

NEP-2020 AND INTERDISCIPLINARY LEARNING IN SCIENCE AND TECHNOLOGY

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Abstract: *The National Education Policy 2020 (NEP-2020) questions the boundaries of disciplines and encourages multi-disciplinary and holistic learning, experiential learning. This paper considers the implications for science and technology education where there are complex problems that demand knowledge from several areas of science, mathematics, computing, engineering, environmental studies and the social sciences. The paper, based on a qualitative examination of the National Curriculum Framework for School Education 2023 (NEP-2020), the curriculum framework for undergraduate programmes of the University Grants Commission (UGC) and literature on active learning and integrated STEM education, examines curriculum, pedagogy, assessment and implementation. There is good convergence between NEP-2020 and the evidence that supports authentic problems, inquiry, design, collaboration and reflective integration. But implementation requires teacher training, assessment change, access to adequate laboratories and digital infrastructure and ways to maintain the rigor of the disciplines. It is suggested that a problem-centred approach should be used where disciplinary knowledge will remain central but be explicitly linked via projects, experiments, data, design and social context.*

Keywords: *NPC in science education and technology education, emphasizing that learning is an interdisciplinary process.*

INTRODUCTION

In the field of science and technology education, problems are becoming more non-disciplinary. In climate change, atmospheric science is coupled with biology, data analysis, engineering, economics and policy; public health is an integral part of life sciences and statistics; artificial intelligence is a blend of mathematics, computing, ethics and domain knowledge. Students may learn concepts but not be able to apply them in complex situations when curricula separate disciplines. The dilemma of this is solved by interdisciplinary learning where two or more disciplinary viewpoints are used and an explanation or a solution that is not fully provided by one discipline is created (Klein, 1990; Newell, 2001).

The concept is at the heart of the National Education Policy of 2020 for India. NEP-2020 aims for the elimination of “hard separations” between the arts, humanities and sciences, and the integration of critical thinking and experiential learning, flexibility and multidisciplinary institutions (Government of India, 2020). The National Curriculum Framework for School Education 2023 builds upon this orientation with a focus on competency-based learning, connecting ideas across the curricular areas, inquiry, experimentation and application (National Council of Educational Research and Training [NCERT], 2023). In the undergraduate level, the Curriculum and Credit Framework allow for flexibility in combining the major, minor, multi-disciplinary and skill-oriented learning (University Grants Commission [UGC], 2022).

Science and technology are particularly critical in the policy direction. Interdisciplinary education can relate scientific explanation with technological design, mathematical modelling, computation and environmental responsibility and human needs. But it is not possible simply to bring together topics or give group projects. Effective integration needs good disciplinary foundations, purposeful connections, explicit synthesis and assessment of disciplinary knowledge and the quality of its integration (Boix Mansilla & Duraisingh, 2007; Repko & Szostak, 2021). This paper examines the role of NEP-2020 to facilitate meaningful interdisciplinary learning, pedagogical models that support its objectives and conditions that enable the achievement of quality and equity.

