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Knowledge Co-Creation in Teacher Education: Multidisciplinary Perspectives and Emerging Models

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Abstract

National Education Policy (NEP) 2020 calls for a fundamental reorientation of teacher education to respond to the intellectual, social, and technological complexities of the twenty-first century. Central to this reorientation is the move toward multidisciplinary learning, integration of digital and computational competencies, and the preparation of reflective, inquiry-oriented teachers capable of working across science, humanities, and social domains. Teacher education in the twenty-first century faces the challenge of preparing educators who can navigate complex, interconnected societal, scientific, and humanistic domains. Traditional disciplinary silos have often constrained the integration of knowledge, limiting teachers' capacity for adaptive, reflective, and socially responsive practice. This paper explores multidisciplinary approaches to knowledge co-creation in teacher education, emphasizing the integration of scientific, social, and humanistic perspectives. Drawing on scholarship from the learning sciences, computational thinking, and teacher professionalism, the paper argues that collaborative, inquiry-driven, and practice-informed frameworks enhance teachers' epistemic and pedagogical capabilities. The analysis situates these approaches within the Indian policy context, highlighting alignment with National Education Policy (NEP) 2020 and recent NCTE reforms, which emphasize interdisciplinary curricula, reflective practice, and holistic teacher preparation. The paper concludes with implications for curriculum design, institutional policy, and professional development, advocating a shift from

isolated disciplinary knowledge toward synergistic, co-constructed learning that equips teachers to address contemporary educational and societal challenges.

Keywords: teacher education, multidisciplinary learning, knowledge co-creation, interdisciplinarity, NEP 2020, NCTE, reflective practice

Introduction

Teacher education stands at a critical juncture in the twenty-first century, shaped by rapid technological transformations, escalating societal complexity, and the growing interdependence of scientific, social, and humanistic forms of knowledge. Advances in digital technologies, data-driven decision-making, and artificial intelligence are fundamentally altering how knowledge is produced, represented, and circulated across domains (Selwyn, 2019; UNESCO, 2021). Simultaneously, societies worldwide face complex and interlinked challenges such as climate change, public health crises, digital citizenship, social inequality, and ethical governance. These issues transcend traditional disciplinary boundaries and demand integrative ways of knowing that combine scientific evidence, social analysis, and humanistic interpretation (National Research Council, 2012; Klein, 2017). Teachers, as key mediators between knowledge and learners, must therefore be prepared to engage with complexity, uncertainty, and interdisciplinarity in ways that conventional subject-bound pedagogies often fail to support. In this context, India's National Education Policy (NEP) 2020 articulates a transformative vision for education in general and teacher education in particular. The policy emphasizes holistic and multidisciplinary education, conceptual understanding over rote learning, digital and technological competence, and the preparation of reflective and research-oriented teachers (National Education Policy [NEP], 2020). NEP 2020 positions teachers not merely as implementers of prescribed curricula, but as intellectual professionals capable of designing meaningful learning experiences, integrating knowledge across domains, and responding to diverse learner needs. The policy's emphasis on interdisciplinary learning, experiential pedagogy, and the ethical use of technology signals a decisive shift from transmission-oriented models of teacher preparation toward more dynamic and epistemically grounded approaches.

Despite repeated policy interventions and regulatory reforms, teacher education in India has historically been characterized by rigid disciplinary silos, fragmented curricula, and limited engagement with authentic knowledge practices (Kumar, 2018; MHRD, 2019). Science, humanities, and social sciences have largely been treated as discrete curricular territories, each governed by its own pedagogical conventions, assessment practices, and epistemological

assumptions. Teacher preparation programs have often prioritized coverage of theoretical content and examination-oriented learning over inquiry, application, and reflective engagement with knowledge (Darling-Hammond, 2006; Zeichner, 2010). As a result, many prospective teachers graduate with compartmentalized understandings of subject matter and limited capacity to design learning experiences that reflect the interconnected and contextual nature of real-world problems. NEP 2020 explicitly challenges this legacy by advocating integrated and multidisciplinary teacher education programs, including four-year integrated B.Ed. models and strengthened postgraduate pathways. It calls for pedagogies that foster critical thinking, inquiry-based learning, and the application of knowledge across disciplinary boundaries (NEP, 2020). However, while the policy clearly articulates what teacher education should achieve, it offers limited guidance on how knowledge should be represented and engaged with pedagogically to enable genuine interdisciplinarity. This raises a central yet underexplored question: how can teacher education reconceptualize knowledge representation in ways that support integrative thinking across science, humanities, and social domains?

