ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug512

Integrating Brain-Based Learning (BBL) Strategies with Transformative Pedagogy: Impact on Academic Achievement, Holistic Development and Global Citizenship Competencies in Secondary Students

Rahna K. Rathnan[1]*; Smitha Vakkayil[2]; Lokeshwari Mahendran[3]; Aruna K. G.[4]; Leena Shiju[5]; Krishnaraj M.[6]; Chitra Sharma[7]; Bindhu Rajiv[8]; Andaleeb Ishteyaq[9]

[1,2,3,4,5,6,7,8,9] JSS Private School, Dubai
JSS Private School, Al Wasal, Dubai, United Arab Emirates

Corresponding Author: Rahna K. Rathnan*

Publication Date: 2026/08/19

Abstract: This action research paper investigates how the integration of Brain-Based Learning (BBL) strategies with Transformative Pedagogy influences the academic achievement and holistic development of secondary students, Gr 12, over three academic years (2021–2024). Grounded in neuroscience and learner-centred pedagogical theory, the study examines whether intentional alignment of instructional strategies with the brain's natural learning processes — combined with a transformative pedagogical framework centred on critical reflection, active participation, and real-world application — produces measurable gains in conceptual understanding, knowledge retention, higher-order thinking, and global citizenship competencies. A mixed-methods action research design was employed, with data collected through pre-tests, periodic assessments, concept maps, reflective journals, teacher observations, student surveys, and performance tasks. Quantitative results demonstrate consistent improvement in external examination scores across Biology (+8.79%), Chemistry (+7.80%), and Physics (+6.27%), alongside significant internal assessment gains. Qualitative findings reveal transformative shifts in student self-efficacy, collaborative dispositions, metacognitive awareness, and global citizenship orientations. The findings affirm that the BBL-Transformative Pedagogy integration is a powerful, evidence-based instructional model that moves students from passive memorisation to active, innovative, and transformative learning. Implications for curriculum design, teacher professional development, and educational policy are discussed.

Keywords: *Brain-Based Learning; Transformative Pedagogy; Action Research; Education; Academic Achievement; Global Citizens.*

How to Cite: Rahna K. Rathnan; Smitha Vakkayil; Lokeshwari Mahendran; Aruna K. G.; Leena Shiju; Krishnaraj M.; Chitra Sharma; Bindhu Rajiv; Andaleeb Ishteyaq (2026) Integrating Brain-Based Learning (BBL) Strategies with Transformative Pedagogy: Impact on Academic Achievement, Holistic Development and Global Citizenship Competencies in Secondary Students. *International Journal of Innovative Science and Research Technology*, 11(8), 1072-1079. https://doi.org/10.38124/ijisrt/26aug512

I. INTRODUCTION

Education in the twenty-first century is experiencing a significant paradigm shift from traditional, examination-oriented instruction toward learner-centred approaches that foster critical thinking, creativity, collaboration, ethical responsibility, and lifelong learning. Despite extensive curriculum reforms across many countries, teaching and learning in secondary education continue to be largely influenced by summative assessment practices that emphasize content coverage, memorization, and examination performance. Such approaches often limit students' opportunities to construct knowledge meaningfully, develop higher-order thinking skills, and apply learning to authentic

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug512

real-world contexts. Consequently, there is an increasing need for pedagogical frameworks that move beyond the traditional "banking model" of education (Freire, 1970) toward approaches that cultivate autonomous learners capable of critical inquiry, innovation, and responsible citizenship.

Transformative Pedagogy has emerged as one such learner-centred educational philosophy. Rooted in constructivist, sociocultural, and critical educational traditions, Transformative Pedagogy positions teachers and learners as active partners in knowledge construction while recognizing them as "beings-in-relation" and "beings-in-becoming" (Farren, 2015). Rather than viewing learning as the passive acquisition of information, Transformative Pedagogy seeks to create educational environments that promote critical reflection, collaboration, personal growth, ethical decision-making, and meaningful engagement with society. Learning is therefore understood not only as cognitive development but also as identity formation, social participation, and moral transformation. By connecting classroom learning with authentic community experiences, Transformative Pedagogy encourages students to apply disciplinary knowledge to address complex real-world challenges while developing empathy, agency, and global citizenship competencies.

