INTERCULTURAL COMPETENCE IN THE DIGITAL AGE THROUGH BRAIN-TARGETED TEACHING AND THE READI FRAMEWORK: A CONCEPTUAL APPLICATION IN BIOLOGY EDUCATION

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Abstract

Background: The growing interconnectedness of global education systems, accelerated by digital technologies, demands pedagogical frameworks that simultaneously address cognitive learning outcomes and intercultural competence (IC). Biology education, as a discipline that crosses cultural and national boundaries, presents a unique opportunity to embed IC within science instruction. Purpose: This paper proposes a conceptual integration of Brain-Targeted Teaching (BTT) (Hardiman, 2012, 2025) and the READI instructional framework (Iswara & Supriyadi, 2026) as complementary tools for fostering intercultural competence in digital-age biology classrooms, with particular reference to secondary school contexts in Iraq. Approach: A conceptual analysis was conducted drawing on established frameworks of intercultural competence (Deardorff, 2006; Byram, 1997), neuroscience-informed pedagogy (Hardiman, 2012), and the READI model's five instructional phases. Conceptual Contribution: The paper demonstrates that each READI phase — Recognition, Engagement, Application, Development, and Integration — provides natural pedagogical opportunities to develop students' intercultural knowledge, skills, and attitudes. When amplified by BTT's six brain targets, these opportunities become neurologically grounded, emotionally resonant, and culturally expansive. Conclusion: The READI-BTT integration offers a scalable, evidence-informed approach to embedding intercultural competence within biology instruction.

Keywords: *intercultural competence; Brain-Targeted Teaching; READI model; biology education; digital age pedagogy; neuroscience-informed instruction*

1. INTRODUCTION

The emergence of digital technologies has fundamentally transformed the landscape of global education. Students and educators across the world now engage continuously across cultural, linguistic, and geographic boundaries through digital platforms, collaborative tools, and open-access learning environments (UNESCO, 2024). This transformation has elevated intercultural competence (IC) from a desirable skill to an essential educational outcome, particularly within science disciplines that are inherently cross-cultural in nature (Deardorff, 2022).

Biology education occupies a unique position at this intersection. Scientific knowledge in the life sciences is produced, communicated, and applied across diverse cultural contexts — from biodiversity conservation practices to public health responses to genetics ethics. Yet, conventional approaches to biology instruction in many educational systems, including secondary schools in Iraq, continue to

prioritize content transmission over culturally embedded, brain-compatible learning experiences (Hardiman, 2012). This paper addresses this gap by proposing a conceptual framework for integrating IC development within biology instruction through two complementary models: the Brain-Targeted Teaching (BTT) Model (Hardiman, 2012, 2025) and the READI instructional design framework (Iswara & Supriyadi, 2026).

2. THEORETICAL FOUNDATIONS

2.1. Intercultural Competence in the Digital Era

Intercultural competence is broadly defined as the ability to communicate and interact effectively and appropriately across cultural boundaries (Deardorff, 2006, p. 247). Deardorff's Process Model identifies three foundational components: attitudes (respect, openness, curiosity), knowledge and comprehension (cultural self-awareness, sociolinguistic awareness), and skills (listening, observing, interpreting, relating). In the digital era, this definition has expanded to include digital awareness, ethical communication, empathy in online spaces, and the capacity to critically interpret information within multicultural online environments. Research consistently demonstrates that IC development in educational settings requires intentional pedagogical design rather than incidental exposure (Deardorff, 2022).

2.2. Neuroscience-Informed Pedagogy: The BTT Framework

The Brain-Targeted Teaching (BTT) Model (Hardiman, 2012) provides a six-component pedagogical framework grounded in cognitive and educational neuroscience. BT1 establishes an emotional climate for learning; BT2 develops the physical learning environment; BT3 designs the learning experience through conceptual unit planning; BT4 teaches for mastery through multi-sensory instruction; BT5 extends and applies knowledge through higher-order thinking; and BT6 evaluates learning through authentic, performance-based assessment. Hardiman's research on arts integration has demonstrated measurable improvements in science content retention through multi-modal instruction (Hardiman et al., 2019).

2.3. The READI Instructional Design Framework

The READI model — Recognition, Engagement, Application, Development, and Integration — is an instructional design framework developed by Iswara and Supriyadi at Universitas Pendidikan Indonesia (2026). The five phases mirror natural cognitive processing sequences: Recognition activates prior knowledge; Engagement generates emotional investment; Application connects abstract concepts to real-world contexts; Development extends higher-order thinking; and Integration supports consolidation and transfer. Iswara et al. (2026) reported substantial improvement across key learning domains in a study involving 90 students and 9 teachers across urban, semi-urban, and rural Indonesian contexts.