NEP 2020 and the Transformation of Teacher Education

NEP 2020 identifies teachers as the “heart of the education system” and calls for systemic reforms in teacher preparation. Key policy directions include:

Transition to multidisciplinary and integrated teacher education programs

Emphasis on foundational literacy and numeracy

Integration of technology in teaching and teacher education

Strengthening research orientation and reflective practice

Continuous professional development through digital platforms

The policy explicitly advocates moving beyond rote learning toward conceptual understanding, critical thinking, and application of knowledge in real-life contexts (NEP, 2020). This requires teachers who can work across disciplinary boundaries and engage learners with complex social and scientific issues.

NCTE Regulations and the Structural Conditions of Teacher Education Reform

While the National Education Policy (NEP) 2020 articulates a bold and future-oriented vision for transforming teacher education in India, the realization of this vision is necessarily mediated by the regulatory architecture of the National Council for Teacher Education (NCTE). As the statutory body responsible for the recognition, regulation, and quality assurance of teacher education institutions, the NCTE plays a decisive role in shaping curricular structures, program duration, practicum requirements, faculty norms, and academic workloads. Consequently, any attempt to recast knowledge across scientific, social, and

humanistic domains within teacher education must be examined in relation to the enabling and constraining conditions established by NCTE regulations. The NCTE Regulations, 2014 marked a significant moment in the professionalization of teacher education in India. By extending the Bachelor of Education (B.Ed.) program from one year to two years, the regulations sought to deepen pedagogical engagement, strengthen school-based practicum, and enhance the reflective and research- oriented dimensions of teacher preparation (National Council for Teacher Education [NCTE], 2014). The revised framework emphasized prolonged internships, reflective journals, engagement with contemporary issues in education, and exposure to inclusive and ICT-enabled pedagogies. These reforms aligned with global trends that recognize teaching as a complex professional practice requiring sustained clinical experience and theoretical grounding (Darling-Hammond, 2006).

However, despite these advances, the curricular logic underpinning the 2014 Regulations largely retained disciplinary compartmentalization. Courses in science education, social science education, foundations of education, and pedagogy continued to be organized as discrete units, with limited structural mechanisms for sustained interdisciplinary engagement. Technology-related components were often positioned as standalone courses or add-ons, rather than as epistemic tools integrated across subject domains. As a result, opportunities for pre- service teachers to engage with knowledge in integrative, model-based, or computationally mediated ways remained constrained by regulatory templates that privileged content segmentation over epistemic coherence (Kumar, 2018). NEP 2020 explicitly critiques this fragmentation and calls for a reconceptualization of teacher education as a multidisciplinary, research-informed, and institutionally embedded enterprise. The policy advocates locating teacher education programs within multidisciplinary higher education institutions, enabling stronger integration of science, humanities, and social sciences, as well as closer engagement with research and innovation ecosystems (National Education Policy [NEP], 2020). Importantly, NEP 2020 emphasizes that teachers must be prepared not only to teach subjects, but to facilitate interdisciplinary learning, critical inquiry, and the ethical use of digital technologies—capacities that cannot emerge from structurally siloed curricula alone.