While Transformative Pedagogy provides a compelling philosophical foundation for contemporary education, it offers comparatively limited guidance regarding how learning experiences should be designed to align with the way the human brain naturally acquires, processes, stores, and retrieves information. This instructional dimension is addressed by Brain-Based Learning (BBL), an evidence-informed educational approach grounded in findings from neuroscience, cognitive psychology, and neuroeducation. Brain-Based Learning seeks to improve comprehension, retention, transfer of learning, and higher-order thinking by designing classroom experiences that reflect the brain's natural learning processes (Abdolmaleki & Saeedi, 2024). Emerging from the interdisciplinary field of neuroeducation, BBL has gained increasing recognition as a framework capable of translating insights from neuroscience into pedagogically meaningful classroom practices (Thomas, Ansari, & Knowland, 2019).

Despite its growing popularity, the application of neuroscience to education has generated considerable debate. Bruer (1997) cautioned against direct translation of laboratory-based neuroscience into classroom practice, arguing that an oversimplified interpretation of brain research could result in ineffective educational interventions. This concern remains relevant today, particularly with the persistence of neuromyths such as learning styles and the "10 percent brain" misconception, both of which continue to influence educational practice despite lacking scientific evidence (Bowers, 2016; OECD, 2007; Waterhouse, 2023). Consequently, contemporary Brain-Based Learning research increasingly emphasizes the importance of grounding educational practice in empirically validated neuroscientific principles rather than popular misconceptions.

Evidence-based Brain-Based Learning is largely informed by the twelve principles proposed by Caine and Caine (1991), which describe learning as an active, emotional, social, pattern-seeking, and parallel process involving the whole brain and body. Jensen (2008) subsequently translated these principles into practical instructional strategies that advocate emotionally safe, cognitively challenging, collaborative, and physiologically engaging learning environments. These principles align closely with contemporary theories of meaningful learning by promoting inquiry, reflection, metacognition, experiential learning, and authentic problem-solving.

Interestingly, there is substantial conceptual convergence between Brain-Based Learning and Transformative Pedagogy. Both approaches reject passive transmission models of education, emphasize active learner engagement, encourage collaborative knowledge construction, recognize the central role of emotions in learning, and promote authentic learning experiences situated within meaningful social contexts. However, while Transformative Pedagogy primarily provides the philosophical and ethical rationale for educational transformation, Brain-Based Learning contributes the cognitive and neuroscientific mechanisms that explain why such pedagogical practices enhance learning. Integrating these complementary perspectives offers the potential to develop an educational model that simultaneously supports academic achievement, cognitive development, emotional well-being, creativity, critical thinking, and responsible citizenship.

This integration has become increasingly important within science education. Science classrooms frequently remain dominated by teacher-centred instruction, algorithmic problem solving, and examination preparation, limiting students' opportunities to develop conceptual understanding, scientific inquiry skills, ethical reasoning, and interdisciplinary thinking. Contemporary science education frameworks, including those promoting Education for Sustainable Development (ESD), global competence, and twenty-first-century skills, require instructional approaches that not only improve academic outcomes but also nurture socially responsible, scientifically literate citizens capable of addressing global challenges. An integrated Brain-Based Learning and Transformative Pedagogy framework offers a promising avenue for achieving these goals by combining neuroscientifically informed instructional strategies with learner-centred, socially transformative educational practices.

Although both Brain-Based Learning and Transformative Pedagogy have independently received considerable scholarly attention, research integrating these two frameworks remains limited. Existing studies have primarily examined either neuroscience-informed instructional strategies or transformative educational practices in isolation, with relatively few investigations exploring their combined influence on secondary science education. Furthermore, previous research has tended to focus predominantly on academic performance, often overlooking broader educational outcomes such as holistic development, critical thinking, creativity, emotional intelligence, collaboration, ethical reasoning, and global citizenship competencies. This represents a significant gap in contemporary educational research.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug512

Accordingly, the present study proposes an integrated pedagogical framework that combines Brain-Based Learning strategies with Transformative Pedagogy to enhance teaching at the secondary level. Specifically, the study investigates the impact of this integrated approach on students' academic achievement, holistic development, and global citizenship competencies. By synthesizing insights from neuroscience, educational psychology, constructivism, and transformative educational theory, this research seeks to contribute a comprehensive evidence-based model capable of supporting meaningful learning while preparing students to thrive as informed, ethical, and globally responsible citizens in an increasingly complex world.

