentiation was taken care of as support was provided to emerging students with templates, guided notes and scaffoldings. Advance learners were asked to make complicated circuits and analyse it.

Floor plan for Lab setup for PBL was as follows:



The following sheet was provided to students:

Project-Based Learning – Current electricity & DC circuits

Grade Level: Grade AS Level Date—6th August, 2025

Topic: Current electricity & DC circuits

Project Title: "Circuit innovations & applications"

Learning Objectives:

- Make the circuit connection for the experiment chosen.
- Draw observation table and record data.
- Draw graph and find the trend.
  - Draw conclusion and analyze the result
  - Make a chart on the experiment conducted and submit on 7th August.

Driving Question:

How are electrical circuits useful through real-world applications and experiments?

Project choices:

1 To find internal resistance of a cell

2 To find unknown resistance using Wheatstone bridge

3 Verification of Ohm's law

4 To verify Kirchoff's first and second laws

5 Verification of resistances in series and parallel

6 Charging and discharging of a capacitor

7 Working of potential divider circuit with a sensor—LDR

8 Working of potential divider circuit with a sensor—thermistor

9 Plot the I-V characteristic curve of a diode

10 Plot the I-V characteristic curve of a bulb

11 Find resistance per unit length of the given wire.

12 Find the resistivity of the material of a given wire.

13 Comparison of emf of two cells

14 Applications of thermistor in fire alarm circuit

15 Application of LDR in automatic street lighting.

Any other relevant electrical experiment.

Suggested Tools & Resources:

- Dry cell 1,5V, 9.0V, power supply
- Connecting wires, constantan wire 1m long mounted on meter rule
- Laptops/tablets, chart paper, markers
- variable resistors, fixed resistors, capacitors, LDR, thermistor, LED, diode, bulb.

Time: 120 min (2 hr)

Assessment Rubric (Total: 15 Marks):

Criteria	Independent (3)	Developing (2)	Emerging (1)
Scientific Accuracy	Accurate and detailed explanation.	Mostly correct with minor errors.	Some misconceptions.
Demonstration of Concepts	Clear and effective demonstration.	Present but partially explained.	Basic or unclear demonstration.
Application & Analysis	Thoughtful application and testing.	One or two applications explored.	Mentioned but not well explored.
Creativity & Design	Highly original and engaging.	Creative and good layout.	Moderate design effort.
Communication & Presentation	Clear, confident, articulate.	Mostly clear, minor errors.	Some difficulty explaining.

Total Marks: 15

Reflection & Peer Review:

Each student writes a short reflection answering:
- What did you learn about electric circuits?
- What challenges did you face?
- What could you improve further?

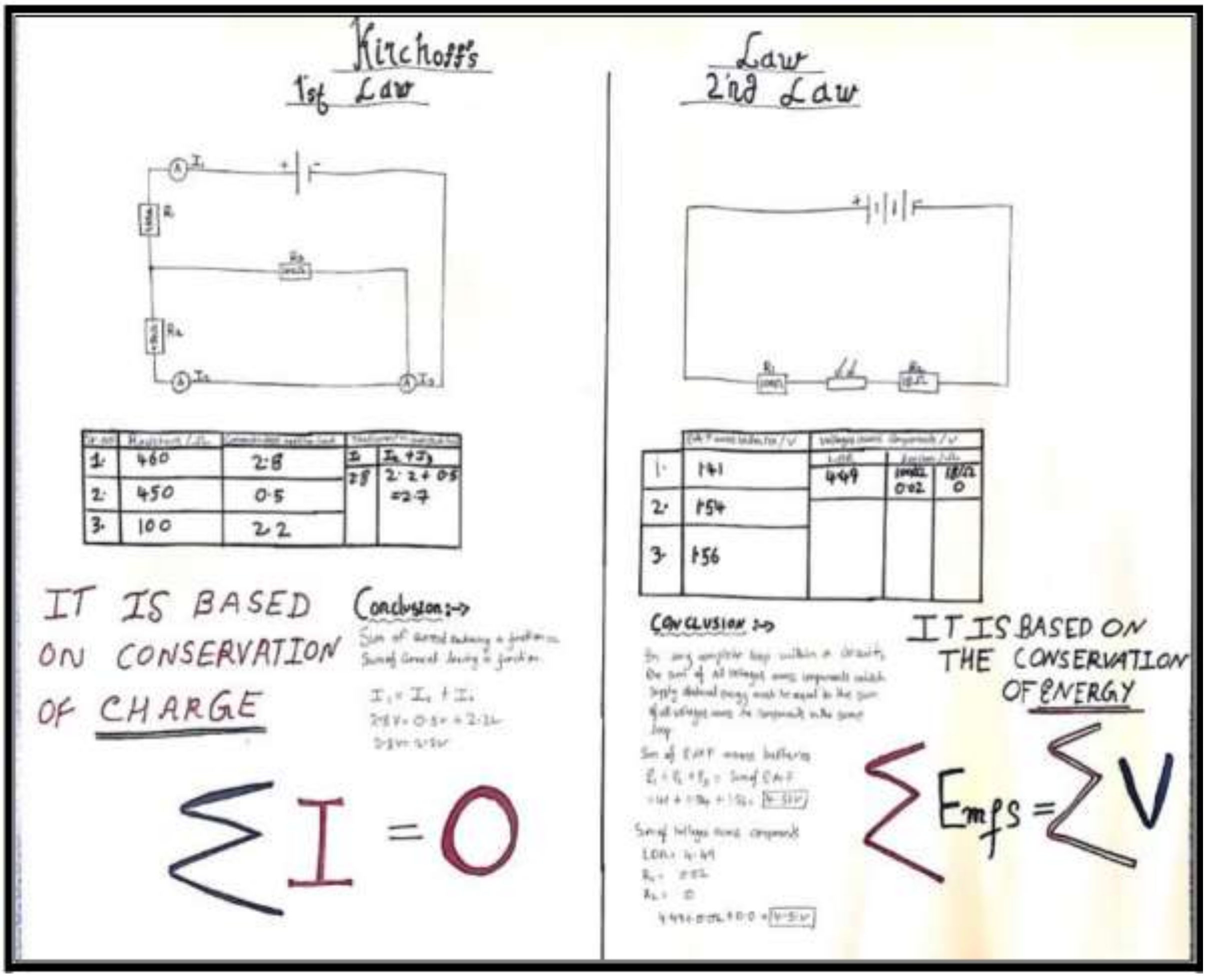
Differentiation:

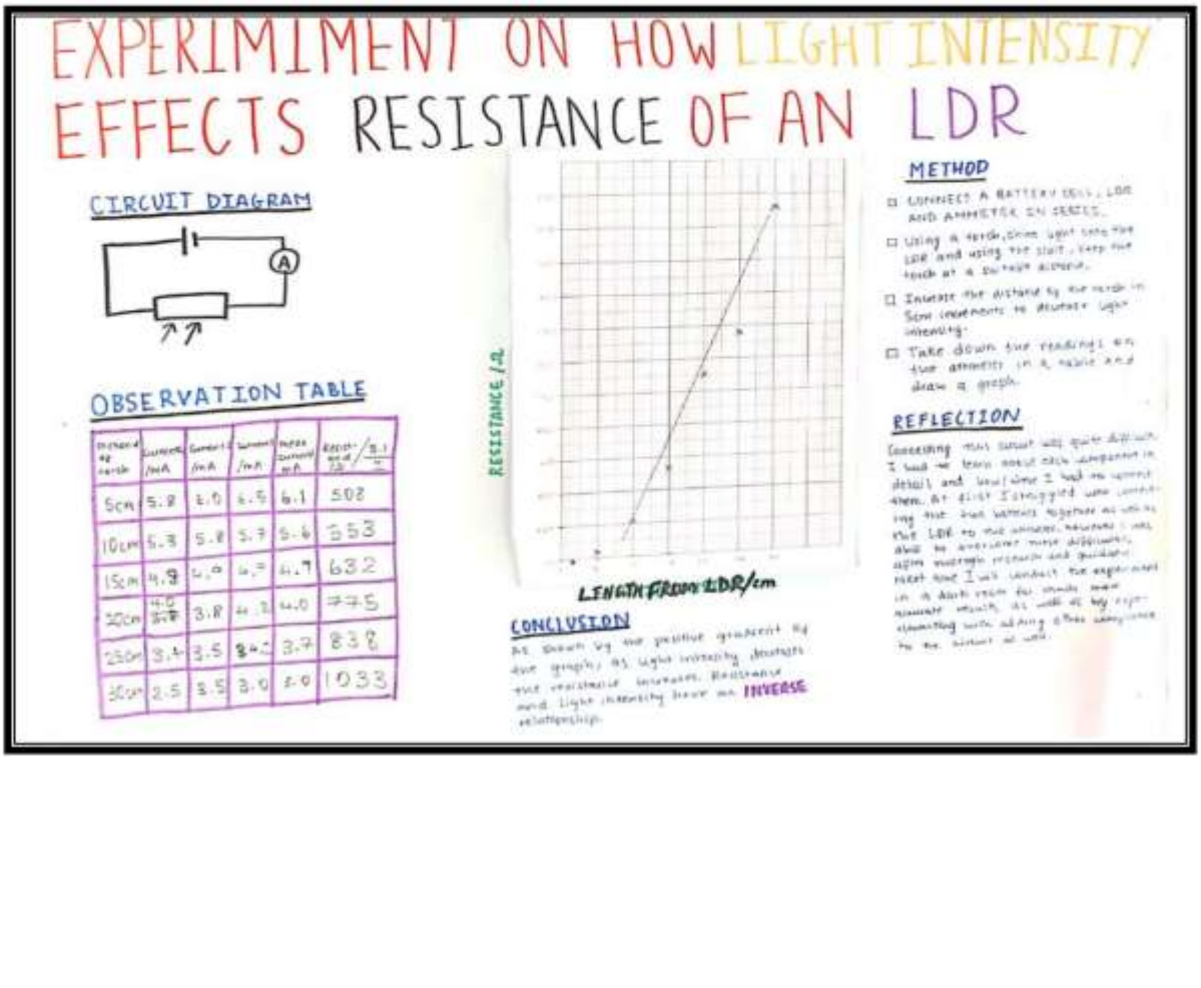
- Support: Provide templates, guided notes, or scaffolding for learners who need help.
- Challenge: Ask advanced learners to make complicated circuits and analyze it.

