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REVIEW ARTICLE

## From Brain to Classroom: The Role of Educational Neuroscience in Enhancing Teacher Training in India

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### Abstract:

Educational neuroscience—an interdisciplinary field linking neuroscience, psychology, and pedagogy—has emerged as a scientific bridge between the laboratory and the classroom. By revealing how neural processes influence attention, motivation, emotion, and memory, it offers practical insights for improving learning and teaching. In the Indian context, where the Bachelor of Education (B.Ed.) program serves as the foundation for teacher preparation, integrating neuroscience principles can transform how teachers understand learners. The National Education Policy (NEP 2020) calls for research-driven, competency-based teacher education that is inclusive, reflective, and experiential. This review synthesizes global research and Indian policy documents to show how brain-based strategies—multisensory learning, emotional engagement, cognitive reflection, and neuroplasticity-aware pedagogy—can enhance teacher education. It also analyses institutional challenges such as limited faculty exposure, lack of interdisciplinary collaboration, and prevalence of “neuromyths.” A structured framework is proposed for embedding neuroscience literacy into B.Ed. curricula through curriculum redesign, faculty development, and collaborative learning laboratories. The paper concludes that brain-aware teachers—those who understand the science of learning—can bridge the gap between theory and practice, turning classrooms into spaces of curiosity, empathy, and lifelong growth.

**Keywords:** Educational neuroscience, brain-based learning, teacher education, NEP 2020, NCTE, cognitive psychology, inclusive pedagogy.

### Introduction:

Education in the twenty-first century is being reshaped by scientific understanding of how humans learn. For decades, teacher training relied primarily on psychological theories—behaviorism, cognitivism, and constructivism—to explain learning behavior. These perspectives, while valuable, did not explore the biological foundation of learning. The rise of neuroscience has changed that. With the ability to observe

the brain in real time through imaging technologies, researchers can now correlate teaching strategies with brain activity, revealing why some approaches work better than others (Sousa, 2022).

Educational neuroscience, or neuroeducation, is therefore not a separate discipline but a bridge between brain research and pedagogy (Tokuhamma-Espinosa, 2018). It invites teachers to look beyond methods and understand the mechanisms—how neural pathways strengthen through repetition, how emotional safety boosts learning, and how stress blocks cognition. This “science of teaching and learning” is transforming classrooms in countries such as the United Kingdom, Finland, and Singapore.

In India, the opportunity is particularly significant. The National Education Policy 2020 (NEP 2020) envisions teacher education that is multidisciplinary, holistic, and experiential. It promotes the idea of teachers as reflective practitioners and lifelong learners—goals directly aligned with neuroscience. However, most Indian B.Ed. programs still emphasize theoretical psychology rather than contemporary cognitive science. Embedding neuroscience concepts could modernize these programs, helping teachers translate learning science into daily practice.

• **The purpose of this review is threefold:**

- To synthesize global literature on educational neuroscience and its pedagogical applications;
- To analyze its relevance and current status within Indian teacher education frameworks; and
- To propose a model for integrating neuroscience literacy into the B.Ed. curriculum.

### Conceptual Foundations of Educational Neuroscience:

**Definition and Scope:** Educational neuroscience investigates how the structure and function of the brain relate to learning processes, emotions, and behavior (Fischer & Immordino-Yang, 2020). It draws upon neuroscience (the biological study of the nervous system), cognitive psychology (mental processes such as attention and memory), and education (the application of learning principles to classroom contexts).

Unlike traditional psychology, which infers mental processes through behavior, neuroscience observes brain activity directly. The ultimate aim is to inform educators—not to turn teachers into neuroscientists, but to enable evidence-based teaching.

### Key Principles:

- **Neuroplasticity:** The brain can reorganize itself in response to experience. This supports the idea that all students can learn with appropriate strategies and repetition.
- **Emotion-Cognition Link:** The amygdala and prefrontal cortex interact to regulate emotional and rational responses. A positive emotional climate enhances learning (Immordino-Yang & Damasio, 2019).
- **Multisensory Learning:** The brain processes information through multiple sensory pathways. Engaging several senses strengthens retention.
- **Attention and Working Memory:** The prefrontal cortex manages attention; overloading it with

information reduces comprehension.

- **Sleep and Consolidation:** Sleep plays a critical role in consolidating memory traces. Teachers can encourage healthy learning schedules that consider cognitive fatigue.