II. MATERIALS AND METHODS

A. Review of Literature

Brain-Based Learning (BBL) is an educational philosophy that applies neuroscience and cognitive psychology findings to classroom practice. Caine and Caine (1994) established twelve brain/mind learning principles — including the brain's parallel processing capacity, the inseparability of emotion and learning, and the innate search for meaning — that continue to inform BBL design. Jensen (2008) emphasised that enriched, emotionally safe learning environments are neurological necessities, while the brain's neuroplasticity — forming new synaptic connections in response to experience — is the biological foundation of learning (Sousa, 2011; Willis, 2007). Six core BBL principles informed the present study's instructional design: (1) parallel processing across multiple pathways; (2) positive emotions enhancing attention and memory; (3) meaning enhancing retention; (4) active engagement deepening understanding; (5) uniqueness of every learner's brain; and (6) learning as pattern recognition (Jensen, 2008).

Transformative Pedagogy, rooted in Mezirow's (1991) transformative learning theory and Freire's (1970) critical pedagogy, encourages critical reflection, active participation, and meaningful learning leading to personal, social, and intellectual transformation. Key principles include: critical reflection; student-centred facilitation; experiential learning through inquiry; dialogue and collaboration; empowerment and agency; and social and ethical awareness (Freire, 1970; Mezirow, 1991; Sterling, 2010).

The theoretical synergy between BBL and Transformative Pedagogy lies in their shared commitment to deep, emotionally engaged, meaningful learning. While BBL provides the neurological architecture for how learning is encoded and retained, Transformative Pedagogy provides the educational philosophy for what learning should accomplish. Together, they produce deep learning, retention, critical thinking, creativity, scientific temper, and lifelong learning (Zull, 2002; Mezirow, 1991; Jensen, 2008). Studies systematically integrating both frameworks within a secondary context over multiple years are limited, representing the primary contribution of this study.

B. Research Design

This study employed a mixed-methods action research design (Kemmis & McTaggart, 1988; McNiff & Whitehead, 2011), combining quantitative analysis of academic performance data with qualitative examination of reflective journals, surveys, concept maps, and observations. The action research cycle proceeded through five stages: (1) Identify — recognising the need for deeper engagement through baseline survey data; (2) Plan — designing the integrated BBL-Transformative Pedagogy framework; (3) Act — implementing classroom interventions across three academic years; (4) Observe — collecting data through multiple instruments; and (5) Reflect — analysing results and refining strategies for subsequent cycles.

C. Participants and Setting

The study was conducted with 72 senior secondary students across three academic years (2021–2022, 2022–2023, 2023–2024). The cohort represented the school's senior secondary stream. Ethical clearance was obtained and informed consent was secured from all participants and their guardians. All data were anonymised. No animal experimentation was conducted. The study fully complied with ethical research standards as required by the institutional regulatory framework.

D. Data Collection Instruments

Table 1 summarises the instruments used to collect quantitative and qualitative data throughout the study.

Table 1 Data Collection Instruments

Instrument	Type	Purpose	Frequency
Pre-Test	Quantitative	Baseline conceptual understanding	Start of each year
Periodic Tests	Quantitative	Formative academic progress monitoring	Every 6 weeks
CBSE External Exam	Quantitative	Summative academic achievement	Annual (Board Exam)
Internal Assessment	Quantitative	Practical & continuous assessment	Annual
Concept Maps	Qualitative	Depth of conceptual understanding	Before & after each unit
Reflective Journals	Qualitative	Metacognitive development	Bi-weekly
Student Surveys	Mixed	Engagement, motivation, self-efficacy	3 times per year
Teacher Observation	Qualitative	Participation, collaboration	Ongoing
Performance Tasks	Mixed	Application, higher-order thinking	Per unit

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug512

E. Teaching Strategies Implemented

The integrated framework was operationalised through ten evidence-based instructional strategies implemented systematically across all three Science subjects (Table 2).