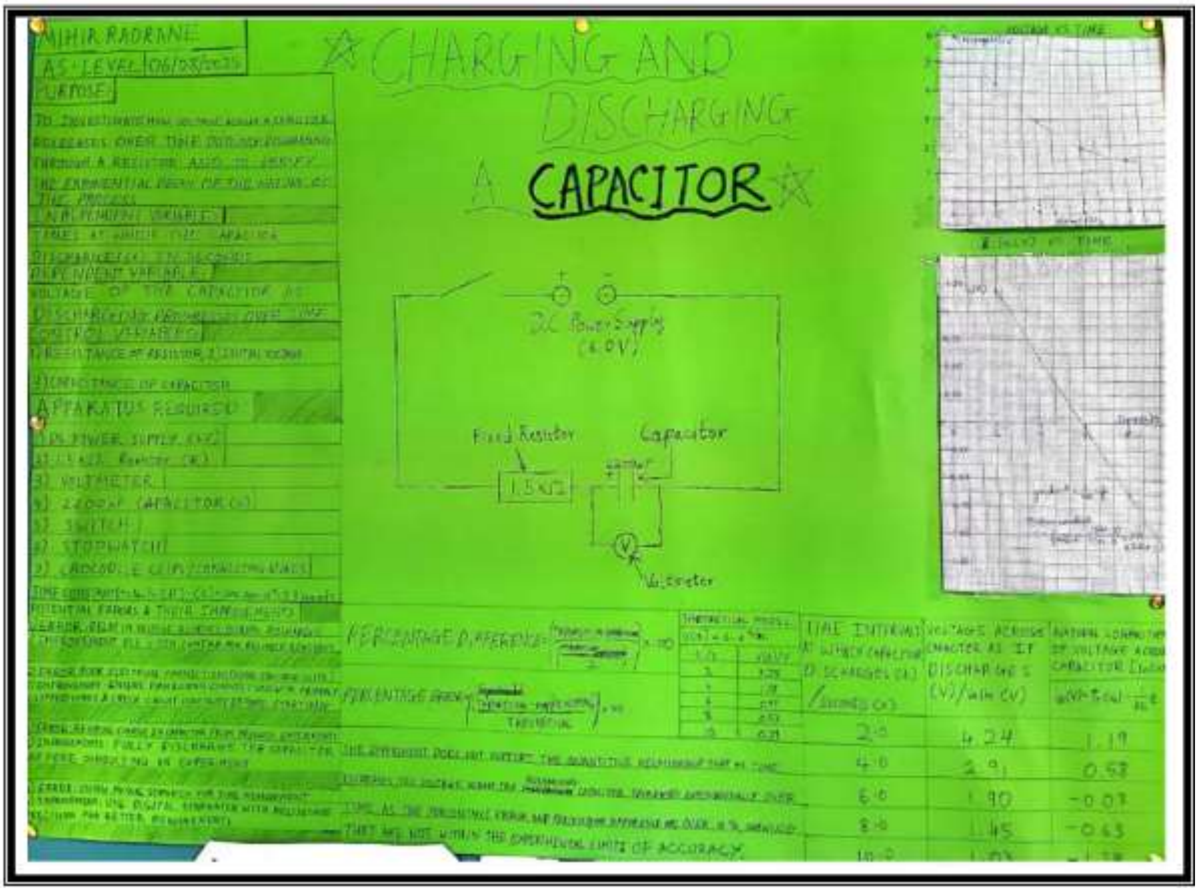
The final result was amazing with each student preparing a chart of their work and findings. It resulted in an in-depth understanding of the application of physics principles.

Each student was interviewed after the PBL session and there was an overwhelming response from all. Students found the learning different from classroom teaching; instead of being passive learners, they explored the topic on their own. At first, many found planning the work challenging, but as they progressed, they found their way out by learning from their mistakes and reflecting on their experience. Thay applied the concepts learnt to real-life situations which helped them to improve their thinking and time-management skills. They thoroughly enjoyed the session and were more confident of the topic, though it required more effort.

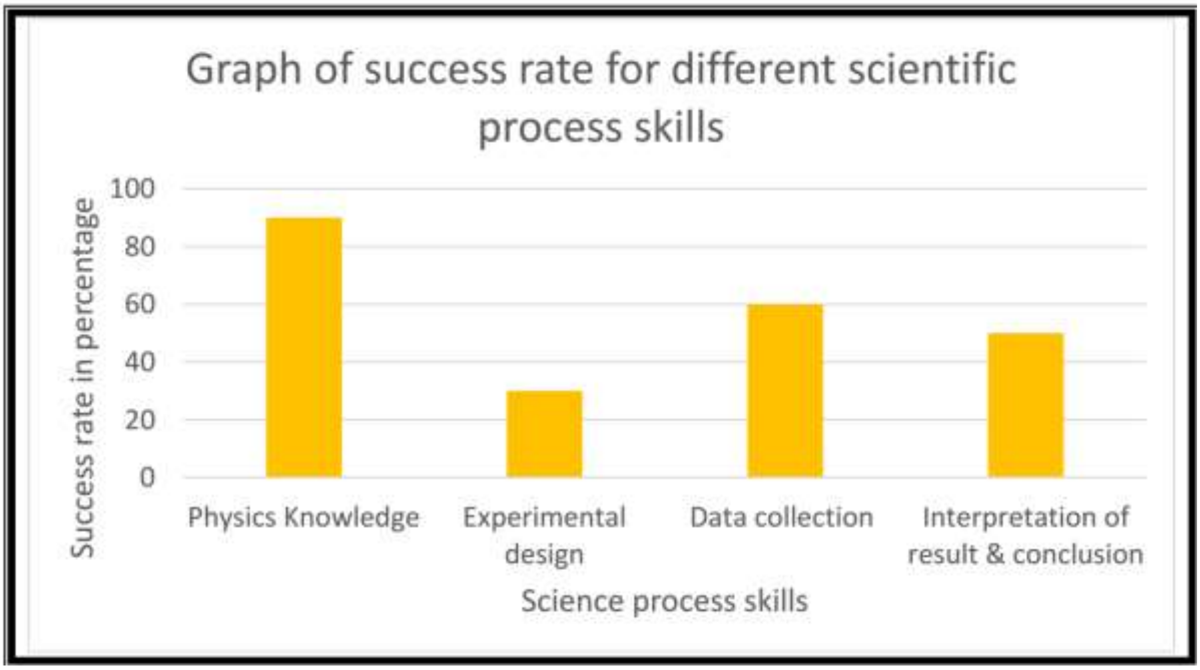
Some exemplars of student work are attached below:


Kirchoff's Law
1st Law
2nd Law
IT IS BASED ON CONSERVATION OF CHARGE
Conclusion :->
$\sum I = 0$
CONCLUSION :->
IT IS BASED ON THE CONSERVATION OF ENERGY
$\sum Emfs = \sum V$


EXPERIMIMENT ON HOW LIGHT INTENSITY EFFECTS RESISTANCE OF AN LDR
CIRCUIT DIAGRAM
OBSERVATION TABLE
METHOD
REFLECTION
RESISTANCE /Ω
LENGTH FROM LDR/cm
CONCLUSION
INVERSE



Following is a graph of success rate versus different scientific process skills:



The graph shows among the different science process skills, experimental design scores a lower success rate. Many students required intervention while designing the experiment which clearly indicates that designing is a critical thinking process which the students have to acquire with more practice and out of the box thinking. Basic physics knowledge and data collection have a higher success rate but interpretation & conclusion shows a relatively lower success rate as this requires a holistic view of the topic at hand.

Project based learning makes learning more **realistic, enjoyable** and **relevant**. It prepares students to face real-life challenges with responsibility, helping them to become independent life-long learners.

There are many **advantages of project-based learning** like a deeper understanding of physics concepts and their application. Also, students develop twenty-first century skills like critical thinking, collaboration, communication and problem solving. PBL encourages higher student engagement and independent learning which help students to become self-directed learners. It improves social skills like conflict resolution and respect for diverse viewpoints. PBL results in better and longer retention of learning as students learn through experience.

There could be few shortcomings of PBL for some students who may not be comfortable with open-ended tasks. There might also be constraint on resources. It is also time-consuming and can have unequal participation if groups are made. There are assessment challenges for teacher as students have to be constantly monitored using the rubric provided and requires strong detailed planning in advance.

Innovative methods in teaching: Use of technology in education

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Young learners are the future of a nation who have to be nurtured with care so that they develop twenty first century skills to become worthy citizens of India and are able to contribute meaningfully to the world. Children in today's world are tech savvy and use a range of gadgets from an early age ranging from mobile phone, laptop and touchscreen tablet. Hence, it has become imperative for teachers also to improvise the learning methods for students to bring in excitement in class through the use to technology.

To bring novelty in class, instead of taking students to the physics laboratory, I used technology to bring experimentation to classroom through the use of simulation. Students do play some popular games on laptop like Angry birds but little do they realise there is so much physics involved in those animated games --- concept of projectile motion in kinematics. If these animations are designed in such a way that independent and dependent variables can be selected and rest of the quantities can be kept constant; by varying the values of independent variable, values of dependent variable can be generated without actually performing the experiment. Then students can follow the regular procedure of making observation table, recording data, drawing graphs & finally analysis, conclusion and evaluation of the experiment done using technology. Students can also compare the advantages and limitations of using virtual experimentation.

Keeping the above factors in mind, a specific session was organised. The session was an inquiry lesson in mechanics which covered both kinematics and dynamics. Students were given a choice board from where they could select any one simulation related to any one learning objective listed by teacher. The purpose of giving choice board to students was to cater to their individual interest and intellectual level. This session was conducted after covering the background theory of entire kinematics and dynamics in previous classroom sessions.

For the process, five separate heterogeneous groups were made, each containing 5 students. Each group chose a different online simulation. Within one group, though they were using the same simulation, students were encouraged to design their experiments individually by taking different independent and dependent variables. Students were given a choice to select their simulation and also asked to design their experiments individually. This way differentiation in class was incorporated to cater to different student needs.

There were three learning objectives listed by the teacher which are as follows:

- Students should be able to describe and explain motion due to a uniform velocity in one direction and a uniform acceleration in a perpendicular direction--Projectile motion
- Students should be able to describe and explain qualitatively the motion of objects in a uniform gravitational field with air resistance & concept of terminal velocity
- Students should be able to apply the principle of conservation of momentum to solve simple problems, including elastic and inelastic interactions between objects in both one and two dimensions

Students were asked to use any one of the online simulations listed below to design an experiment and collect data through simulation by varying the independent variable and recording the value of dependent variable. This set of data was taken from an international school where students were privileged to have individual i-pads/laptops.