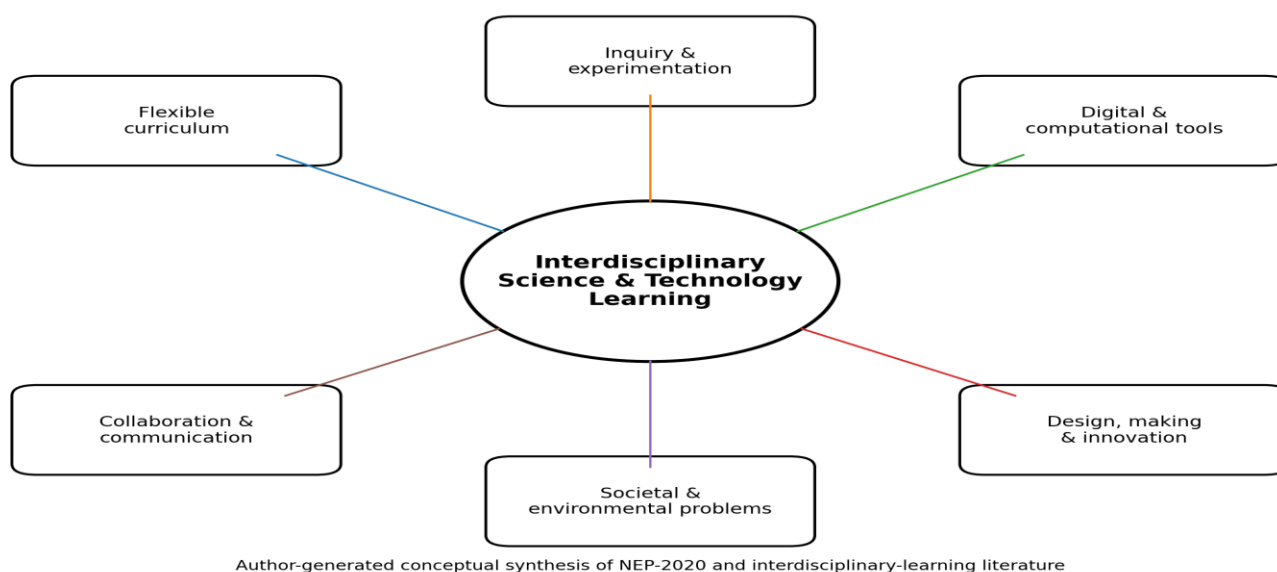
Conceptual and Theoretical Foundations

Interdisciplinarity refers to more than the coexistence of different subjects. Klein (1990) describes it as “interaction across disciplines” and Newell (2001) says “interdisciplinary inquiry is required when a problem is simply too complicated for any one disciplinary perspective to handle. In education the core business is integration: students must grasp the ideas of the different disciplines they learn and then relate them to one another to create a more integrated picture. Boix Mansilla and Duraisingh (2007) also highlight the importance of disciplinary foundations, development of knowledge and the synthesis of ideas as integral parts of effective interdisciplinary practice.

Exp. learning is supported by this view. Kolb (1984) suggests that learning takes place through four steps: concrete experience, reflection, conceptualization and active experimentation. A learner can observe a phenomenon, ask questions, collect evidence, use concepts, test a model and interpret conclusions in science and technology. This focus is supported by research on active learning: Prince (2004) found that there were significant improvements in engineering education, and Freeman et al. (2014) showed that performance in science, technology, engineering and mathematics courses was better than in traditional lectures.

Integrated STEM research also views science, technology, engineering and mathematics as interrelated disciplines. Honey et al. (2014) suggest that integration is best implemented when there are intentional links, and clear learning outcomes. Kelley and Knowles (2016) highlight situated learning, engineering design, inquiry, technological literacy and mathematical thinking. These types of models are suitable for NEP-2020 because the disciplinary knowledge is preserved and its application is manifested in actual tasks.

Figure 1. Conceptual ecosystem for interdisciplinary science and technology learning under NEP-2020



Methodology

Qualitative narrative reviews and policy analysis are used in this paper. The core documents are NEP-2020, National Curriculum Framework for School Education 2023 and the UGC Curriculum and Credit Framework for Undergraduate Programmes, which are supported by research on interdisciplinarity, active learning, experiential learning and integrated STEM. Policy framing, learning process, pedagogical organisation, specific competences and barriers to implementation were analysed.

Figure 3 was created using simple thematic coding. The paper reviewed 14 policy and research sources and identified which ones included meaningful attention to seven themes: problem solving or inquiry, transdisciplinary integration, experiential/active learning, collaboration, the societal or sustainability context, the use of digital or computational tools, and communication or reflection. The counts are NOT statistics, or population estimates but indicators of convergence in the literature reviewed in this purposive literature set.