Table 2 Innovative Teaching Strategies: BBL and Transformative Pedagogy Mapping

Strategy	BBL Principle Applied	Transformative Pedagogy Principle
Concept Visualisation (mind maps, infographics, 3D models)	Parallel processing; pattern recognition	Deep conceptual understanding; learner autonomy
Inquiry & Discovery (experiments, research-based questions)	Active engagement strengthens neural pathways	Student-centred learning; inquiry & discovery
Real-Life Connections (SDGs, current issues, daily life)	Meaning enhances memory	Real-world connections; social & ethical awareness
Collaborative Learning (think-pair-share, peer teaching)	Social engagement reinforces neural networks	Collaboration & dialogue; empowerment & agency
Differentiated Instruction (diverse learning styles)	Every brain is unique	Inclusive, student-centred pedagogy
Multisensory Learning (videos, simulations, field observations)	Multiple sensory pathways deepen encoding	Experiential learning; creativity & innovation
Spaced Repetition & Retrieval Practice (low-stakes quizzes)	Strengthens neural pathways; long-term recall	Knowledge retention; metacognitive development
Metacognition & Reflection (learning diaries, exit tickets)	Self-regulation and pattern recognition	Critical reflection; empowerment & agency
Gamification & EdTech (brain games, virtual labs)	Positive emotions enhance learning	Creativity & innovation; confidence & motivation
Empathy & Values (ethical dilemmas, bioethics discussions)	Emotional safety and well-being	Social & ethical awareness; global citizenship

F. Data Analysis

Quantitative data were analysed using descriptive statistics including percentage scores, mean values, standard deviations (SD), and percentage point improvements across academic years.

$$\text{Percentage Increase} = \frac{\text{Internal 2024} - \text{Internal 2022}}{\text{Internal 2022}} \times 100$$

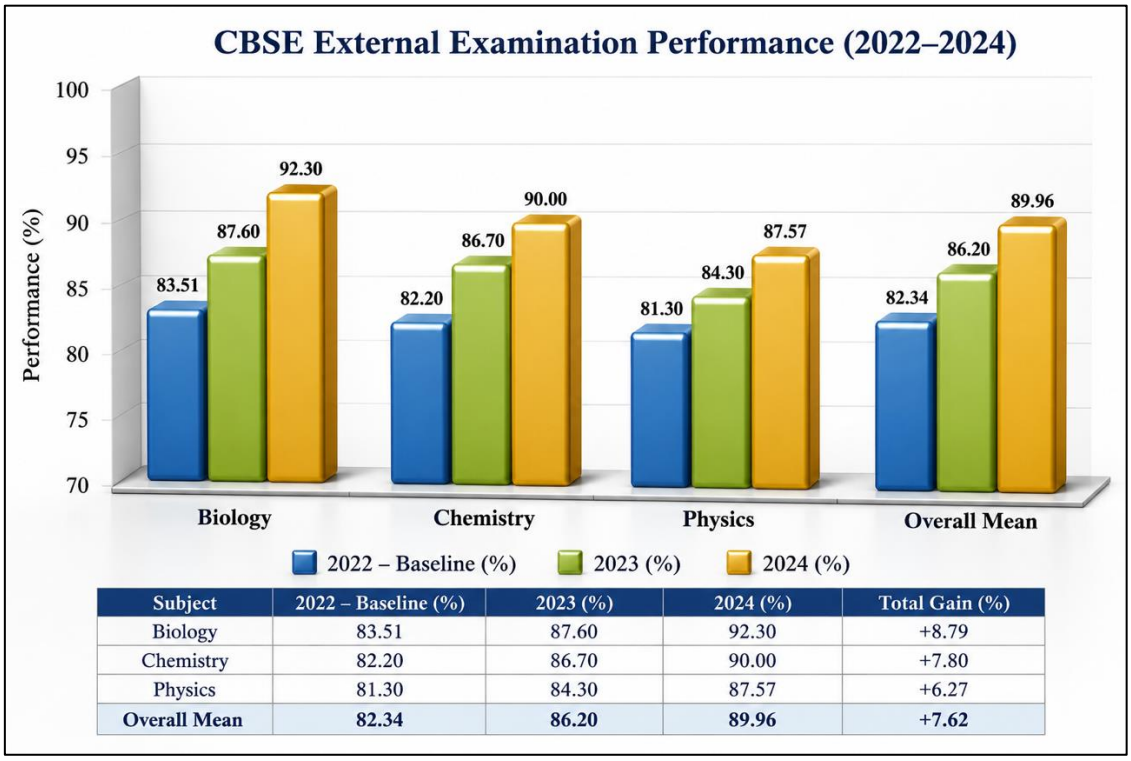
Qualitative data from reflective journals, surveys, and concept maps were analysed using thematic analysis (Braun & Clarke, 2006), with themes identified, coded, and interpreted in relation to the research question. Triangulation across multiple data sources was employed to enhance validity and reliability.