Sample size: 25, Source: Private international school with privileged students, grade 11th.

Web URLs provided for student use are as follows:

https://phet.colorado.edu/en/simulations/projectile-motion

https://www.physicsclassroom.com/interactive/newtons-laws/skydiving/launch

https://phet.colorado.edu/sims/html/collision-lab/latest/collision-lab_all.html

https://www.geogebra.org/m/rYmNxYMY
https://ophysics.com/
https://visualize-it.github.io/projectile_motion/simulation.html
https://www.physicslens.com/simulation-of-projectile-motion-with-air-resistance/
https://physics.bu.edu/~duffy/sims.html
https://en.wikipedia.org/wiki/Algodoo
https://opensourcephysics.github.io/tracker-website/
https://demonstrations.wolfram.com/MotionOfProjectileWithOrWithoutAirResistance/

The activity was timed and steps were clearly specified to the students.

Activities:

- Students will identify independent and dependent variables. (10 min)
- Students will use the simulation to record data from simulation experiment. (20 min)

- Students will analyse the data collected and draw graph. (30 min)
- Students will write limitations & improvements for the experiment done using simulation (10 min)

After this, students were asked higher order thinking questions which they had to discuss and answer in next 10 minutes.

- How can you optimize the launch angle for maximum range if there is air resistance? Would the "45° rule" still apply?
- In reality, air density decreases with altitude. How would this affect the velocity-time graph of a skydiver compared to the simplified constant-drag-coefficient model?
- In sports (like billiards or football), how do players use intuitive physics of 2D collisions to control outcomes?

3 | P a g e

Plenary/assessment was conducted by the teacher in the last 20 minutes.

Students were asked to upload their work on **Padlet**--- again the use of technology is highlighted.

Students were asked to go through other students' works in their own group as well as in other groups and write their comment. This way **peer observation** is take care of.

Finally, teacher leads a **discussion on reflection:** 'What is one new insight you gained from another group's work?' Teacher also gives oral feedback on both physics content and communication skills.

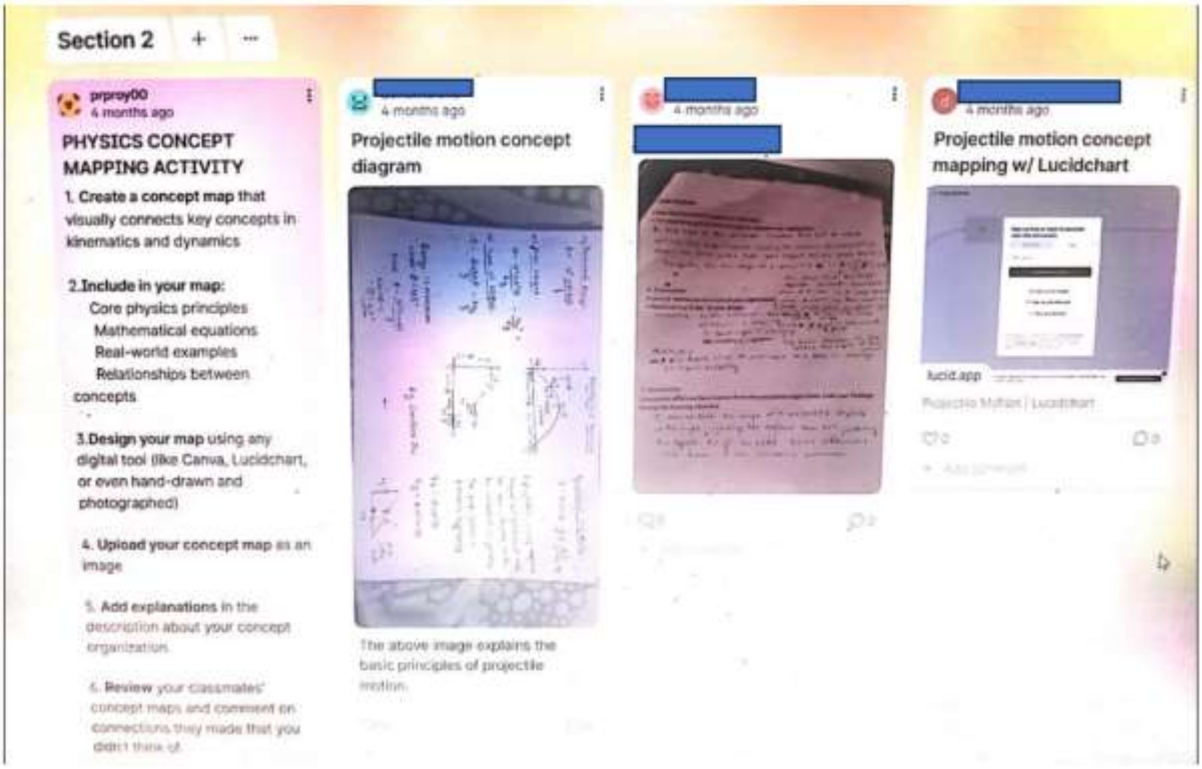
Finally, students fill in a reflection sheet using **google form**----here too technology is used.

A screenshot of the Padlet work submitted by students is as shown in following image.

A classroom seating was provided to the students at the beginning of the class with their names displayed on the screen so that students could assemble in their respective groups without delay or confusion.

A rubric was shared with the students at the beginning so that students get a clear idea of marking and how to score good grades.


Padlet
prproy00 • 11 • 4mo
Physics SIMULATION activity
Create visual concept maps to connect and understand kinematics and dynamics concepts
Instructions
prproy00
4 months ago
Using SIMULATION, design your experiment, define independent, dependent and control variables, collect data, analyse, evaluate and conclude. Upload your work here. Review your classmates' work and comment on their experiment.
DOCX
[redacted]
4 months ago
It was a fun and unique activity
~Aayush
[redacted]
[redacted]
4 months ago
Coefficient of Restitution Experiment using 1-dimensional collisions (Mihir Raorane)
PDF
through this experiment I was able to learn how restitution is a property of a collision or its system alongside learning about the theoretical definition of it
[redacted]
4 months ago
Surface area's effect on range of projectile motion
PDF
Through this experiment , I was able to fully and clearly understand the concept, as well as learn about new things such as projectile motion with air resistance and the equation of trajectory
[redacted]


Section 2
prproy00
4 months ago
PHYSICS CONCEPT MAPPING ACTIVITY
1. Create a concept map that visually connects key concepts in kinematics and dynamics
2. Include in your map:
Core physics principles
Mathematical equations
Real-world examples
Relationships between concepts
3. Design your map using any digital tool (like Canva, Lucidchart, or even hand-drawn and photographed)
4. Upload your concept map as an image
5. Add explanations in the description about your concept organization
6. Review your classmates' concept maps and comment on connections they made that you didn't think of
[redacted]
4 months ago
Projectile motion concept diagram
The above image explains the basic principles of projectile motion.
[redacted]
4 months ago
[redacted]
[redacted]
4 months ago
Projectile motion concept mapping w/ Lucidchart
lucid.app
Projectile Motion | Lucidchart

A sample of student work is as follows:

Simulation site used: www.geogebra.com/m/eYueNxYMY

1. Designing Your Experiment

Describe the experiment you designed using the simulation and state your projected outcome:

Investigating the effect of launch angle on the range of the trajectory of a body with fixed mass

2. Identifying Variables

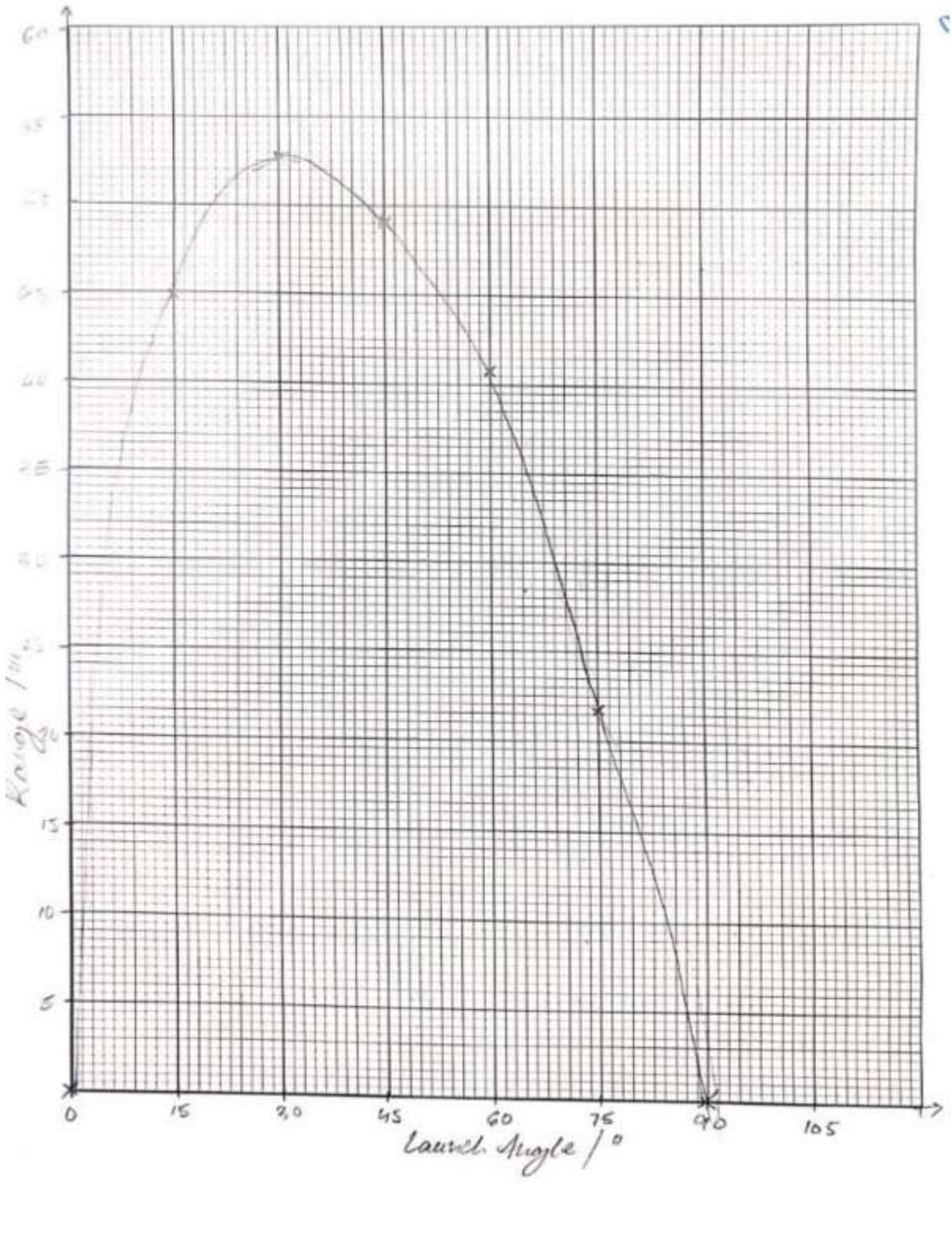
Type of Variable	Description
Independent Variable	Launch angle
Dependent Variable	Range
Control Variables	Air density (0.37 kgm⁻³) Drag coefficient (0.8) mass (0.01 kg) Gravity [acceleration due to gravity (3 ms⁻²) Launch velocity (20.2 ms⁻¹) Surface area (0.01)