In response to this policy direction, recent NCTE initiatives—most notably the introduction of the four-year Integrated Teacher Education Programme (ITEP)—represent an important regulatory shift. The ITEP seeks to integrate disciplinary knowledge, pedagogical training, and school experience within a single coherent program, thereby addressing long-standing concerns about fragmentation between subject mastery and professional preparation (NCTE,

2021). By situating teacher education within multidisciplinary institutions, the ITEP creates new structural possibilities for curricular integration across science, humanities, and social domains. NCTE guidelines require standalone teacher education institutions (TEIs) to transition into multidisciplinary higher education institutions (HEIs) by a specified timeline (e.g., 2030). This requirement means TEIs offering only B.Ed./M.Ed. programs must expand their offerings (e.g., BA, BSc, BCom) or merge with existing HEIs to qualify for recognition under the new regulatory dispensation. Such mandates align with policy directions that aim to break down rigid disciplinary silos and embed teacher education within broader academic contexts.

The success of these regulatory reforms depends not only on structural redesign but also on deeper epistemic transformation—specifically, on how knowledge is represented, engaged with, and mobilized within teacher education curricula. Without rethinking epistemic tools and pedagogical representations, multidisciplinary structures risk reproducing disciplinary silos under new institutional arrangements. Computational representations offer a powerful means to address this challenge by providing shared epistemic tools—such as models, simulations, and data visualizations—that cut across disciplinary boundaries and enable integrative reasoning. In this sense, aligning NCTE regulations with NEP 2020 requires not only curricular integration at the program level, but also a reconceptualization of the forms of knowledge and modes of inquiry that teacher education legitimizes and prioritizes.

Reconceptualization of the forms of knowledge and modes of inquiry in Teacher Education
Teacher education is fundamentally concerned with legitimizing particular forms of knowledge and cultivating specific modes of inquiry that shape how teachers understand teaching, learning, and their professional role. Traditionally, teacher education programs—both in India and globally—have privileged stable disciplinary content, propositional knowledge, and transmission-oriented pedagogies. However, the accelerating pace of technological change, the increasing complexity of social problems, and the growing interdependence of scientific, social, and humanistic knowledge demand a profound rethinking of what counts as valid knowledge and how inquiry is conducted in teacher education. In India, this epistemic challenge has acquired renewed urgency in the wake of the National Education Policy (NEP) 2020 and ongoing regulatory reforms led by the National Council for Teacher Education (NCTE). NEP 2020 calls for a decisive shift toward multidisciplinary education, conceptual

understanding, critical thinking, and reflective practice. These policy aspirations cannot be realized through structural reforms alone; they require a deeper epistemic transformation in teacher education—one that reconceptualizes the forms of knowledge teacher education legitimizes and the modes of inquiry it prioritizes. This essay argues that teacher education must move beyond narrow disciplinary and transmissive conceptions of knowledge toward integrative, practice-oriented, and inquiry-driven epistemologies. Such a reconceptualization is essential for preparing teachers who can engage meaningfully with complex societal challenges and support holistic learning across science, humanities, and social domains.

Traditional Knowledge Hierarchies in Teacher Education

Historically, teacher education has been organized around a hierarchical conception of knowledge in which disciplinary content knowledge is treated as primary, pedagogical knowledge as derivative, and experiential or contextual knowledge as secondary (Shulman, 1987). In the Indian context, this hierarchy has been reinforced by examination-oriented schooling, rigid subject boundaries, and regulatory frameworks that emphasize course completion and content coverage (Kumar, 2018). As a result, teacher education programs have often privileged theoretical exposition over inquiry, reflection, and knowledge construction.

Shulman's (1987) foundational work on teacher knowledge highlighted the prominence of content knowledge in traditional teacher education. Disciplinary mastery has historically been treated as the most legitimate form of professional preparation, with pedagogical knowledge framed as a derivative application of content expertise. In India, this orientation has been mirrored in curriculum design and assessment practices, where examinations prioritize factual recall and subject-specific problem-solving over reflection or applied understanding (Kumar, 2018). Pedagogical knowledge, which includes understanding of learning processes, classroom management, and instructional strategies, has often been subordinated to disciplinary expertise. Similarly, experiential knowledge—gained through practicum, school internships, and engagement with local contexts—has frequently been treated as supplementary rather than central to teacher learning (Darling-Hammond, 2006). These arrangements reinforce a static, decontextualized conception of knowledge, limiting teachers' capacity to adapt theory to practice or respond effectively to diverse learners and educational challenges.