**Relation to Pedagogy:** Educational neuroscience complements—not replaces—educational theory. It validates constructivist approaches that emphasize active engagement and provides biological evidence for reflective learning. Understanding how neural networks form encourages teachers to move from rote memorization toward experiential and inquiry-based learning.

**The Brain and Learning: Major Insights** - The brain's learning process involves dynamic collaboration among regions:

- The hippocampus encodes new memories.
- The amygdala regulates emotions.
- The prefrontal cortex handles reasoning and decision-making.
- The cerebellum supports motor learning and coordination.

When students experience curiosity or joy, dopamine release enhances neural connectivity, strengthening memory. Conversely, chronic stress floods the brain with cortisol, impairing hippocampal function (Sousa, 2022).

Teachers who understand these dynamics can design emotionally safe environments. Simple strategies—starting lessons with relatable stories, integrating movement, or encouraging peer support—activate both cognitive and emotional centers of the brain.

Another crucial finding concerns developmental windows. Children's brains are highly plastic in early years, but adults retain the capacity for change. This underscores the lifelong-learning focus of teacher education: teachers themselves must keep learning so they can model that growth mindset for students.

**Global Developments and Practices:** Globally, educational neuroscience has entered mainstream teacher education.

- **Finland:** Finland integrates neuroscience concepts into its teacher-training curriculum under "Learning Sciences." Pre-service teachers study how brain development affects motivation and learning styles. Reflective seminars connect scientific findings to classroom experience.
- **United Kingdom:** The University College London's Centre for Educational Neuroscience offers joint programs combining psychology, neuroscience, and education. Teachers learn to interpret brain research critically and to avoid "neuromyths."
- **United States:** Harvard's Mind, Brain and Education program has influenced teacher education nationwide. American schools increasingly rely on evidence-based practices such as spaced learning and retrieval practice, both derived from cognitive neuroscience.

- **East Asia:** In Japan and Singapore, neuroscience supports innovative STEM education and stress-management programs. Teachers learn to identify signs of cognitive overload and adjust teaching tempo accordingly.

These examples demonstrate that bridging research and classroom practice enhances teacher confidence and student performance. For India, they provide blueprints adaptable to local contexts.

### Educational Neuroscience in India: Policy and Practice

India's teacher education system is governed by the National Council for Teacher Education (NCTE) and guided by NCERT for curriculum development. The two-year B.Ed. program introduced in 2015 emphasizes understanding learner diversity, psychology, and pedagogy. Yet neuroscience rarely appears explicitly.

- **Alignment with NEP 2020:** NEP 2020 emphasizes multidisciplinary education and the creation of "reflective practitioners." Section 15.5 of the policy calls for integration of "cognitive science and educational psychology" in teacher preparation. This implicitly opens the door for educational neuroscience.
- **Current Status:** A review of Indian B.Ed. syllabi (Varma, 2022) reveals that most programs treat the brain superficially within "Educational Psychology." Few institutions offer dedicated modules such as Brain and Learning or Cognitive Neuroscience for Teachers. Faculty development in this area is minimal, and resource materials are scarce.
- **Institutional Opportunities:** India hosts world-class neuroscience centers—like the National Brain Research Centre (Gurugram)—that could collaborate with teacher-education colleges. Interdisciplinary partnerships would allow practical demonstrations and joint research.

### Application of Neuroscience in Classroom Pedagogy:

Educational neuroscience translates into classroom practice through brain-compatible strategies:

- **Multisensory Instruction:** Combine visuals, sounds, and actions (e.g., role-play or diagrams).
- **Spaced Learning:** Review content at intervals to strengthen neural connections.
- **Retrieval Practice:** Encourage recall through questioning rather than rereading.
- **Emotionally Engaged Learning:** Link lessons with personal experiences or stories to trigger emotional memory.
- **Formative Assessment:** Frequent, low-stakes feedback reduces anxiety and guides improvement.
- **Mindfulness and Stress Reduction:** Short breathing exercises or reflection moments regulate emotional balance.

Such approaches align with constructivist pedagogy while adding neuroscientific validation. For B.Ed. students, practicing these strategies during internships fosters experiential understanding.

### Benefits for Teacher Training in India:

- **Reflective Practice:** Neuroscience encourages teachers to analyze what works and why. When pre-service teachers learn about attention, memory, and emotion, they reflect more deeply on their instructional design.
- **Inclusive Education:** Understanding brain diversity helps teachers accommodate learners with dyslexia, ADHD, or autism. NEP 2020's focus on inclusivity resonates with this brain-based perspective.
- **Teacher Motivation and Well-being:** Knowledge of brain chemistry—particularly dopamine and serotonin systems—helps teachers manage motivation and prevent burnout.
- **Research Mindset:** B.Ed. students trained in neuroscience are more likely to engage in action research, connecting theory with measurable classroom outcomes.