3. Recording Data

Record your observations in the table below:

Control Variables (constant values):

Trial	Independent Variable Launch Angle (°)	Dependent Variable Range / m {with air resistance}	Time / s	Observations
1	0°	00.00	0.00	
2	30°	57.3	5.93	The range and launch angle show a non-linear trend.
3	45°	54.07	7.96	
4	15°	44.93	3.31	
5	60°	40.71	8.64	
6	90°	00.00	4.06	
7	75°	~~00.00~~ 21.69	~~9.45~~ 8.47	

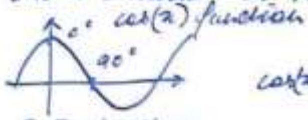


Range / m
Launch Angle / °
0
15
30
45
60
75
90
105
5
10
15

5. Data Analysis

- Describe the trend or pattern in your data.
- Use equations and physics concepts to support your explanation.

The data obtained shows somewhat of a parabolic trend which is skewed to one side. The horizontal velocity and hence the horizontal range are affected by the cosine function, which peaks at 0° and then decreases till it reaches 0 at 90°. The graph peaking somewhere near 30° ~~has got to do~~ is because time, which is also decided by the vertical velocity, happens to be the highest in conjugation with the horizontal velocity [$x = u_x \times t$]



	0°	15°	30°	45°	60°	75°	90°
cos(x)	1	$\frac{\sqrt{6}+\sqrt{2}}{4}$	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{1}{2}$	$\frac{\sqrt{6}-\sqrt{2}}{4}$	0

6. Evaluation

1. • Identify limitations or errors in your experiment.
- Modifications, if any, to your design.

① The only limitations in my experiment are that ~~they~~ my results are a product of a mathematical model in which its impossible to consider every factor that may affect the ~~...~~ trajectory of the ball.

② The only solution to this would be to carry out the experiment in real life, which will produce different results ~~to~~ the difference in values of g, air density, etc.

7. Conclusion

Summarize what you have learned from this simulation experiment. Link your findings back to the learning objective.

I learnt, practically, the roles velocity, launch angles and time played in the horizontal trajectory of a given body. I can now confidently express my learnings visually and mathematically.

Students were thoroughly engaged and found the activity novel and interesting. During this study, learner profile developed by students were-**research skill-**student could independently design, refine, and execute sophisticated research plans and **open-minded**-students listened to different opinions and learn from each other. Approaches to learning (ATL skills) incorporated were-**communication skill**-Using subject-specific vocabulary and again, **research skill**-student could critically assess data quality and relevance.

Differentiation in both content and process were taken care of. Content was addressed by providing handouts on kinematics & dynamics and high achievers were challenged with advanced experiments using simulations. Resources used were on line simulations, handouts and worksheet for recoding observations, analysis & conclusions. Teaching strategy used was inquiry and collaboration.

A mix of direct instruction, visual aids, guided practice, simulation and collaborative learning was used. Scaffolding tools for learners at different proficiency levels were used. Simulation worked better on laptops.

In this session, teacher was just a facilitator observing students continuously and grading them according to the rubric provided to students. Students' enthusiasm was evident to perform experiment in a new way using technology. This technique is used in IBDP (International Baccalaureate Diploma Programme) for internal assessments were students compare their hands on experimental result with results from simulation.

One disadvantage of using simulation is the **lack of real-world uncertainty** as simulations are based on idealised model. Real experiments include random and systematic errors, also environmental effects like friction, air resistance etc which are missing in simplified models. Also, students do not develop practical hands-on skills and are unable to deal with error in measurements and propagation of uncertainties due to oversimplification of physics. Here outcomes are limited as students cannot explore parameters which are outside the coded parameters.

Simulations are still useful where experiments are unsafe like radioactivity, high voltage; or where instruments are costly and unavailable. Simulations can also help where students require a pre-lab conceptual understanding before performing hands-on experiments.

Activity Based Learning as a Pathway to Emotional Wellbeing as the Foundation of Learning in the Early Years: Insights from Balvatika Classroom, under NEP 2020

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Abstract

Emotional wellbeing is the starting point of all learning for young children. NEP 2020 emphasizes joyful, play-based, and activity driven classrooms — where children feel secure enough to explore, question, and grow. This paper illustrates how activity-based learning routines such as, morning circle time, collaborative building, outdoor exploration and inquiry-based STEM activities — nurture emotional security and social emotional skills in young learners. Drawing experiences from Balvatika classroom setting, the study highlights that emotionally anchored children demonstrate greater curiosity, resilience, and engagement in learning tasks. When activities are designed to integrate emotional and cognitive growth, learning becomes meaningful, lasting and holistic.

Keywords: Emotional wellbeing; early childhood education; NEP 2020; STEM; Balvatika; social–emotional learning.

Introduction

Early childhood years ages 3 years to 8 years is critical period for laying the foundation of lifelong learning and development. During these formative years, children not only acquire literacy and numeracy skills but also develop their earliest perceptions of self, relationships, and the world around them. Research and policy frameworks, including NEP2020 emphasize that learning in this stage must be experiential, play-based, and emotionally supportive.

Activity based learning offers a powerful approach to achieving these goals. Through hands-on experiences, such as storytelling, collaborative building, nature walks, and inquiry driven science activities – children engage their sense express emotions and build social skills. These activities create a safe inclusive environment where children feel valued and confident to take risks, solve problems and learn through trial and error. Emotional well being is not an isolated goal, it is woven into everyday classroom interaction and routines. When children feel secure and connected, they participate more actively show persistence during challenges and develop resilience – qualities essential for academic readiness and holistic growth.

NEP 2020 strongly echoes this understanding, which places immense importance on creating learning experiences that are hands-on, play-based, and emotionally supportive [1]. Observations from the Balvatika classroom children who feel emotionally secure are more willing to explore materials, ask questions, and take small but meaningful risks in learning. On the other hand, when children feel anxious or disconnected, even simple tasks can feel overwhelming.

Emotional wellbeing is also deeply tied to the sensory systems that develop rapidly in the early years. Children make sense of the world through their 8 senses: sight, smell, taste, hearing, touch, vestibular, proprioception and interoception [2]. When these sensory needs are met, children are better able to regulate their emotions, stay focused, and participate fully in classroom life.

International research supports these experiences [3]. Studies have shown that social–emotional learning in early childhood strengthens school readiness, academic engagement, and long-term emotional health [4]. In simple classroom terms: when children feel good, they learn well.

NEP 2020 and Emotional Wellbeing

NEP 2020 gives teachers permission to prioritize emotional development—not as an extra activity, but as a central part of teaching. Some key ideas that guide my everyday practice include:

• **Learning through play and exploration:** Children enjoy learning through diverse ways like talking, listening, playing with toys, dancing, singing etc. These activities naturally bring out emotions, problem-solving, imagination, and social skills. It allows children to make choices, negotiate with friends, and express themselves freely.

• **Creating safe and inclusive environments:** A classroom becomes a "second home" when children feel welcomed, cared for, and listened to. Safety is not only physical—it is emotional. Children must feel free to try, fail, and try again.

• **Supporting children's agency:** When children are encouraged to make decisions—choosing materials, suggesting activities, helping peers—they develop confidence and a sense of identity.

• **Building emotional skills through daily routines**: SEL is not something separate. It happens in simple moments: sharing toys, helping a friend, taking turns, solving a disagreement, or celebrating small victories.

These principles shape the way we plan, interact, and respond to children in the classroom.

Activity Based Learning in Practice

Activity based learning in early childhood is not limited to academic tasks, it is a holistic approach that integrates emotional, social and cognitive development. In the Balvatika classroom several routines and experiences illustrate how activities become vehicles for emotional wellbeing and meaningful learning.

• **Morning Circle Time: A Gentle Start:** Every morning, we gather in a circle—a safe space where children can check in with their feelings. Some say they are happy, some tired, some excited, and occasionally someone says, “I feel sad today.”

Circle time teaches children that all emotions are welcome. Over the months, I saw shy children begin speaking up, children with big feelings finding words, and children learning to listen to one another with care.

• Conflict Resolution: Learning to Navigate Emotions: Conflicts are natural in early years. Instead of solving problems for children, we guide them through the process.

One memorable example happened during calendar time. The author tried several methods to choose the “calendar helper”—alphabetical order, turns, random selection—none worked smoothly. Finally, we tried teamwork: one child picked the day, and others helped them read the letters and sounds. The most heartwarming moment was when children insisted on helping a friend who struggled with letter recognition.

This was emotional wellbeing in action—inclusion, empathy, and patience.

• **Anecdotal Observations:** The classroom interactions children who feel supported emotionally share their viewpoints:

• take more risks during activities
• ask deeper questions
• show persistence during challenges
• enjoy working with peers
• handle mistakes with greater ease

Their emotional stability fuels their curiosity and learning.

STEM Activities as Pathways to Emotional Growth

STEM in early childhood is not about formal science or complex problem-solving. It is about exploration, wonder, and collaboration. And these experiences are deeply emotional [5].

• **Collaborative Building:** When children use blocks or recycled materials to build structures, they learn to negotiate, share ideas, and celebrate achievements together. These activities build confidence, communication, and teamwork.

• **Nature-Based Learning:** Whether watching plants sprout or observing how water moves, children experience calmness and curiosity at the same time. Nature has a grounding effect—it reduces anxiety and invites children to explore freely.

• **Storytelling:** Stories are a window to the world for children. These are good medium for learning about emotions, awareness about life skills. Listening to stories improves vocabulary and critical thinking skills. Some stories create awareness about the surroundings.

• **Inquiry-Based Science:** Activities like colour mixing or exploring magnets create moments of excitement and sometimes disappointment. Both are valuable. We help children recognize and talk about these emotions, showing them that scientists also feel the same way when experiments succeed or fail.