NEP-2020 as Policy Framework for Interdisciplinary Learning

NEP-2020's biggest impact is its defiance of the fixed division of the curriculum. The policy states that education shall be holistic and multidisciplinary, and the student to be able to integrate sciences, mathematics, arts, humanities and vocational learning in a manner that will facilitate the students' interests and emerging needs (Government of India, 2020). In science and technology, this allows for courses and projects that bridge conceptual, computational, communication and the social aspects of science and technology. A renewable-energy project might be undertaken in a discipline other than energy physics, such as mathematical modelling, electronics or environmental studies and cost analysis, but not only in one textbook chapter.

Inquiry, discovery, discussion, analysis and experiential learning are also key features of the policy. These processes are important because when learning is interdisciplinary, there needs to be a reason for learning to connect the pieces of knowledge. That's what a complex problem provides. Students could learn the facts in parallel, or they could research local water quality, build heat, assistive devices and/or air pollution data and use these facts as tools. This is a strategy that reflects the National Research Council's focus on scientific practices, crosscutting concepts and core ideas (NRC, 2012).

In the higher education sector, flexible credit systems can be used to offer a variety of major and minor study options or multidisciplinary study (UGC, 2022). It applies to disciplines like bioinformatics, materials engineering, and digital health and the environment. Shared laboratories, foundation courses and team-taught modules can also be established at the institutional level. Yet, curricular choice is not sufficient to ensure integration; students require the structures to promote connections between learning across courses (Lattuca et al., 2004).

Table 1: Selected NEP-2020-aligned provisions and implications for science and technology learning

Policy direction	Interdisciplinary implication	Key source
Removal of hard separations	Allows science, mathematics, technology, arts and vocational areas to connect around common questions.	Government of India, 2020
Experiential and inquiry-oriented learning	Supports investigations, fieldwork, experimentation, making and problem solving instead of recall-only instruction.	Government of India, 2020; NCERT, 2023
Flexible subject and credit choices	Enables combinations of majors, minors, electives and multidisciplinary courses in emerging fields.	UGC, 2022
Competency-based assessment	Creates space to assess application, reasoning, design, communication and integration in addition to factual knowledge.	NCERT, 2023
Technology integration	Makes data, simulation, coding, digital fabrication and blend potential learning connectors across disciplines.	Government of India, 2020

Note. Synthesized from the policy and research literature cited in the text.

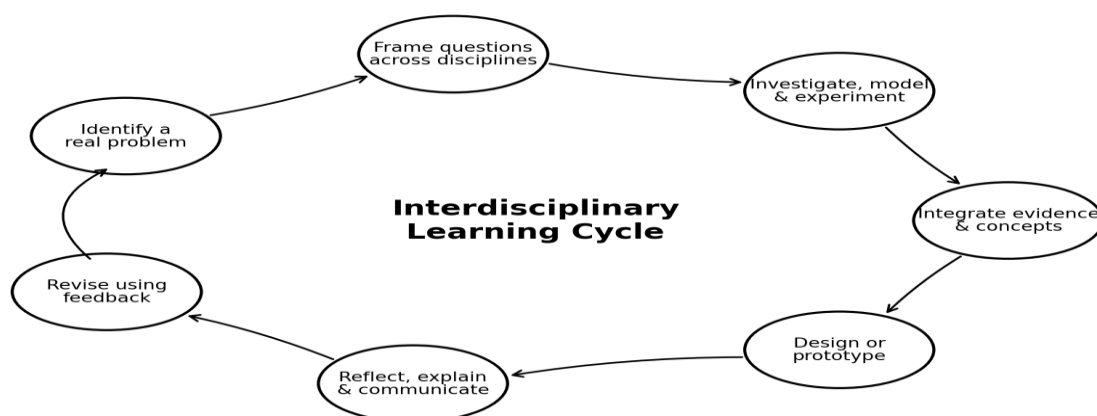
Pedagogical Models for Interdisciplinary Science and Technology

PBL and PBL provide a practical link between policy and practice. Students start with a complex question, determine what they need to know, explore evidence and create a model, explanation or presentation. This allows students to make connections between disciplines explicit, since learners are required to determine when and where scientific ideas, mathematical tools, technological methods or social evidence are relevant. Thus, teachers create spaces where the content and the learning of the discipline are activated for a common objective, not only as parallel sequences.