3. CONCEPTUAL INTEGRATION: READI-BTT FOR IC IN BIOLOGY EDUCATION

3.1. Rationale for Integration

The complementarity of READI and BTT rests on three convergent premises. First, both frameworks foreground emotional and motivational dimensions — READI through its Engagement phase and BTT through BT1 and BT2. Second, both emphasize authentic, real-world application — READI's Application phase and BTT's BT4 and BT5. Third, both culminate in integration and transfer, reflecting neuroscientific understandings of long-term memory consolidation.

3.2. Phase 1: Recognition — Activating Cultural Prior Knowledge

The Recognition phase invites educators to activate what students already know, experience, and believe. In a biology classroom, this may involve asking students to articulate how their cultural background shapes their understanding of heredity, disease, or ecology. Practical applications in secondary biology in Iraq include culturally comparative mind-mapping activities on topics such as the human immune system, traditional and scientific explanations of plant growth, and community

perceptions of genetic inheritance. This activation creates the emotionally safe environment (BT1) essential for intercultural openness.

3.3. Phase 2: Engagement — Generating Intercultural Motivation

The Engagement phase generates emotional investment in learning content. In the IC-integrated biology classroom, this involves making biology globally resonant through cross-cultural debates, analysis of international health data, and role-play activities. BTT's BT2 is directly activated: sensory-rich, culturally diverse digital materials stimulate the novelty-driven dopaminergic systems that underpin sustained motivation (Hardiman, 2012). Research on digital intercultural exchange confirms that emotionally engaging cross-cultural encounters produce measurable gains in IC attitudes and knowledge (Hackett et al., 2023).

3.4. Phase 3: Application — Building Cross-Cultural Biological Meaning

Application connects abstract biological concepts to globally distributed realities. Biology problems — pandemic response, ecosystem degradation, genetic diversity — are inherently cross-cultural. When students in Iraqi secondary schools examine how immune responses vary across populations, or compare water-scarce ecosystem adaptations in the Middle East with tropical biodiversity strategies in Southeast Asia, they simultaneously build biological understanding and IC skills. BTT's BT4 encodes biological content through multiple neural pathways while embedding it in culturally diverse contexts.

3.5. Phase 4: Development — Deepening Intercultural Scientific Reasoning

Development phase tasks push students toward higher-order thinking: analysis, evaluation, and synthesis. In the IC-integrated biology classroom, this involves comparative and critical analysis of scientific knowledge produced in different cultural contexts. Questions such as why species evolve differently across biogeographic regions, or how different civilizations have historically contributed to biology, directly activate BTT's BT5 — engaging prefrontal cortical processes associated with long-term memory consolidation and creative problem-solving.

3.6. Phase 5: Integration — Transferring IC Through Biology

The Integration phase supports consolidation and personal ownership of learning. Students teach concepts to peers from different backgrounds, build cross-cultural science portfolios, and engage in reflective writing about how their own cultural lens shapes their understanding of biological systems. BTT's BT6 — authentic, performance-based assessment — provides the evaluative infrastructure for this phase. Portfolio assessment and peer-teaching tasks produce evidence of genuine IC development that standardized examinations cannot capture (Hardiman, 2012, 2025).

4. IMPLICATIONS FOR PRACTICE AND FUTURE RESEARCH

The READI-BTT framework offers biology teachers in diverse cultural contexts a practical, research-grounded approach to embedding IC within existing curriculum frameworks. The five-phase structure maps naturally onto standard lesson planning, requiring no additional time allocation — only a reorientation of pedagogical intent. Professional development programs informed by this framework should prioritize teacher IC alongside student IC, equipping educators with the attitudes, knowledge, and skills to navigate cultural diversity in the biology classroom.

Biology curricula in culturally diverse contexts — including secondary schools in Iraq — should explicitly incorporate IC learning outcomes alongside scientific content objectives. The Iraq–Indonesia research collaboration underpinning this paper represents a model for such recontextualization: the first application of the READI framework in an Arabic-language biology education context. Future research should examine the measurable effects of the READI-BTT integration on both biology achievement outcomes and IC development through quasi-experimental designs and mixed-method approaches.

5. CONCLUSION

This paper has proposed a conceptual integration of intercultural competence, Brain-Targeted Teaching, and the READI instructional framework as a novel approach to biology education in the digital age. The central claim — that each phase of READI constitutes a natural opportunity for IC development, amplified by BTT's neuroscientific architecture — has been substantiated through theoretical analysis and practical illustration within secondary biology contexts.

The digital era has transformed intercultural competence from an aspirational goal to an instructional imperative. Biology, as a discipline that transcends national and cultural boundaries, is uniquely positioned to serve as a site of intercultural learning. The READI-BTT framework offers a research-grounded, practically implementable, and culturally expansive approach to biology instruction that may reshape how students see and engage with a deeply connected world.

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