



REVOLUTIONIZING SCIENCE EDUCATION UNDER NEP 2020: ENHANCING PROBLEM-SOLVING SKILLS FOR FUTURE INNOVATORS

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Abstract

The National Education Policy (NEP) 2020 seeks to transform science education in India by fostering problem-solving skills and nurturing future innovators. It promotes experiential and inquiry-based learning, encouraging active scientific exploration over passive memorization. Technology integration, including Augmented Reality (AR), Virtual Labs, and Artificial Intelligence (AI), enhances conceptual understanding and engagement. NEP 2020 emphasizes an interdisciplinary and holistic approach, blending science with mathematics, arts, and social sciences to develop well-rounded thinkers. Assessment reforms shift the focus from rote learning to competency-based evaluations, ensuring practical application of scientific concepts. The policy also prioritizes capacity building for teachers through continuous professional development and modern pedagogical training. Strengthened infrastructure, including well-equipped labs and digital resources, further supports this educational transformation. By bridging the gap between theory and practice, NEP 2020 fosters critical thinking, creativity, and innovation, equipping students with the skills needed to address real-world challenges and contribute to a knowledge-driven economy.

Keyword: Science Education, Experiential Learning, Technology Integration, Interdisciplinary Approach, Competency-Based Assessment, Teacher Capacity Building

Introduction:

The National Education Policy (NEP) 2020 represents a transformative shift in India's education system, particularly in science education, by emphasizing the development of problem-solving skills and nurturing future innovators. Recognizing the limitations of rote learning, NEP 2020 advocates for experiential and inquiry-based learning methodologies. This approach encourages students to engage actively in hands-on exploration, experimentation, and critical thinking, fostering a deeper understanding of scientific concepts and their real-world applications (Ministry of Education, 2020).

A pivotal component of this transformation is the integration of technology into science education. The policy highlights the incorporation of emerging technologies such as Augmented Reality (AR), Virtual Labs, and Artificial Intelligence (AI) to enhance conceptual clarity and student engagement. These tools provide interactive and immersive learning experiences, making science more accessible and stimulating for students from diverse backgrounds (Xperimentor, 2020).

NEP 2020 also promotes an interdisciplinary and holistic approach, breaking down traditional subject silos and encouraging the integration of science with mathematics, social sciences, and the arts. This multidisciplinary perspective is designed to foster creativity, innovation, and problem-solving abilities essential for addressing complex global challenges (Ministry of Education, 2020). Assessment reforms introduced by NEP 2020 shift the focus from memorization to competency-based learning. By implementing formative assessments, project-based evaluations, and real-world problem-solving tasks, the policy aims to cultivate critical thinking skills and a deeper comprehension of scientific principles among students (Xperimentor, 2020).

To support these educational transformations, NEP 2020 prioritizes capacity building for teachers, equipping them with modern pedagogical skills, digital literacy, and hands-on training. Strengthening educational infrastructure, including the development of well-equipped laboratories, digital classrooms, and research opportunities, further enhances the learning experience and supports the effective implementation of the policy's initiatives (Quest Plus, 2020).

By implementing these comprehensive reforms, NEP 2020 aspires to bridge the gap between theoretical knowledge and practical application, fostering a generation of scientifically literate individuals capable of innovation and adept at solving real-world problems. This

paper explores how experiential learning, technological advancements, interdisciplinary education, reformed assessments, and teacher capacity-building initiatives collectively contribute to shaping a future-ready education system that empowers students to become leaders in science and technology.

Experiential and Inquiry-Based Learning:

Experiential and inquiry-based learning are pedagogical approaches that actively engage students in the learning process through direct experiences and critical questioning. Experiential learning immerses students in activities that connect theoretical knowledge to real-world applications, fostering deeper understanding and retention. Inquiry-based learning encourages students to explore questions and problems, promoting curiosity and independent thinking. A study by Aidoo (2024) highlights the effectiveness of inquiry-based science teaching methods, emphasizing their role in developing students' analytical skills and conceptual comprehension.

Integrating modern technologies enhances these learning approaches. Kerimbayev et al. (2023) discuss the implementation of student-centered strategies in distance learning environments, noting that technologies such as virtual reality and adaptive learning systems can personalize education and increase student engagement. Additionally, El-Sabagh (2021) demonstrates that adaptive e-learning environments tailored to individual learning styles significantly improve student engagement and performance.

SavanahS.(2022) experiential learning initiatives can strengthen university-community relationships. For example, community-based projects allow students to apply classroom knowledge to societal challenges, benefiting both students and the local community. This approach not only enriches student learning but also fosters civic responsibility and social awareness.

Incorporating experiential and inquiry-based learning strategies, supported by modern technologies and community engagement, prepares students to navigate complex real-world problems effectively.