Impact on Children's Learning

• **Higher Engagement:** When emotional needs are met, children want to participate. They become curious, energetic learners.

• **Stronger Social Skills:** Through collaborative tasks, children learn empathy, cooperation, and peaceful problem-solving.

• **Increased Resilience:** Children become more comfortable with trial and error. They begin to see mistakes as part of the learning process.

• **Improved Academic Readiness:** Emotionally secure children are better at focusing, reasoning, communicating, and remembering—skills that form the base of academic learning.

Conclusions

Emotional wellbeing is not an add-on to the curriculum—it is the soil in which every other form of learning takes root. When children feel emotionally safe, they explore more boldly, interact kindlier, and learn more joyfully. NEP 2020 gives educators the framework to honour this truth.

As teachers, we can shape classrooms where children feel seen, heard, and valued. When we collaborate with families, observe children closely, and respond with warmth and understanding, we support their growth not only as learners—but as whole human beings. Activity based learning provides the practical pathway to achieve this vision.

Acknowledgements

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Enquiry-Driven Classrooms in Physics: Making Kinetic and Potential Energy Come Alive (Std. X)

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Abstract

Physics becomes meaningful for students only when they can relate it to their own lives. The National Education Policy (NEP) 2020 encourages such meaningful, experiential, and enquiry-driven learning, where students are active participants rather than passive listeners. This paper shares a humane, classroom-based approach to teaching Kinetic and Potential Energy in Std. X Physics through students' questions, experiences, and simple activities. By encouraging curiosity, discussion, and reflection, the classroom gradually shifts from rote learning of formulas to genuine understanding. The paper is rooted in everyday classroom practice and highlights how a warm, supportive learning environment can nurture confidence, curiosity, and scientific thinking among students.

Introduction

When students hear the word energy in Physics, many immediately think of formulas to be memorized and problems to be solved for examinations. However, energy is something they experience every day — while running, climbing stairs, playing games, or even sitting quietly at the top of a slide. A humane, enquiry-driven classroom recognises these lived experiences and uses them as a starting point for learning. Teaching kinetic and potential energy at the Std. X level offers a valuable opportunity to slow down, listen to students, and build concepts gently. Instead of beginning with definitions from the textbook, the focus shifts to conversations, observations, and simple questions that make students feel comfortable expressing their ideas — even if those ideas are incomplete or incorrect. Such an approach aligns strongly with the spirit of NEP, which emphasises understanding over memorisation and empathy over authority.

Why an Enquiry-Driven and Humane Approach Matters?

In many classrooms, students hesitate to ask questions for fear of being wrong. A humane classroom creates emotional safety, where curiosity is welcomed and mistakes are seen as part of learning. An enquiry-driven approach:

- Values students' thoughts and questions
- Encourages dialogue rather than one-way teaching
- Builds confidence along with content knowledge
- Helps students see Physics as meaningful, not intimidating

When students feel heard, they engage more deeply. This is especially important for abstract ideas like kinetic and potential energy, which become clearer only when students can visualise and experience them.

Beginning the Lesson: Listening Before Teaching

The lesson begins with simple, familiar questions:

“Have you ever been hurt by a fast-moving ball?”
“Why do we feel scared standing at the edge of a high place?”

Students eagerly share personal experiences — from playground accidents to climbing ladders at home. These stories are acknowledged and discussed, gently guiding students to realise that motion and position both play a role in how objects can do work. Without naming formulas, students intuitively grasp the ideas behind kinetic and potential energy.

Learning Through Simple, Shared Activities

Activity 1: Feeling Kinetic Energy

Students roll balls of different sizes on the classroom floor or down a small slope made with books. They observe how harder hits and heavier balls cause greater impact. Instead of telling them the relationship, the teacher asks:

- “What made the difference here?”
- “Was it the weight, the speed, or both?”

Through discussion, students slowly arrive at the understanding that kinetic energy depends on mass and speed. The formula is introduced later, almost as a summary of what they have already discovered.

Activity 2: Understanding Potential Energy Through Height

A ball is held at different heights before being released. Students watch carefully and share what they notice.

Gentle questions guide them:

- “Which drop looked more powerful?”
- “What changed when the height increased?”

Students realise that even when an object is not moving, it can possess energy because of its position. This understanding makes the idea of potential energy feel natural rather than forced.

Encouraging Conversation and Reflection Throughout the lesson, students are encouraged to talk — to the teacher and to each other. Short pair discussions help quieter students participate. Wrong answers are not dismissed; instead, they are explored with kindness.

Questions like:

● “What do you think will happen next?”
● “Why do you feel so?”
help students reflect on their thinking. This process builds reasoning skills and shows students that their ideas matter.

Connecting Physics to Real Life

To make learning meaningful, students are asked to find examples of kinetic and potential energy around them:

● Moving vehicles, fans, and flowing water (kinetic energy)

● Water stored in tanks, lifted objects, stretched rubber bands (potential energy)

Discussing dams and hydroelectric power helps students understand how stored energy is converted into usable energy. Such discussions also help them appreciate how Physics connects to society and daily life.

Nurturing Scientific Temperament

A humane enquiry-driven classroom naturally develops scientific temperament.

Students learn to:
● Observe carefully
● Ask questions without fear
● Accept evidence over assumptions
● Change their ideas when faced with new understanding

Predicting outcomes before activities and reflecting afterward helps students become thoughtful and responsible learners — skills that extend beyond the Physics classroom.

The Teacher’s Role: Guiding with Empathy

In this approach, the teacher is not the sole authority but a guide and listener. The teacher:

● Encourages participation from every student
● Responds patiently to doubts
● Uses mistakes as learning moments
● Builds trust and rapport in the classroom

Such a role shift makes learning more humane and inclusive, especially for students who struggle academically.

Student Responses and Observed Outcomes

Students responded positively to this approach. Many expressed that Physics felt easier and more relatable. Increased participation, better conceptual clarity, and improved confidence in solving problems were observed. Students were more willing to ask questions and help each other, creating a supportive learning environment.

Conclusion

Teaching kinetic and potential energy through a humane, enquiry-driven approach transforms both learning and learners. By starting with students' experiences, encouraging dialogue, and gently guiding discovery, Physics becomes less about fear and more about understanding. Such classrooms reflect the true spirit of NEP — where education is not just about marks, but about nurturing curious, confident, and thoughtful individuals. When students feel valued and understood, meaningful learning naturally follows.

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National Education Policy (NEP) 2020

Reflective classroom teaching experiences

Enhancing Conceptual Understanding Through Inquiry-Based Science Activities

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Abstract

The science subject is always associated with applications in real-life. It is not limited to text books only. Science brings fun and enjoyment with hands-on activities. It is never limited to the four walls of the classroom. For over a decade, researchers and educators have been emphasizing activity-based learning for young minds. With NEP 2020, it has been made mandatory for schools to bring a change in teaching learning patterns. It emphasizes more on developing motor skills, igniting curiosity and an analytical mind-set among young minds. Teaching is undergoing a major transition from rote learning to activity-based, inquiry-based learning, etc. This has helped students to learn science as each one contributes in various ways, like view point to look at a problem and to look for the solution for the same in multiple ways. The rise of AI is helping students to explore and develop different strategies to overcome challenges at different levels.

We at Reliance Foundation carry out activity-based learning and art integrated learning for class 8 students for the topic given in the curriculum. In this activity, the teacher explained the concept and students were asked to draw and make a circuit and an electromagnet. It was an individual activity. Students participated in the activity. The activity was not just limited to submitting a model, but it fueled up with a variety of questions from students. It also brought up challenges faced during circuit making and solutions for the same. These activities helped students for deeper understanding of the concept. It helped students to apply the knowledge in daily life. This activity further expanded to wise usage of electricity and to save the resources also.

Keywords: Activity-based learning, motor skills, analytical reasoning, resources, etc.

Science subject sounds boring for few students and interesting for others in a classroom. In a classroom everyone may or may not have inclination towards learning sciences. For school students' science is one of the mandatory subject. It is to learn basic logic, reasoning and analytical skills. 1Teachers and educators are developing, implementing different pedagogy methods to make learning sciences interesting for the students. Science is an application based subject with logical understanding. It turns out to be boring when it is learnt in a rote learning manner or traditional manner.[2]

[2]In recent years there has been a dynamic change in the teaching-learning methods. The education pattern has undergone change from teacher centric to student centric. It emphasis on new pedagogy methodologies for inclusive classroom. There are different methodologies developed like[3] flipped classroom, use of AI tools for teaching, etc. These methods have brought a positive change among students' attitude and skills.

The launch and implementation of NEP 2020 transition in education. It has introduced experiential learning, multi-disciplinary and minimisation of rote learning are the key features of the same. This year CBSE introduce new textbook of science for class 8. This new textbook explains the concept with activities. The book presents activities and demonstrations for the concepts. This new pattern is in alignment with the NEP 2020. It introduces questions type cased-based questions, application of knowledge, etc. The traditional pattern of questions answers is changed to application-based questions. Taking up this as motivation we introduce activity-based learning (ABL) for 34 students of class 8.

4Activity Based Learning (ABL) is hands-on learning. Science learnt with hands-on activities helps to remember and understand the concept thoroughly. In ABL students are actively engaged. It helps to develop motor skills, reasoning and cognitive skills also. Students participate in group discussion and share their learning with each other. It helps them to enhanced their knowledge as well as develop listening skills and ownership quality also. It is a self-paced class activity. In this everyone gets opportunity to share about their learning and short-comings in the activity.

In order to bring a change in the teaching methodology we introduced model making activity for the students. The objective of this activity was to give hands-on experience to the students, explore possible raw material required for the making of the circuit, to compare the similarities and differences of circuit made by students, analyse challenges faced by students in making a circuit and provide solutions for the same.

For the topic (electricity and magnetic effects) teacher explains the concept of circuit and electromagnet and the elements required to make a simple circuit. Students were asked to make a working model of circuit and electromagnet. Initially this activity seemed to be very simple for the students. But it has helped to initiate discussion on different questions. Students asked variety of questions and shared different challenges they have faced during these activities. Students faced challenges like type of wire, power of bulb (LED or other bulb), which battery to use etc., This was an individual activity for the students. They have to make the model and bring it to the class. Students have to display the working of the model as well.

Students were participative and showed ownership for the model. Models show variation with respect to different bulbs, 2V or 9V battery, thickness of wire, etc. Teacher appreciated the hard work of the students and also explains the student's doubts. This helped students to design an error free electromagnet model.