The hierarchical privileging of content over practice constrains the development of reflective and inquiry-oriented teachers. When inquiry is present, it is frequently confined to formal research methodology courses rather than embedded throughout the curriculum. This limits

opportunities for pre-service teachers to integrate knowledge across domains, engage with authentic educational problems, or develop critical and adaptive reasoning skills (Darling-Hammond, 2006; Shulman, 1987). Consequently, teacher education programs risk producing professionals who are technically competent in subject matter but insufficiently prepared to navigate the complex, dynamic realities of contemporary classrooms.

Reconceptualizing Forms of Knowledge

Reconceptualizing knowledge in teacher education involves moving beyond traditional hierarchies that privilege disciplinary content to recognize and legitimize multiple, interrelated forms of knowing. Effective teacher preparation requires integrating procedural, epistemic, contextual, and ethical knowledge, enabling teachers to navigate the complexity of contemporary classrooms and societal challenges.

Procedural knowledge refers to understanding the processes by which knowledge is generated, validated, and revised within and across disciplines (diSessa, 2000). For teachers, this involves recognizing how scientific models are developed, how historical narratives are constructed, or how social phenomena are analyzed, and translating these processes into teachable experiences. Procedural knowledge equips teachers to guide students in inquiry-based learning, experimentation, and evidence-based reasoning.

Epistemic knowledge emphasizes awareness of the assumptions, limitations, and values underlying different knowledge claims. It encourages critical reflection on what counts as valid knowledge, how knowledge is justified, and the cultural or disciplinary frameworks that shape understanding (Cochran-Smith & Lytle, 2009; diSessa, 2000). In teacher education, cultivating epistemic knowledge helps pre-service teachers question biases, evaluate sources critically, and engage in reasoned debate across disciplinary perspectives.

Contextual knowledge situates learning within local cultures, languages, communities, and social realities. NEP 2020 underscores the importance of integrating Indian knowledge systems and contextually relevant pedagogies alongside global frameworks, emphasizing that effective teaching is inseparable from the sociocultural context of learners (National Education Policy [NEP], 2020). For example, understanding local environmental practices or social norms can enhance science education, social studies instruction, and ethical reasoning.

Ethical knowledge involves sensitivity to issues of equity, inclusion, and social justice. Teachers are positioned as agents of democratic citizenship, and ethical reasoning informs curriculum choices, classroom interactions, and engagement with diverse learners (UNESCO, 2021). Recognizing systemic inequalities, designing inclusive learning activities, and fostering empathy are all practices rooted in ethical knowledge.

By legitimizing these diverse forms of knowledge, teacher education can move toward a dynamic and integrative epistemology, where disciplinary expertise, inquiry, and ethical reasoning coalesce to prepare teachers capable of adaptive, reflective, and socially responsive practice. Such reconceptualization aligns with NEP 2020's vision of holistic, multidisciplinary teacher education, positioning teachers not merely as transmitters of content but as facilitators of knowledge co-construction across scientific, social, and humanistic domains.

Shifting Modes of Inquiry in Teacher Education

Alongside reconceptualizing knowledge forms, teacher education must also transform the modes of inquiry it prioritizes. Traditional modes of inquiry in teacher education have often been limited to textual analysis, lectures, and summative assessments. While these remain important, they are insufficient for preparing teachers to engage with complex, interdisciplinary problems. Inquiry-oriented teacher education emphasizes problem-based learning, design-based research, reflective practice, and collaborative inquiry (Zeichner, 2010). These modes of inquiry position teachers as active knowledge constructors who investigate educational problems, test pedagogical strategies, and reflect critically on outcomes. Such approaches align with NEP 2020's emphasis on experiential learning, formative assessment, and continuous professional development. Importantly, inquiry in teacher education must extend beyond methodological training to become a pervasive pedagogical stance. When inquiry is embedded across courses—science education, social science education, educational foundations, and practicum—it supports coherence and integration across domains.