Design-based learning is particularly beneficial in the context of technology. Engineering design is a process that challenges students to clearly identify a problem, establish constraints, brainstorm possible solutions, create prototypical models, test and then refine. Science is about understanding and explanation, and engineering is about working solutions within constraints (National Research Council, 2012). For instance, a water purification project might involve chemistry for contaminants, physics for flow, mathematics for efficiency and engineering for device improvement and social inquiry for making the project affordable.

Computational thinking can also be a way to link disciplines. Data collection, coding, modeling and visualization enable students to explore phenomena in biology, physics, geography and social science. Although technology should not be limited to hardware—students should explore tools' design, production of data, assumptions embedded in models, and ethical implications of technology decisions. This wider perspective bridges innovation and responsibility in the NEP-2020 framework.

Figure 2. A problem-centred interdisciplinary learning cycle for science and technology.



A problem-centred cycle linking scientific inquiry, technological design, integration and reflection

Table 2: Pedagogical models for interdisciplinary science and technology learning

Model	Typical learning structure	Capabilities developed
Problem-based inquiry	A complex question requiring evidence from several fields.	Reasoning, research planning, integration, explanation
Project-based learning	Extended investigation resulting in a product, model or presentation.	Application, collaboration, communication, project management
Design-based learning	Iterative design, prototyping, testing and revision.	Engineering thinking, creativity, trade-off analysis
Data/computational investigation	Use of datasets, coding, simulation or modelling across domains.	Quantitative reasoning, computational thinking, interpretation
Community/sustainability challenge	Local environmental, health or infrastructure problems linked to field evidence.	Systems thinking, civic relevance, ethical judgement

Note. Synthesized from the policy and research literature cited in the text.

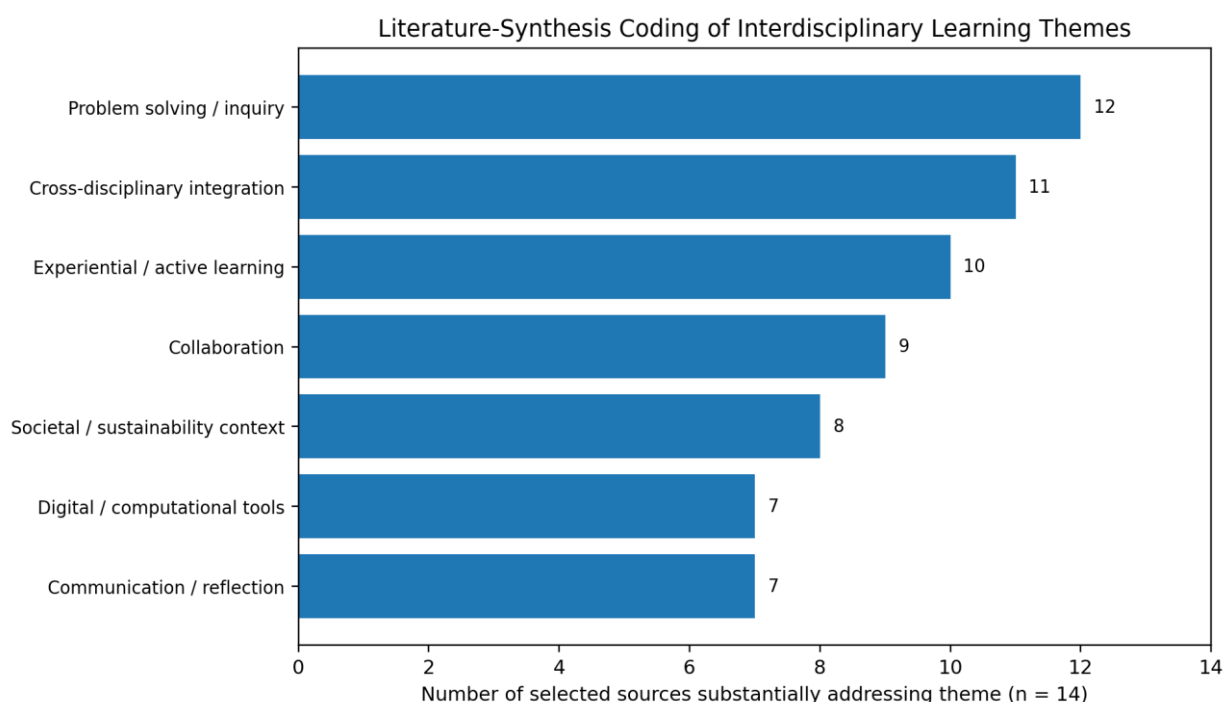
Evaluation and maintaining Disciplinary Rigour.