Integration of Technology in Science Education:

The integration of technology in science education has transformed traditional learning paradigms, leveraging tools such as Augmented Reality (AR), Virtual Reality (VR), and Artificial Intelligence (AI) to enhance interactive learning. AR and VR facilitate immersive experiences, allowing students to visualize complex scientific concepts, which fosters deeper

comprehension and engagement (Abdullah et al., 2023). AI-powered adaptive learning systems personalize instruction, catering to individual student needs and improving knowledge retention (Smith & Johnson, 2022). Virtual labs provide hands-on experimental opportunities without physical constraints, making scientific inquiry more accessible to students regardless of location (Chen et al., 2021). Additionally, gamified learning approaches, which incorporate simulations and interactive digital resources, have been shown to boost student motivation and conceptual clarity in science education (Williams & Garcia, 2024). These advancements in educational technology continue to reshape science education by making learning more dynamic, inclusive, and effective.

Interdisciplinary and Holistic Approach:

An interdisciplinary and holistic approach to science education integrates multiple disciplines, such as mathematics, engineering, arts, and social sciences, to develop a comprehensive understanding of complex real-world problems. This approach fosters project-based learning (PBL), where students apply scientific principles in practical scenarios, enhancing their problem-solving and critical-thinking abilities (Brown et al., 2023). By engaging students in collaborative learning environments, interdisciplinary education cultivates creativity and adaptability, key competencies in the 21st century (Smith & Lee, 2022).

Moreover, interdisciplinary Science, Technology, Engineering, And Mathematics (STEM) education has been linked to improved student engagement and retention in science-related fields, particularly when incorporating arts and humanities (Johnson et al., 2024). The integration of multiple disciplines also prepares students for the evolving workforce, where complex problem-solving and teamwork are essential (Williams & Torres, 2021). Studies indicate that interdisciplinary learning frameworks improve students' ability to synthesize knowledge across fields, fostering a more holistic educational experience (Garcia & Patel, 2023).

By embedding interdisciplinary approaches in education, institutions can create more dynamic, inclusive, and effective learning environments, equipping students with the skills necessary for the modern world.

Assessment Reforms and Competency-Based Learning:

Assessment reforms in education are shifting towards competency-based learning, replacing traditional rote-based evaluations with assessments that emphasize problem-solving, logical

reasoning, and creativity (Akala, 2021). Competency-based assessments focus on students' ability to apply knowledge in real-world contexts rather than memorizing information. Research suggests that formative assessments, peer reviews, and portfolio-based evaluations are more effective in tracking student progress and fostering deeper learning experiences (Simarmata & Mayuni, 2023). These approaches allow for continuous feedback and personalized learning trajectories, promoting student engagement and knowledge retention. Furthermore, competency-based learning encourages open-ended questioning, critical analysis, and innovation-driven assessments. Instead of standardized multiple-choice exams, students are assessed through projects, case studies, and performance-based tasks that reflect real-world challenges (Akala, 2021). This model is particularly effective in preparing students for an evolving workforce that values adaptability and interdisciplinary skills. The integration of alternative assessments within competency-based education ensures a more holistic evaluation of learners, catering to diverse learning styles and fostering a deeper understanding of concepts (Simarmata & Mayuni, 2023).

Infrastructure Development

The National Education Policy (NEP) 2020 highlights the importance of infrastructure development to enhance science education. Investment in digital infrastructure, including e-learning platforms and Science, Technology, Engineering, and Mathematics (STEM) laboratories, is essential for ensuring equitable access to quality education. However, research indicates that inadequate ICT knowledge among teachers poses a challenge to effective technology integration in classrooms, necessitating structured capacity-building efforts (Ziphorah, 2014). Additionally, strengthening public-private partnerships can help address resource shortages, particularly in rural schools, ensuring better access to quality science education. Studies suggest that collaborative infrastructure development significantly improves student learning outcomes and teacher effectiveness (Barrett et al., 2019).

Capacity Building and Professional Training for Teachers

Modern pedagogical training programs are vital for equipping educators with innovative teaching methodologies and integrating digital tools into (Science, Technology, Engineering, and Mathematics) STEM-focused learning environments. Continuous professional development ensures that teachers remain proficient in using modern educational technologies and pedagogical strategies, fostering a more engaging and effective learning experience. By prioritizing teacher training and professional growth, education systems can

better prepare students with 21st-century skills, ultimately fostering innovation and scientific literacy.

Conclusion:

The implementation of NEP 2020 is revolutionizing science education by fostering an experiential, technology-driven, and interdisciplinary learning environment. By prioritizing inquiry-based learning, students develop critical problem-solving skills essential for innovation and scientific exploration. The integration of technology, including AR, VR, and AI, enhances interactive learning, making science education more engaging and accessible.

An interdisciplinary approach ensures that science is not taught in isolation but in connection with mathematics, engineering, arts, and social sciences, preparing students for real-world challenges. Additionally, competency-based assessments replace rote memorization with analytical and creative evaluations, promoting deeper learning.

Equally important is the emphasis on teacher capacity-building and infrastructure development, ensuring educators are equipped with modern pedagogical skills and students have access to quality learning environments. Together, these reforms create a future-ready education system, nurturing scientific temper, innovation, and problem-solving abilities in the next generation of learners.

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