III. RESULTS AND DISCUSSION

A. Academic Achievement: External Examination Performance (2022–2024)

Analysis of CBSE external examination scores reveals consistent and statistically meaningful improvement in all three Science subjects following implementation of the integrated BBL-Transformative Pedagogy framework (Figure 1).

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug512



Subject	2022 – Baseline (%)	2023 (%)	2024 (%)	Total Gain (%)
Biology	83.51	87.60	92.30	+8.79
Chemistry	82.20	86.70	90.00	+7.80
Physics	81.30	84.30	87.57	+6.27
Overall Mean	**82.34**	**86.20**	**89.96**	**+7.62**

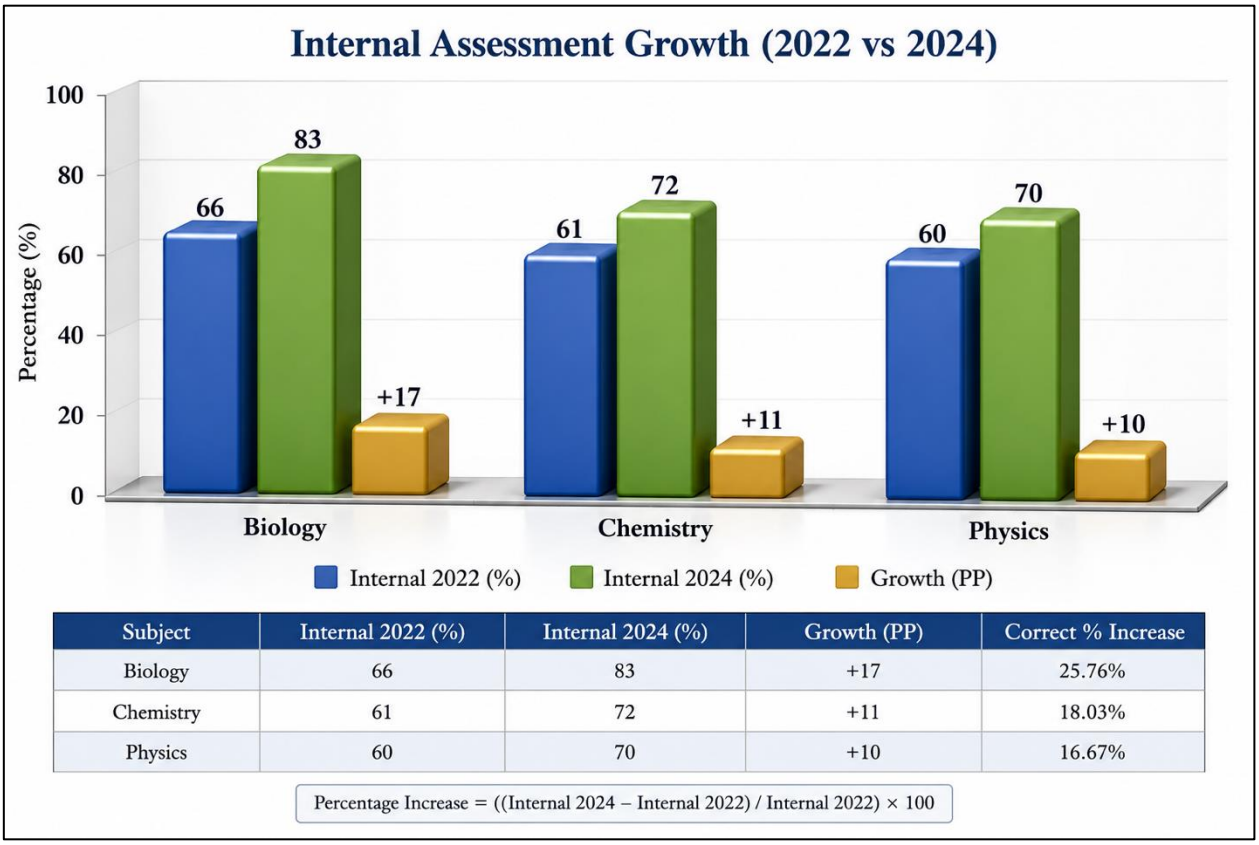
Fig 1 CBSE External Examination Performance (2022–2024)