Emerging forms of computational and representational inquiry offer powerful opportunities to support epistemic transformation in teacher education. Computational representations—such as simulations, models, and data visualizations—enable teachers to explore complex systems, examine relationships, and test hypotheses across disciplinary boundaries (Wing, 2006; Weintrop et al., 2016). These tools support systemic and evidence-based reasoning in both scientific and social domains. In teacher education, computational modes of inquiry can help bridge quantitative and qualitative traditions, enabling teachers to integrate data analysis with contextual interpretation and ethical reflection. Importantly, engaging with computational representations does not require teachers to become technologists; rather, it supports epistemic fluency—the ability to work with multiple representations of knowledge and to select appropriate modes of inquiry for different educational purposes (Mishra & Koehler, 2006).

Policy Imperatives for Epistemic Transformation

NEP 2020 explicitly challenges traditional knowledge hierarchies by emphasizing holistic and multidisciplinary education, experiential learning, and critical inquiry. The policy envisions teachers as reflective practitioners, curriculum designers, and facilitators of learning rather than mere transmitters of content (National Education Policy [NEP], 2020). It calls for integrating sciences, social sciences, humanities, and vocational knowledge, while also foregrounding ethical reasoning, constitutional values, and digital literacy.

Parallel regulatory developments, including NCTE's move toward integrated teacher education programs such as the four-year Integrated Teacher Education Programme (ITEP), create structural conditions for epistemic change (National Council for Teacher Education [NCTE], 2021). However, as several scholars argue, multidisciplinary structures alone do not guarantee epistemic integration (Klein, 2017). Without rethinking the forms of knowledge that are legitimized and the modes of inquiry that are prioritized, reforms risk reproducing disciplinary silos within new institutional arrangements. To translate this vision into practice, several interrelated recommendations are offered for strengthening multidisciplinary in teacher education and enhancing the quality of professional teacher preparation.

First, teacher education curricula need be revisited around interdisciplinary themes and problems rather than isolated subjects. Core societal challenges—such as environmental sustainability, public health, digital citizenship, equity, and constitutional values—should serve as organizing frameworks through which scientific, social, and humanistic perspectives are integrated. This approach aligns with NEP 2020's emphasis on holistic education and enables prospective teachers to experience knowledge as interconnected and socially situated. Multidisciplinary coursework should be complemented by integrative assessments that value synthesis, inquiry, and reflective reasoning over rote recall.

Second, pedagogical practices within teacher education programs must explicitly model interdisciplinary inquiry. Teacher educators should adopt pedagogies such as problem-based learning, design-based projects, collaborative inquiry, and case-based analysis that cut across disciplinary boundaries. Computational representations, data-informed inquiry, and reflective narratives can function as shared epistemic tools across science, humanities, and social sciences, supporting systemic thinking and evidence-based reasoning. Embedding these approaches across pedagogy courses, practicum, and research components can help prospective teachers internalize multidisciplinary ways of thinking and teaching.

Third, institutional structures and faculty development must be aligned with multidisciplinary goals. Multidisciplinary cannot be sustained if teacher education institutions remain

organizationally fragmented. In line with NEP 2020 and recent NCTE reforms, teacher education programs should be embedded within multidisciplinary higher education institutions that facilitate collaboration among faculty from sciences, social sciences, humanities, and education. Equally important is sustained professional development for teacher educators, focusing on interdisciplinary curriculum design, inquiry-oriented pedagogy, and the ethical use of digital and computational tools.

Fourth, regulatory and quality assurance frameworks should move beyond compliance-driven metrics toward indicators that capture epistemic integration and professional learning. While NCTE regulations play a critical role in ensuring minimum standards, they should also encourage innovation in curriculum design, interdisciplinary teaching, and reflective practice. Accreditation and review processes could explicitly recognize integrative coursework, interdisciplinary practicum experiences, and teacher inquiry as markers of quality professional preparation.

Finally, teacher professionalism must be reimagined as an ongoing, inquiry-based, and socially embedded practice. Multidisciplinary teacher education should cultivate dispositions of lifelong learning, ethical judgment, and civic responsibility. Teachers prepared within such frameworks are more likely to view themselves as curriculum designers and knowledge co-creators, capable of engaging learners with complex real-world issues and contributing to democratic and inclusive education systems.