These two activities open up platform for discussion among students and teacher-students. It also helped them to apply text-book knowledge into real life. It helped them to learn beyond text-books. Hands-on activities brought a transition among students. It has help to develop curiosity, interest in the subject and scientific temperament among students. The graphical data gives a positive change in the students' behaviour with the activity-based learning methodology. It also made an inclusive classroom practice. Although initially few students were proactive in the class. Few students share the model in the class and it has motivated the class to participate in the activity. Overall students showed a positive response for the activity-based learning joined with the traditional method of teaching and learning. It turns out to be win-win situation for both teacher and students.

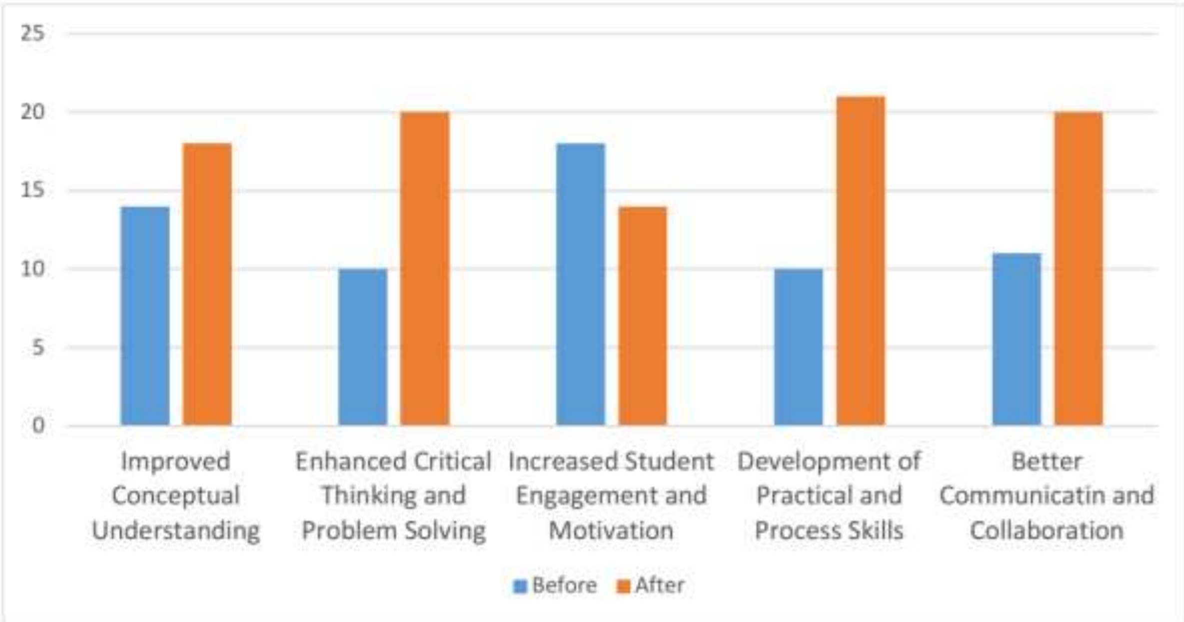

Fig. 1: Analytical data of the activity based learning

 

Fig. 2 & 3: Students with the model

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Enhancing Geometry Learning Through Dynamic Visualization: Comparative Insights on Teaching Geometry with GeoGebra in Middle and Senior School

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Abstract

This guide presents a classroom-friendly, comparative view of teaching geometry with traditional methods versus teaching the same topics using GeoGebra, an open and dynamic mathematics environment. It is written in humanised language for teachers and school leaders working with Classes 6 to 12. The central idea is simple: when students can build a figure, drag a point, and see measurements change instantly, they form more accurate mental pictures, connect ideas faster, and are better prepared to explain and prove what they observe. The guide synthesises evidence reporting medium-to-large gains in achievement, conceptual understanding, and spatial visualisation with GeoGebra—especially for visual topics such as circle theorems, transformations, vectors, and 3D sections—while noting that impact depends on task design, teacher facilitation, and access to devices (Mthethwa et al., 2020; Uwurukundo et al., 2023; Muslim et al., 2023; Zhang et al., 2025). We organise the discussion by grade bands and by learning indicators (conceptual grasp, representational fluency, application/transfer, and geometric reasoning), and we emphasise student experiences, application and concept connections, visual impact, and photographic memory. You will find short activities, a practical rubric for pre/post analysis, and clear comparative notes: what traditional lessons do well (tool discipline, formal writing) and what GeoGebra adds (visibility of invariants, multi-representation thinking, and proof readiness). The final section outlines realistic classroom routines and tips for assessment alignment so that dynamic exploration complements—not replaces—core teaching.

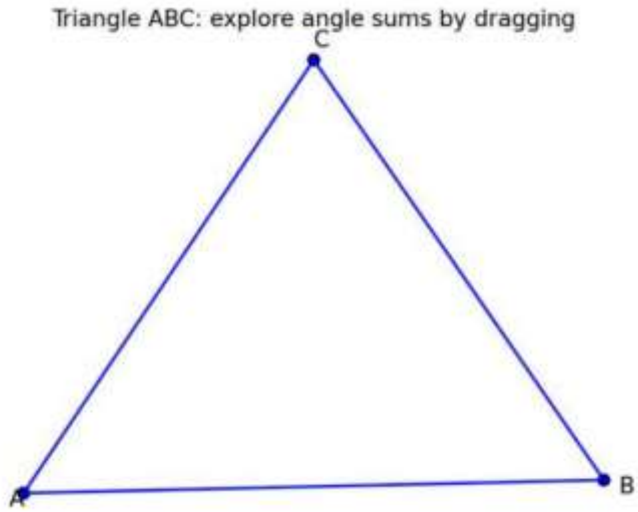
Keywords

GeoGebra; geometry education; secondary school; dynamic geometry software; visualisation; photographic memory; Van Hiele levels; qualitative rubric; India

Introduction

Geometry across Classes 6–12 covers basic constructions, polygons, circle theorems, transformations, coordinate geometry, vectors, and three-dimensional visualisation. In traditional lessons, students see a static diagram and listen to a verbal or chalkboard proof. Many learners struggle to imagine movement, track multiple relations, and connect diagram changes to algebra or measurement. Research on visual representations suggests that interactive digital resources support transitions across concrete–pictorial–abstract forms and improve outcomes—even for problems without provided diagrams (Žakelj & Klančar, 2022). GeoGebra places movement and measurement on the screen. Learners drag points, watch distances and angles update, and quickly notice invariants (for example, the tangent is always perpendicular to the radius at the point of contact). Systematic reviews and meta-analyses report consistent positive effects of GeoGebra on mathematics achievement and spatial visualisation, particularly in geometry topics (Muslim et al., 2023; Zhang et al., 2025).

Figure 1. Triangle ABC: students drag a vertex to explore which measures change and which stay constant.



What GeoGebra Adds to Geometry Learning

GeoGebra integrates geometry, algebra, and measurement in one space. Students construct figures, drag elements, and see values update live. This reduces guesswork and accelerates the 'see → say → prove' journey. Studies in secondary schools—including resource-constrained settings—show that learners using GeoGebra are more successful at solving problems and justifying statements compared with lecture-based groups (Mthethwa et al., 2020). For 3D topics, quasi-experimental research reports statistically significant performance gains and improved attitudes when GeoGebra is used to visualise sections of solids (Uwurukundo et al., 2023).

Comparative Analysis: Traditional vs GeoGebra

Below we compare both approaches across learning indicators, student experiences, application and concept connections, and visual impact/photographic memory. The aim is not to replace traditional methods but to clarify how GeoGebra complements them.

1) Learning Indicators

• Conceptual grasp: In traditional classes, students memorise properties and reproduce steps. With GeoGebra, they observe the property under drag, measure angles, and articulate conditions—this visibility strengthens concept formation and reduces misconceptions (Žakelj & Klančar, 2022).

• Representational fluency: Traditional work often separates diagram from algebra and measurement. GeoGebra keeps them together—diagram, table, graph, and algebra are linked—helping students move smoothly across representations (Žakelj & Klančar, 2022).

• Application/transfer: GeoGebra's live feedback encourages experimentation and transfer (e.g., composing reflections to 'discover' rotation equivalence), which studies associate with broader improvements in problem solving (Muslim et al., 2023).

• Geometric reasoning & proof: GeoGebra supports a 'conjecture first, proof next' routine; learners justify steps using patterns they have observed, yielding better explanations and more confident proofs (Mthethwa et al., 2020).

2) Student Experiences

• Engagement: Dragging and measuring turn geometry into a game of 'what stays the same?' Motivational gains are repeatedly reported in secondary contexts using GeoGebra

• Confidence: Students often say, 'Now I can see it.' This seeing builds courage to explain and reduces anxiety around proofs.

• Collaboration: Short, group-based GeoGebra tasks promote talk moves, which improves collective reasoning. Collaborative designs with GeoGebra correlate with stronger conceptual outcomes than solo use (Gurmua et al., 2024).

3) Application and Connecting Concepts

• Transformations ↔ Coordinates: Two reflections in intersecting lines feel abstract on paper; in GeoGebra, students watch a rotation emerge and then connect the rotation angle to the angle between the lines.

• Geometry ↔ Algebra: Slope becomes visible when a point moves; learners link geometric conditions (parallel/perpendicular) to numeric slope values.

• Vectors and 3D sections: Vector addition and projection are clearer with arrows that move; cylinder slices reveal conic sections, bridging geometry with analytic descriptions—evidence shows significant gains for 3D geometry under GeoGebra instruction (Uwurukundo et al., 2023).

4) Visual Impact and Photographic Memory

Traditional diagrams are snapshots. GeoGebra creates short visual stories: a point moves, a value updates, and an invariant holds. These micro-stories support stronger visual encoding and what students call 'photographic memory'—they remember the picture and the behaviour. Research on visual representations explains why such multimodal experiences improve recall and transfer to non-diagram tasks (Žakelj & Klančar, 2022). Meta-analytic findings also link dynamic visualisation to sizeable achievement effects (Zhang et al., 2025).