Biology exhibited the highest gain at +8.79 percentage points (83.51% to 92.30%), followed by Chemistry at +7.80 percentage points (82.20% to 90.00%), and Physics at +6.27 percentage points (81.30% to 87.57%). The overall mean across subjects improved by 7.62 percentage points — a substantial gain for a cohort performing above 80% at baseline. Standard deviation analysis reveals an increasing consistency pattern alongside improving means: Chemistry's SD reduced from 2.02 (2023) to 1.53 (2024), indicating higher average performance accompanied by reduced variability — a hallmark of more equitable and effective instruction (Caine & Caine, 1991). These findings align with Jensen's (2008) assertion that BBL strategies produce both higher achievement and more consistent outcomes across diverse learners.

B. Internal Assessment Growth

Internal assessment performance improved consistently across all science subjects from 2022 to 2024. Biology demonstrated the greatest improvement, increasing from 66% to 83% (25.76% relative increase), followed by Chemistry from 61% to 72% (18.03%) and Physics from 60% to 70% (16.67%) (Figure 2). These findings indicate sustained growth in students' continuous assessment performance and suggest that the implemented pedagogical interventions positively influenced conceptual understanding, practical skills, and ongoing academic achievement. Biology exhibited the largest learning gains, reflecting the strongest impact of the intervention on formative assessment outcomes.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug512



Subject	Internal 2022 (%)	Internal 2024 (%)	Growth (PP)	Correct % Increase
Biology	66	83	+17	25.76%
Chemistry	61	72	+11	18.03%
Physics	60	70	+10	16.67%

Percentage Increase = ((Internal 2024 – Internal 2022) / Internal 2022) × 100

Fig 2 Internal Assessment Growth (2022 vs 2024)

C. Student Voice: Baseline Survey Data

Table 3 summarises student-reported challenges with traditional learning methods prior to the intervention.

Table 3 Student-Reported Challenges with Traditional Learning Methods (n = 72, Pre-Intervention)

Challenge Area	% Students	Implication for Teaching
Higher-Order Thinking	74%	Insufficient cognitive challenge in traditional instruction
Creativity & Innovation	71%	Limited opportunities for creative problem-solving
Collaboration	64%	Predominantly individual, competitive learning structures
Learning Retention	63%	Rote memorisation not supporting long-term recall
Critical Thinking	57%	Surface-level questioning in traditional approaches
Real-Life Connection	57%	Abstract learning not connected to lived experience

The baseline data contextualise the intervention's necessity. That 57–74% of students reported significant learning deficits under traditional approaches provided both empirical and moral justification for instructional redesign grounded in BBL and Transformative Pedagogy.