A common objection to interdisciplinary education is that breadth can be a substitute to depth. This danger is possible in case of integration in advance of students having adequate disciplinary knowledge. Interdisciplinary curriculum must then take the form of what can be termed as disciplined integration: students need to know what and how they are integrating, why each viewpoint is important and where varying standards of evidence exist. According to Boix Mansilla and Duraisingh (2007), assessment must be done to look at the disciplinary grounding, quality of integration and progress of understanding. This offers a practical guideline to NEP-2020 implementation.

It should not only be the final product that is assessed. Scientific accuracy, mathematical reasoning, data quality, technological design, trade-off justification, collaboration and reflective explanation can be individually evaluated with interdisciplinary tasks. Rubrics do not allow a pretty prototype to conceal poor science and do not allow a good grasp of the subject to be lost behind a plain design. An individual understanding can be shown by oral questioning, notebooks and reflective commentaries. The NCF competency-based assessment provides room to such evidence (NCERT, 2023).

Figure 3. Thematic emphasis across the selected policy and research literature.

Note. Author coding of 14 sources; counts indicate substantial thematic attention and are not population statistics.



Environmental and Social Challenges in its implementation in India

One of the key challenges is organizational. Timetables, departments, textbooks and examinations are typically content driven, which means teachers may be able to support interdisciplinary but may not have planning time together. Faster credits may be offered by universities without connecting courses. As pointed out by Lattuca et al. (2004), interdisciplinary learning requires curriculum, pedagogy and institutional context; changes in only one of these, are not enough.

But teacher preparation is also critical. To undertake interdisciplinary teaching, the teacher does not have to have competence in all disciplines, but he/she must have confidence in collaboration, investigating design, project facilitation, and assessment of integrating. Professional development should mirror these practices in co-creating unit design and co-developing disciplinary outcomes and co-moderating student work. Communities of practice can facilitate specialists' ability to retain depth while also learning to make useful connections.

An equity issue arises with infrastructure because interdisciplinary science and technology is typically linked with high-cost laboratories, robotics, or advanced computing. A layered approach is fairer: Advanced technology can enhance learning but does not need to be a prerequisite. Low-cost materials, school environments, mobile sensors, and open datasets and shared community resources can be used in strong projects. Virtual laboratories can be used in support of physical experiments, but not to the exclusion of physical experiments where material behaviour or uncertainty lies to the core.

Assessment systems can limit change. When exams are high stakes, and the exam content is largely separate, teaching and learning are not likely to be geared toward complicated projects. Interdisciplinary learning should then be aligned to questions, practical work, portfolios and capstone tasks that consider application, unfamiliar contexts and extended reasoning in relation to competency.

Table 3: Implementation risks and practical responses

Challenge	Likely effect	Policy/practice response
Rigid timetables and departmental silos	Little shared planning; interdisciplinary tasks become add-ons.	Protected co-planning time; common project weeks; team teaching where feasible.
Teacher confidence and workload	Superficial integration or overreliance on one subject.	Collaborative professional development; exemplar units; moderation of student work.
Unequal laboratory/digital access	Resource-rich institutions gain disproportionate benefits.	Low-cost inquiry kits; shared labs; open-source tools; community and mobile resources.
Subject-dominated examinations	Students prioritise recall over integration.	Competency-based questions; portfolios; practical and project components.
Risk of reduced disciplinary depth	Projects become broad but conceptually weak.	Explicit disciplinary learning goals plus rubrics for both depth and integration.