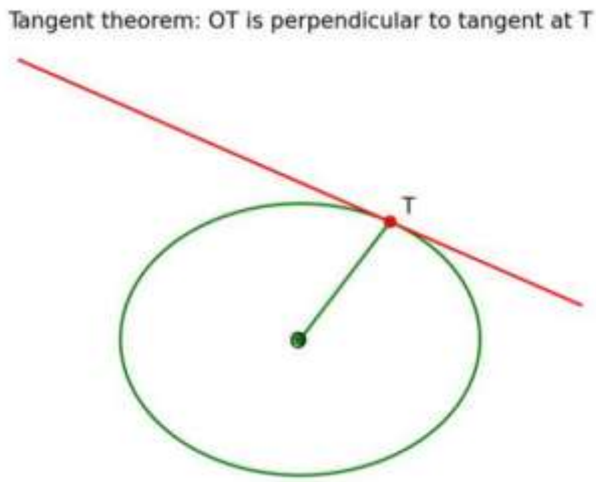


Figure 2. Tangent theorem observed dynamically: as T moves, -(OT, tangent) remains a right angle—an image students remember.

Grade-Level Plans and GeoGebra Activities

Classes 6–8 (Middle School)

Topics: constructions (perpendicular and angle bisectors), triangles/quadrilaterals, symmetry and tessellation. Activities: build a perpendicular bisector; show distances; drag and watch equality; show triangle angle measures; design tessellations with reflections/rotations. Ease compared with traditional: hands-on movement reduces cognitive load and exposes invariants early (Žakelj & Klančar, 2022).

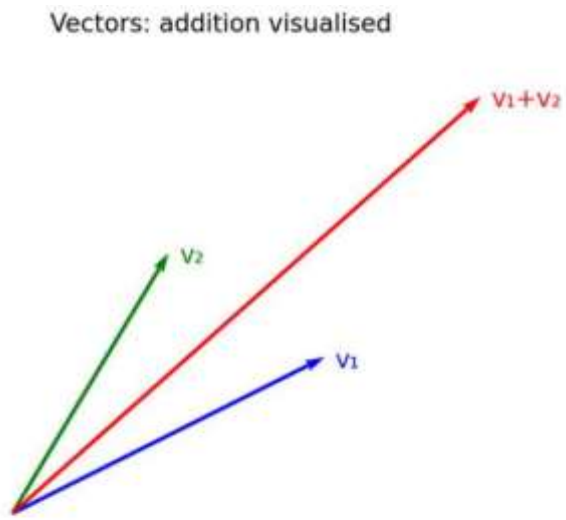


Figure 3. Vectors: addition seen as arrow composition—students connect diagram changes to algebraic sums.

Classes 9–10 (Secondary)

Topics: circle theorems, transformations, coordinate geometry. Activities: tangent theorem explorer; transformation composition; slope lab. Ease compared with traditional: dynamic measurement supports conjecture and transitions cleanly to proof (Mthethwa et al., 2020; Bhagat & Chang, 2015).

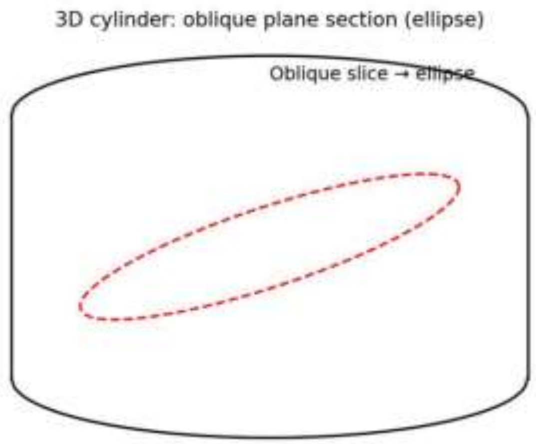


Figure 4. 3D section: the oblique slice of a cylinder appears as an ellipse—link this visual to conic definitions and exam-style projections.

Classes 11–12 (Senior Secondary)
Topics: vectors and 3D geometry. Activities: vector narratives and 3D slices with orthographic views. Ease compared with traditional: interactive arrows and 3D views reduce abstraction barriers; significant performance gains reported for 3D topics (Uwurukundo et al., 2023).

Methodology: A Short Pre/Post Design with Human-Centred Feedback
Pre-phase: 10-minute concept check and 5-minute rubric conversation. Intervention: short GeoGebra activities within group discussion (explore → conjecture → explain). Post-phase: repeat check and rubric; two-sentence reflection. Instruments: concept test; quick Van Hiele-style check; four-parameter qualitative rubric (Kutluca, 2013; Gurmua et al., 2024).

Qualitative Rubric (Pre/Post, score 0–3 per parameter)

Parameter	0 – Insufficient	1 – Emerging	2 – Proficient	3 – Exemplary
Conceptual Grasp	Rote facts; misconceptions	Partial, some properties	Sound understanding; limited generalisation	Deep understanding; explains invariants and conditions
Representational Fluency	Struggles to link diagram ⍰ symbols	Reads static diagrams only	Interprets dynamic measures; connects to symbols	Moves fluently across diagram, table, graph, algebra; justifies
Application/Transfer	Cannot apply to new problems	Applies in familiar cases	Solves varied problems with some support	Transfers to novel contexts; self⍰justifies
Geometric Reasoning & Proof	Narrative/empirical only	Statements without order	Structured argument with minor gaps	Complete deductive proof using dynamic evidence

Side-by-Side Comparison: Traditional vs GeoGebra

Dimension	Traditional Methods	GeoGebra-Supported Methods
Learning indicators	Focus on steps and final answers; strong tool discipline and formal writing	Focus on invariants and conditions; strong concept formation and cross-representation links (Žakelj & Klančar, 2022)
Student experience	Listening and note-taking; engagement depends on teacher talk	Drag-measure-explain routines; higher motivation and participation (Mthethwa et al., 2020)
Application & connections	Transfer to unfamiliar contexts can be limited	Experimentation supports transfer; links geometry ↔ algebra and 3D ↔ 2D (Uwurukundo et al., 2023)
Visual impact	Static snapshots; memory tied to a single figure	Micro-stories with movement; stronger visual encoding and recall (Žakelj & Klančar, 2022; Zhang et al., 2025)
Proof readiness	Proof may feel opaque; fewer entry points	Conjecture first → proof next; clearer justifications (Mthethwa et al., 2020)
Assessment alignment	Matches current exam style	Complement exams with rubric-based formative checks; write proofs from observed patterns

Dimension Traditional Methods GeoGebra-Supported Methods

Common Challenges and Practical Solutions

Access: rotate groups on limited devices; pair a 'driver' with an 'explainer'. Teacher confidence: start with ready-to-use applets and short scripts; adapt gradually. Assessment alignment: use the rubric for formative feedback and keep a notebook of proofs built from GeoGebra observations. Time: plan micro-activities (8–12 minutes).

Reflections:

Inviting students to write a 100-word reflection with a screenshot and a caption ('the tangent stayed perpendicular while I moved T'). and building a gallery of these micro-stories to reinforce photographic memory and proof structures, helped us Keep notes on invariants noticed, measures tried, and how quickly learners switched to algebra—these make the next lesson sharper and keep the focus on understanding rather than coverage.

Extended Comparative Analysis: What Learners Actually Do and Feel Traditional lesson flow (typical): The teacher draws or projects a static diagram, states a theorem, and works through a proof. Students copy steps and practice similar problems. This flow builds discipline and exam fluency; however, many learners treat properties as rules to remember rather than relationships to understand. GeoGebra lesson flow (typical): Students open or view an applet, explore by dragging, and collect short observations ('this angle stayed equal', 'the slope changed when x moved'). The class then names the property and proves it. Research indicates that this kind of exploration improves problem-solving and justification in Euclidean topics (Mthethwa et al., 2020) and boosts spatial visualisation for 3D content (Uwurukundo et al., 2023).

Learning Indicators in Detail

Conceptual grasp means knowing the conditions under which a property holds and being able to explain why. In circle theorems, for example, students must recognise where the tangent touches, which radius is relevant, and how triangle properties finish the argument. GeoGebra's dynamic measurement (Žakelj & Klančar, 2022) helps students test and refine these conditions quickly. Representational fluency is the ability to move between diagram, measurement, table, graph, and algebra without losing meaning. Because GeoGebra keeps these views linked, learners see how a geometric change affects a numeric relation. Reviews note higher success on tasks that require such switching. Application and transfer show when a learner can handle a new situation—like composing transformations or reading a 3D section—without being told the exact steps. Meta-analyses report medium-to-large effects on achievement when dynamic visualisation supports such transfer (Muslim et al., 2023; Zhang et al., 2025). Geometric reasoning and proof involves putting observations into a logical sequence. Traditional methods teach the language of proofs; GeoGebra provides better entry points by grounding each step in what learners have already witnessed (Mthethwa et al., 2020).

Classroom Vignettes (Grade-wise)

Class 7 (Polygons): During a regular hexagon activity, a student drags a vertex and notices the interior angle stays 120°. The teacher asks, 'What else stayed the same?' Another student points to exterior angles. The class connects the pattern to the angle-sum formula and writes a two-line explanation. This routine turns memorised facts into noticed relationships.

Class 9 (Circles): Learners move point T on a circle and watch the tangent-radius right angle persist. When asked to prove it, they reference the observed perpendicularity and use triangle properties to finish the proof. Studies in India and South Africa report that such dynamic exploration leads to better justification and problem-solving (Bhagat & Chang, 2015; Mthethwa et al., 2020).

Class 11 (Vectors): Students drag v_1 and v_2 and view the red arrow v_1+v_2. One group explains the dot product as 'how much of v_1 lies on v_2'. Because they can see the projection change with the angle, the algebraic formula feels meaningful rather than arbitrary.

Class 12 (3D sections): Learners slice a cylinder with an oblique plane and identify the ellipse. Switching to orthographic views makes exam-style diagrams easier. Quasi-experimental evidence shows significant performance gains for such 3D topics with GeoGebra (Uwurukundo et al., 2023).

Why the Visual Impact Matters

Cognitive research in mathematics education highlights that well-designed visual experiences reduce mental load and improve retention. When learners watch a property hold under movement (like equal angles or parallel lines), they form strong mental pictures and verbal labels together. Reviews of visual representation in geometry teaching link such integrated experiences to better performance—both with and without provided diagrams. Meta-analyses specific to GeoGebra report medium-to-large achievement effects arising from dynamic visualisation (Zhang et al., 2025).

Practical Routines That Blend Both Approaches

- See / Say / Prove: Learners first 'see' an invariant in GeoGebra, then 'say' it in their own words, and finally 'prove' it on paper.
- Driver/Explainer pairs: One student controls the applet; the other narrates observations using precise language—angle, arc, chord, slope.
- Two-minute capture: After exploration, students take a screenshot and write a caption. These micro-stories build photographic memory and a quick portfolio of ideas. Blackboard synthesis: Finish with a traditional proof or worked example to consolidate formal writing and exam style.