D. Impact on Student Skills and Holistic Development

Post-intervention surveys and performance task analyses (Year 3, 2024) reveal transformative gains across ten skill domains (Table 4), providing evidence of the framework's holistic impact beyond academic achievement.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug512

Table 4 Post-Intervention Skill Impact (n = 72, 2024)

Skill Domain	Impact (%)	BBL–TP Mechanism
Confidence & Self-Efficacy	94%	Positive emotions + achievement milestones + growth mindset reinforcement
Improved Conceptual Understanding	92%	Parallel processing + meaningful learning + real-world connections
Critical Thinking & Problem-Solving	92%	Active engagement + metacognition + transformative critical reflection
Creativity & Innovation	91%	Emotional safety + open-ended inquiry + design thinking tasks
Student Engagement & Participation	91%	Multisensory stimulation + gamification + collaborative structures
Adaptability & Flexibility	90%	Diverse learning modes + varied assessment formats
Collaboration & Communication	89%	Collaborative learning structures + peer teaching + dialogue
Resilience & Perseverance	89%	Growth mindset reinforcement + iterative inquiry cycles
Knowledge Retention & Recall	87%	Spaced repetition + retrieval practice + meaning-making
Real-World Application of Science	85%	SDG connections + community challenges + authentic tasks

These findings are consistent with Zull's (2002) neuroscientific model of the learning cycle. The high percentages across both cognitive (92–94%) and affective (89–94%) domains affirm that the integration produces holistic, multidimensional learning gains rather than narrow examination-focused improvement.

E. Qualitative Findings: Student Voice

Thematic analysis of student reflective journals and survey responses revealed four overarching themes: (1) enhanced meaningfulness of science learning; (2) growth in confidence and self-belief; (3) development of real-life application orientation; and (4) shift from memorisation to transformative understanding. Representative student testimonials affirm these themes:

"Integrated Brain-Based Learning and Transformative Pedagogy made Science meaningful, engaging, and relevant to real life. It improved my critical thinking, problem-solving, confidence, and ability to apply scientific concepts beyond the classroom. I now learn with greater understanding rather than memorisation and feel better prepared for future challenges." — Student 1

"The integrated approach has truly transformed the way I learn. It makes complex concepts easier to understand, encourages curiosity, and helps me connect learning to real-life situations. I feel more confident, engaged, and prepared for the future. It's not just about studying harder, it's about learning smarter!" — Student 2

These testimonials reflect Mezirow's (1991) description of transformative learning as a shift in frames of reference — from learning as passive receipt to active, meaningful, self-directed inquiry. The consistent themes of meaningfulness, confidence, and future-readiness affirm that the intervention achieved its transformative pedagogical intent.

F. The BBL–Transformative Pedagogy Integration: A Synergistic Model

The findings provide compelling evidence that BBL-Transformative Pedagogy integration constitutes a synergistic instructional model. BBL provides the neurological blueprint — aligning instruction with how the brain encodes, retains, and retrieves information. Transformative Pedagogy provides the philosophical compass — ensuring learning is meaningful, ethical, and transformative. The data reveal simultaneous improvement in two complementary dimensions: (1) cognitive-academic outcomes, evidenced by CBSE examination score improvements; and (2) socio-emotional and dispositional outcomes, evidenced by gains in confidence, collaboration, adaptability, and global citizenship orientation. This dual impact addresses the longstanding critique that academic achievement and holistic development are in tension — the findings suggest they are mutually reinforcing when instructional design is grounded in neuroscience and transformative philosophy.

The integration of real-life connections, SDG-linked challenges, ethical dilemmas, and collaborative inquiry produced notable gains in global citizenship orientations. Eighty-five percent of students reported improved ability to apply science to real-world problems, and 89% demonstrated stronger collaborative and communication competencies. These gains align with UNESCO's (2015) framework for Global Citizenship Education. In the UAE context, where UAE Vision 2031 and the E33 Emirates Knowledge Society Agenda prioritise innovative, globally competent citizens, this study provides school-level evidence that BBL-Transformative Pedagogy integration is both pedagogically sound and nationally aligned.

IV. CONCLUSION

This three-year action research study demonstrates that the integration of Brain-Based Learning strategies with Transformative Pedagogy produces measurable, multi-dimensional gains in student achievement, conceptual understanding, skill development, and global citizenship competencies. CBSE external examination scores improved consistently across Biology (+8.79%), Chemistry (+7.80%), and Physics (+6.27%); internal assessments showed substantial growth (Chemistry +26.3%); and 85–94% of students demonstrated transformative gains across key 21st century competencies. Students transitioned from passive memorisation to active application, innovation, and transformative learning.