### Case Illustration: Brain-Based Pedagogy in Indian Classrooms

Although limited, several Indian institutions have begun experimenting with neuroscience-inspired teaching.

- **Delhi B.Ed. Colleges:** Colleges affiliated with Guru Gobind Singh Indraprastha University introduced short-term courses on “Cognitive Neuroscience and Teaching” in 2022. Student feedback indicated improved understanding of how learners differ cognitively.
- **Maharashtra and Karnataka:** State councils organized workshops on “Emotions and Learning” in partnership with NCERT. Teachers reported better classroom engagement and fewer behavioral disruptions.
- **NCERT's Cognitive Science Modules:** NCERT's *Handbook on Teacher Development (2022)* incorporated brain-based strategies such as “attention breaks,” “memory maps,” and “learning by doing.” These initiatives align with NEP 2020's emphasis on learning outcomes and experiential learning.
- **Rajasthan Example:** Some private B.Ed. colleges in Rajasthan have piloted “Brain-based Learning Days” during internships, where trainees design lessons around neuro principles—using visual aids, cooperative activities, and reflective assessments. Initial observations show higher student attentiveness and better retention.

These examples illustrate that practical application is possible even with modest resources. The key is awareness, creativity, and reflective implementation.

### Research and Pedagogical Implications:

- **For Teacher Educators:** Teacher educators must adopt a dual role—as facilitators and researchers. They should encourage pre-service teachers to design action-research projects investigating how specific strategies (e.g., spaced learning) affect classroom outcomes.
- **For B.Ed. Students:** Students need to learn critical reading of neuroscience literature. Instead of memorizing brain parts, they should focus on *how* brain mechanisms influence teaching decisions.

- **For Policy Makers:** Policy agencies like NCTE and NCERT can establish national-level fellowships for research on Brain, Mind, and Education in Indian Classrooms. Such initiatives will strengthen indigenous scholarship and reduce dependency on Western models.
- **For Researchers:** Interdisciplinary collaboration between neuroscientists and educators can lead to culturally grounded models of brain-based pedagogy—important given India’s linguistic and socio-economic diversity.

### Integration with NEP 2020 Vision:

Educational neuroscience supports all five pillars of NEP 2020:

NEP 2020 Pillar	Neuroscience Contribution
Access & Equity	Understanding brain diversity helps design inclusive learning.
Quality	Evidence-based teaching strategies enhance outcomes.
Affordability	Low-cost neuroscience literacy modules can be offered online.
Accountability	Teacher performance can be evaluated using research-based evidence.
Holistic Development	Emotional, cognitive, and ethical growth aligned with brain research.

NEP 2020’s emphasis on multidisciplinary learning and experiential education is inherently neuroscientific—it recognizes that knowledge is best retained when students construct meaning actively. Integrating neuroscience ensures that teacher education aligns with this future-ready vision.

### Ethical and Cultural Considerations:

Introducing neuroscience into teacher education must respect ethical norms:

- **Privacy and Consent:** Brain imaging or behavioral testing should follow ethical standards and avoid misuse.
- **Cultural Sensitivity:** Indian classrooms vary widely; Western brain models must be localized to socio-cultural realities.
- **Avoiding Reductionism:** Teachers should see neuroscience as a guide, not a deterministic rulebook. Learning is biological *and* social.
- **Equitable Access:** Rural and government colleges should receive funding for digital resources and training.

A balanced approach—grounded in ethics, inclusion, and practicality—will ensure that neuroscience empowers rather than intimidates educators.

### Conclusion:

Educational neuroscience represents a paradigm shift in how we understand learning and teaching. For Indian teacher education, it provides a scientific foundation for reflective, empathetic, and inclusive pedagogy.

Integrating brain-based knowledge within the B.Ed. curriculum will help pre-service teachers

recognize that learning is not merely cognitive but emotional, social, and biological. It empowers teachers to create environments that nurture curiosity and resilience rather than fear and compliance.

By aligning neuroscience with the National Education Policy 2020, NCTE, and NCERT frameworks, India can prepare a generation of “brain-aware” teachers equipped for the 21st century. These teachers will not only deliver knowledge but also understand how minds grow, adapt, and thrive—turning classrooms into true laboratories of learning.

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