Note. Synthesized from the policy and research literature cited in the text.

Discussion

The literature reviewed indicates that the interpretation of NEP-2020 as a call to dissolve disciplines and their relations is the weakest, but the deliberate connection is the strongest. While disciplines offer concepts, methods and standards of evidence, and interdisciplinarity enhances the material when concepts, methods and standards are related around a problem that truly requires more than one perspective. This separation is useful to prevent the usual fragmentation and the superficial thematic projects which lack intellectual synthesis.

There are three levels in balanced architecture. Students must have discipline in science, mathematics and technology before they can learn about their integration. Recurring connectors should then be selected from the curricula, including systems, modelling, evidence, optimization, sustainability and uncertainty. Last, learners must be repeatedly exposed to authentic problems that demand integration, moving from scaffolded to capstone investigations and independent projects.

This layout illustrates the current way of producing knowledge, in which research and engineering groups are composed of specialists with varying skills. Learners must thus question in subject areas, discuss between methodologies, and explain the incorporation of evidence. Repko and Szostak (2021) emphasize that integration is not a natural result of group work but must be taught as a comparison and a synthesis.

The policy window is big. NEP-2020 can transform the science and technology education pedagogy from delivery driven by coverage to conceptually challenging and socially relevant science and technology education. However, policy needs to be translated into curriculum resources, professional learning, assessment rubrics, equitable infrastructure and workable schedules. These supports are crucial for implementing interdisciplinarity, or otherwise it can never become a norm.

Recommendations

1. Create interdisciplinary units to address real world problems instead of content areas. Disciplinary concepts to be learned should be identified by each unit as well as the reason why the discipline is integrated and what is the final evidence of learning.
2. Develop progression for grades and programmes. There can be guided links between two subjects at the beginning of tasks and subsequent tasks may require independent linking, designing and evaluation in a few subject areas.
3. Build teacher collaboration as infrastructure. This is to be understood as a requirement for implementing timetabled co-planning, not a nice-to-have. Implementation of interdisciplinary professional development and shared moderation should not be regarded as a nice-to-have, but as a requirement of implementation.
4. Apply assessment rubrics that assess four distinct components: disciplinary accuracy, integration, inquiry/design process, evidence, communication and reflection. This safeguards rigor while encouraging synthesis.
5. Use an equity-based resource system. Interdisciplinary learning needs are not dependent on high-end equipment, as low-cost experimental materials and open datasets, as well as shared laboratories and virtual tools should ensure this learning.
6. Link projects to local and national priorities such as water, energy, agriculture, health, climate resilience and accessibility. Contextualization can motivate and highlight the role of science and technology in society.
7. Establish links with universities, research centres, industry and community groups, while maintaining complementary links that enhance curriculum objectives, not supplant curriculum decision making by teachers.

Conclusion

The NEP-2020 offers robust policy support for interdisciplinary learning in science and technology, where it advocates flexibility, learning through experiences, building competency and eliminating the rigidity of curricular separations. The underlying educational logic of the research on interdisciplinarity, integrated STEM, and active learning is that students learn more meaningfully when the ideas from these disciplines are applied, compared and integrated in authentic contexts (Freeman et al., 2014; Honey et al., 2014; Kelley & Knowles, 2016). However, integration in education is not beneficial unless it retains the depth of the disciplines and makes the synthesis explicit.

The best model is neither all subject-based nor all themed. Students must acquire a solid scientific and mathematical base, have access to technological and computational tools, and have multiple problem-centered learning experiences that involve integration. Assessment should celebrate the process of reasoning, synthesis, design and reflection as well as the accuracy of the content. Teamwork of teachers, equitable resources and institutional flexibility are key. Under such circumstances, NEP-2020 can make science and technology education a coherent space where learners learn science concepts, but also integrate and apply them to investigate, design, communicate and act responsibly in complex world.

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