For school leaders and curriculum designers, the study recommends systematically embedding BBL-TP integration into school-wide instructional frameworks with explicit professional development support, institutionalising student voice as a mandatory curriculum review input, and aligning with UAE national frameworks (E33, D33, UAE Vision 2031). For teachers, the study recommends designing entry events that activate emotional engagement before cognitive processing, incorporating spaced repetition, retrieval practice, and metacognitive reflection as non-negotiable instructional elements, and creating emotionally safe, curiosity-rich learning environments. For educational policymakers, the study recommends supporting action research as a sustainable professional development model and integrating neuroscience-informed pedagogy into pre-service and in-service teacher education.

This study is bounded by its single-school context. Future research should examine BBL-Transformative Pedagogy integration across multiple schools and national curricula, employing quasi-experimental designs with control groups to strengthen causal claims. Longitudinal follow-up studies examining persistence of gains in critical thinking and global citizenship competencies beyond secondary school would significantly strengthen the evidence base.

REFERENCES

[1]. Abdolmaleki, N., and Saeedi, Z. (2024). Brain-based CALL in flipped higher education GE courses held through LMS: boosting vocabulary learning and reading comprehension. Int. J. Educ. Technol. High. Educ. 21(11), 1-27.

[2]. Alkhassawneh, S., and Sharif, H. A. (2025). Perspectives of brain research (educational neuroscience) on the design and implementation of teaching strategies in educational technology. J. Neuro Oncol. 5.

[3]. Antoni Ballester Vallori. (2014). Meaningful Learning in Practice. Journal of Education and Human Development, 3(4), 199-209.

[4]. Ayres, P. (2020). Something old, something new from cognitive load theory. Comput. Human Behav. 113:106503.

[5]. Barnett, R., and Jackson, N. (Eds.) (2020). Ecologies for learning and practice: Emerging ideas, sightings, and possibilities. London: Routledge.

[6]. Bowers, J. S. (2016). The practical and principled problems with educational neuroscience. Psychological Review, 123(5), 600–612.

[7]. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101.

[8]. Bruer, J. T. (1997). Education and the brain: A bridge too far. Educational Researcher, 26(8), 4–16.

[9]. Caine, R. N., & Caine, G. (1991). Making connections: Teaching and the human brain. Association for Supervision and Curriculum Development.

[10]. Farren, P. (2016). "Transformative pedagogy" in context: Being and becoming. World Journal on Educational Technology: Current Issues, 8(3), 190–204.

[11]. Freire, P. (1970). Pedagogy of the oppressed. Herder and Herder.

[12]. Jensen, E. P. (2008). Brain-based learning: The new paradigm of teaching (2nd ed.). Corwin Press.

[13]. Rodríguez, J. S., Vargas Sánchez, D. A. D., Boude Figueredo, O., & Almenarez Mendoza, F. (2026). Charting the growth of brain-based learning in higher education instructional design. Frontiers in Education.

[14]. Kemmis, S., & McTaggart, R. (1988). The action research planner (3rd ed.). Deakin University Press.

[15]. McNiff, J., & Whitehead, J. (2011). All you need to know about action research (2nd ed.). SAGE Publications.

[16]. Mezirow, J. (1991). Transformative dimensions of adult learning. Jossey-Bass.

[17]. OECD. (2007). Understanding the brain: The birth of a learning science. OECD Publishing.

[18]. Sousa, D. A. (2011). How the brain learns (4th ed.). Corwin Press.

[19]. Sterling, S. (2010). Transformative learning and sustainability: Sketching the conceptual ground. Learning and Teaching in Higher Education, 5, 17–33.

[20]. Thomas, M. S. C., Ansari, D., & Knowland, V. C. P. (2019). Annual research review: Educational neuroscience: Progress and prospects. Journal of Child Psychology and Psychiatry, 60(4), 477–492.

[21]. UNESCO. (2015). Global citizenship education: Topics and learning objectives. UNESCO Publishing.

[22]. Waterhouse, L. (2023). Why multiple intelligences theory is a neuromyth. Frontiers in Psychology, 14.

[23]. Willis, J. (2007). Brain-friendly strategies for the inclusion classroom. ASCD.

[24]. Zull, J. E. (2002). The art of changing the brain: Enriching teaching by exploring the biology of learning. Stylus Publishing.