Assessment Blueprint (Formative + Summative)

Formative: Use the rubric weekly—score conceptual grasp, representation switching, application/transfer, and reasoning. Invite short student reflections.

Summative: Keep traditional tests but include one 'transfer' item (e.g., compose transformations or interpret a 3D view) that rewards explanation and diagram to algebra links.

Evidence notes: Multi-study reviews and meta-analyses support the value of dynamic tasks and short interventions, especially in geometry topics.

Extended Grade-Level Plans

Classes 6–8: Aim for four 10-minute GeoGebra activities per unit. Focus on constructions, triangle properties, and symmetry. Collect one screenshot per week with a caption and add to a class gallery.

Classes 9–10: Prioritise circle theorems and transformations. Use dynamic measures to generate conjectures; then practise formal proofs and coordinate calculations. Encourage students to connect geometry statements to slopes, distances, and midpoints.

Classes 11–12: Combine vector applets with analytic geometry and 3D sections. Toggle views between 3D and orthographic to keep exam diagrams familiar. Ask students to create one applet or screenshot set that explains a difficult idea to the next grade.

Teacher and Student Voice Prompts

Teacher prompt: 'When you dragged point T, what stayed the same? What changed? Which measure confirms your claim?' Student prompt: 'Write a caption for your screenshot that a younger student would understand. Include one number or angle measure.' Debrief: 'How did the GeoGebra picture help you write a proof or solve the problem?' Emphasise linking the picture to formal steps.

Comparative Narrative: Tangent Theorem End-to-End

Traditional path: We draw a circle, a tangent at T, and the radius OT. The teacher states the theorem and proves it with triangle properties. Students copy and try similar questions. Some remember the steps; others still wonder why the right angle appears. GeoGebra-enhanced path: Students move T and watch the angle at the point of contact stay at 90°. They measure and record this invariant, then attempt the proof. Because they have already 'seen' the perpendicular relationship in action, the proof feels like a logical explanation rather than a new rule. Empirical studies report better justification and problem-solving in such settings.

Some Important facts teachers need to know:

- Use GeoGebra to make relationships visible, then practice manual constructions to build precision and exam confidence.
- Short bursts (8–12 minutes) inside a regular lesson are effective; meta-analyses note strong effects from focused interventions.
- Rotate pairs; one 'driver', one 'explainer'. Whole-class demos work too—pause and ask learners to predict measurements before you drag.
- Use the rubric weekly, attach screenshot captions to notebooks, and score clarity of explanation, not just final answers.
- Give tiered prompts: basic observation ('what stayed the same?'), intermediate explanation ('why?'), and advanced proof ('justify each step').

Conclusion

Traditional teaching gives structure, tool discipline, and formal writing—skills students still need. GeoGebra adds visibility of invariants, multi-representation thinking, and easier entry points into proof. Across Classes 6–12, short, collaborative GeoGebra activities strengthen conceptual grasp, representation switching, application, and reasoning. They also create memorable visual stories—useful 'photographs' in students' minds—so ideas stick and transfer to exam problems. Blend both approaches, use the rubric for feedback, and keep tasks focused for a more human classroom. The literature converges on a optimistic finding: GeoGebra, thoughtfully integrated into geometry instruction from Class 6 to Class 12, enhances students' conceptual understanding, spatial visualization, representational fluency, and problem-solving compared with traditional approaches. Gains are strongest for topics that benefit from dynamic visualization (circles, transformations, vectors, 3D sections) and when paired with collaborative inquiry and teacher facilitation. Meta-analytic evidence corroborates medium-to-large effects across achievement and visualization outcomes.

To realize these benefits broadly, systems should invest in teacher PD, ready-to-use GeoGebra kits aligned with local curricula, and rubric-based formative assessment that values dynamic reasoning. In contexts with uneven infrastructure, even modest access can yield positive outcomes if tasks and orchestration are well designed. Future research can extend longitudinal designs (retention, transfer to proofs), explore integration with standardized assessments, and refine rubrics mapped to Van Hiele levels to better capture growth in geometric thinking.

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Teacher Readiness for Holistic Science Education: Role of Meditation in Enhancing Teaching Effectiveness

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Abstract

The successful implementation of holistic and experiential science education, as envisioned by the National Education Policy (NEP) 2020, largely depends on teacher readiness. While policy documents emphasize innovative pedagogy and learner-centric approaches, limited attention has been given to the internal preparedness of teachers—particularly their emotional balance, reflective capacity, and stress management. This conceptual paper explores the role of meditation as a supportive professional development strategy to enhance teaching effectiveness in science education.

Keywords: Teacher Readiness, Meditation, Holistic Education, Science Teaching, NEP 2020

1. Introduction Educational reforms worldwide increasingly recognize that meaningful learning outcomes depend not only on curriculum and pedagogy but also on the emotional and psychological readiness of teachers. NEP 2020 emphasizes holistic and experiential learning, requiring emotionally balanced and reflective teachers.

2. Concept of Teacher Readiness Teacher readiness is a multidimensional construct involving cognitive preparedness, emotional stability, reflective capacity, and openness to innovation.

3. Holistic and Experiential Science Education under NEP 2020 NEP 2020 promotes learning by doing, development of scientific temper, and integrated development of learners.

4. Meditation as a Reflective Practice for Teachers Meditation supports emotional regulation, stress reduction, and reflective awareness, enabling teachers to handle classroom challenges effectively.

5. Linking Meditation to Teaching Effectiveness Meditation enhances clarity, classroom engagement, inquiry facilitation, and a positive learning environment.

6. Conceptual Framework Meditation → Emotional Regulation → Reflective Teaching → Pedagogical Flexibility → Holistic Science Education

7. Educational and Policy Implications Meditation may be integrated into teacher education and in-service training programs.

8. Conclusion Teacher readiness is foundational to holistic science education. Meditation offers a sustainable and supportive approach to enhance teaching effectiveness.

Promoting Creativity, Critical Thinking, and Scientific/Technical Temperament Among Students.

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ABSTRACT

PROMOTING CREATIVITY, CRITICAL THINKING, AND SCIENTIFIC/TECHNICAL TEMPERAMENT AMONG STUDENTS.

Problem Statement: In many ICT and AI classrooms, students memorize terms such as TCP, UDP, or network layers, yet struggle to understand how digital systems actually function or apply this knowledge to real-life problem solving.

Aligned with the National Education Policy (NEP) 2020 and the theme of Teachers' Conference–2026, this abstract presents experiential, inquiry-driven classroom practices that transform AI and ICT education from rote instruction to meaningful exploration.
Instead of theoretical explanations, students engaged in real-life simulations of TCP and UDP through role-based packet-flow activities to understand **reliability**, **sequencing**, and **data loss**.
Learning was further reinforced through a Wi-Fi repeater activity, where students configured an unused router via IP settings to visualise network architecture and data flow.
An AI-based Question Bot project introduced basic mathematical modelling to analyse learning responses, shifting focus from answers to thinking patterns.
By blending hardware, software, simulation, and reflection, these low-cost activities foster curiosity, logical reasoning, and scientific temperament.
We will understand how experiential AI and ICT learning can make science engaging, practical, and deeply aligned with NEP's vision of learning by doing.

Novelty Statement:
This approach empowers teachers to move from rote explanations to guided exploration, making complex AI and ICT concepts accessible through simple, low-cost classroom innovations.

Keywords:
Experiential Learning, AI & ICT Education, TCP–UDP Simulation, NEP 2020, Scientific Temperament, Inquiry-Based Learning

Challenges and remedies in teachers' role in Experiential Learning

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Abstract

The National Education Policy 2020 (NEP 2020) is a transformative policy that brings fundamental changes to the Indian education system. It emphasizes experiential, activity-based, and learner-centered education instead of the traditional rote learning approach. Particularly in science education, greater importance is given to experiments, observation, problem-solving, and innovation. This research paper presents a detailed study of the concept, need, characteristics, teachers' roles, and the limitations of rote learning in the context of activity-based learning in science education as envisaged by NEP 2020.

Keywords: NEP 2020, Science Education, Activity-Based Learning, Rote Learning, Experiential Learning

Introduction

Science is not merely a subject for memorizing facts; it is an effective means of understanding natural phenomena. However, traditional teaching methods in science education have largely emphasized rote memorization. As a result, students often lack conceptual understanding, experimental skills, and a scientific attitude. NEP 2020 addresses these limitations by strongly advocating the adoption of activity-based learning in science education.

Concept and Limitations of Rote Learning

Rote learning refers to memorizing information without understanding the underlying concepts.

Major limitations of rote learning include:

1. It does not foster creativity among students.
2. It fails to develop a scientific attitude.
3. Knowledge gained remains short-term.
4. Problem-solving skills are not adequately developed.

Concept of Activity-Based Learning

Activity-based learning refers to "learning proach, students acquire knowledge through experiments, projects, observation, discussions, group work, and model-making activities.

According to NEP 2020, the learner is placed at the center of the teaching–learning process.

Changes in Science Education under NEP 2020

NEP 2020 suggests the following reforms in science education:

1.Experiential and inquiry-based learning
2.Teaching based on experiments and activities
3.Inclusion of STEAM education
4.Activities linked to local contexts
5.Continuous and comprehensive evaluation methods

Importance of Activity-Based Learning in Science Education
1.Develops scientific thinking among students
2.Ensures clear and long-term conceptual understanding
3.Enhances problem-solving abilities
4.Promotes teamwork and communication skills
5.Makes learning more interesting and meaningful

Role of the Science Teacher

According to NEP 2020, the teacher is not merely a provider of information but acts as a facilitator, motivator, and co-learner.

The teacher's role includes:

- Selecting appropriate activities
- Motivating students to perform experiments
- Encouraging questioning and curiosity
- Providing positive feedback
- Considering individual learning needs of students

Examples of Activity-Based Teaching

- Physics: Constructing an electric circuit using household materials
- Chemistry: Using natural indicators to identify acids and bases
- Biology: Conducting experiments and observations on plant growth

Challenges and Remedies

<u>Challenges:</u>

- Lack of time
- Insufficient teaching–learning resources
- Inadequate teacher training

<u>Remedies:</u>

- Organizing teacher training programs
- Utilizing locally available resources

- Using digital tools and virtual laboratories

Conclusion

Activity-based learning in science education under NEP 2020 is the need of the hour. This approach effectively overcomes the limitations of rote learning and helps in developing scientific temperament, creativity, and self-confidence among students. Consequently, science education becomes more effective, enjoyable, and relevant to real life.

Reference:

National Education Policy 2020

NCERT and Educational Journals