From the perspective of NEP 2020, this epistemic orientation directly supports the policy's emphasis on teacher autonomy, reflective practice, and continuous professional development. The policy envisions teachers as lifelong learners who engage in ongoing inquiry into their own practice, collaborate within professional learning communities, and update their knowledge in response to evolving educational and societal demands (National Education Policy [NEP], 2020). Teachers prepared to work with diverse forms of knowledge—empirical, interpretive, computational, and ethical—are more likely to view professional development not as episodic training but as sustained intellectual engagement. Such dispositions align with contemporary models of teacher professionalism that foreground inquiry, evidence-based decision-making, and professional agency (Cochran-Smith & Lytle, 2009). Moreover,

legitimizing diverse forms of knowledge and inquiry contributes to a more democratic and inclusive conception of teacher professionalism. Epistemic frameworks that value contextual judgment recognize teachers as knowledgeable actors who draw on local cultures, learners' lived experiences, and ethical considerations in shaping pedagogy. This recognition is

especially significant in culturally and socially diverse contexts such as India, where teachers must negotiate multiple languages, knowledge traditions, and social realities.

Ethical responsibility is also central to this reconceptualized professionalism. As teachers increasingly engage with data, digital technologies, and computational representations, questions of equity, inclusion, and ethical use of knowledge become integral to professional practice. Preparing teachers to critically examine the assumptions embedded in representations, algorithms, and curricular materials strengthens their capacity to act as ethical stewards of knowledge in democratic societies (Selwyn, 2019; UNESCO, 2021). In this sense, reconceptualizing knowledge and inquiry not only enhances instructional competence but also reinforces teachers' moral and civic responsibilities. Taken together, these shifts point toward a model of teacher professionalism that is intellectually robust, socially responsive, and ethically grounded. By legitimizing multiple ways of knowing and diverse modes of inquiry, teacher education aligned with NEP 2020 can empower teachers as curriculum designers, reflective practitioners, and agents of educational transformation—capable of contributing meaningfully to both learner development and broader societal well-being.

Conclusion

In conclusion, multidisciplinary in teacher education is not merely an organizational or curricular reform; it represents a profound epistemic and professional shift. By reconceptualizing what counts as knowledge and how inquiry is conducted, teacher education aligned with NEP 2020 can strengthen the quality, relevance, and social purpose of teacher professional training. Such a transformation is essential for preparing teachers who can lead learning in an uncertain world and contribute meaningfully to educational and societal transformation. Reconceptualizing knowledge and modes of inquiry in teacher education has far-reaching implications for teacher professionalism in contemporary education systems. When teachers are prepared within epistemic frameworks that value integrative, inquiry-driven, and representational forms of knowledge, they are better equipped to exercise professional judgment in dynamic and uncertain contexts. Rather than functioning as implementers of externally prescribed curricula, such teachers are positioned as adaptive professionals who can interpret curricular goals, respond to diverse learner needs, and design interdisciplinary learning experiences that connect scientific reasoning, social understanding, and humanistic reflection (Darling-Hammond, 2006; Klein, 2017). This capacity is particularly critical in addressing emerging societal challenges—such as climate change,

public health, digital citizenship, and social inequality—which demand pedagogical approaches that transcend single-disciplinary perspectives.

Reforming teacher education in alignment with the National Education Policy (NEP) 2020 requires far more than curricular restructuring or regulatory compliance. It necessitates a fundamental reconceptualization of the forms of knowledge and modes of inquiry that teacher education legitimizes and prioritizes. As this paper has argued, moving beyond narrow disciplinary hierarchies toward integrative, inquiry-driven epistemologies is central to preparing teachers who can navigate complexity, foster interdisciplinary understanding, and respond effectively to contemporary societal challenges. Such an epistemic shift is essential for realizing the transformative intent of NEP 2020 and for positioning teachers as intellectual, ethical, and socially responsive professionals.

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