

# An Ecological Framework for L2 Teachers' ICT Integration: A Theory-Driven Review (2015–2025)

Sulin He<sup>1\*</sup>, Joseph Roche<sup>1</sup>

<sup>1</sup> School of Education, Trinity College Dublin

\* [suliana0157@gmail.com](mailto:suliana0157@gmail.com)

**Abstract:** Over the past decade, the application of Information and Communication Technology (ICT) in second language (L2) teaching has become increasingly embedded. However, despite a large body of research, the literature remains fragmented and lacks a unifying framework. This paper introduces Bronfenbrenner's Ecological Systems Theory and constructs a multi-level theoretical analysis framework from the individual, teaching, organization, and student perspectives. ICT integration emerges from multi-level interactions among teachers' competencies, task design, institutional support, and student responses. This review makes three theoretical contributions: (1) It reconceptualizes L2 teachers' ICT integration as a cross-level, recursive ecological process; (2) It specifies cross-system pathways linking teacher cognition, instructional interaction, institutional conditions, and student feedback; (3) It extends existing TAM/TPACK-based explanations by embedding them within a temporal (chronosystem) perspective.

**Keywords:** Second language teachers, ICT integration, Ecological Systems Theory, Multi-level framework, Cross-level interactions

## 1. Introduction

L2 teaching is undergoing a profound transformation due to digital technologies and Artificial Intelligence. ICT provides enhanced learning opportunities and reshapes classroom interaction. Under these circumstances, teachers are positioned not just as technology users but as instructional designers, learning facilitators, and integrators. Existing studies tend to focus on influencing factors at a single level—individual, classroom, or institutional. Although these studies have provided insightful empirical evidence, they have paid limited attention to cross-level feedback loops. Building on these limitations, this paper adopts Bronfenbrenner's Ecological Systems Theory as its analytical lens. This theory conceptualizes individual behavior as embedded within a dynamic ecological system where interactions across levels jointly shape individuals' cognition, behavior, and development. Compared with prior research perspectives, an ecological approach offers a more comprehensive explanatory framework for understanding L2 teachers' ICT integration.

## 2. Literature Review

### 2.1. Individual Teacher Level

At the individual teacher level, research primarily focuses on psychological and professional readiness. Early studies mainly focused on teachers' basic acceptance of ICT and the fundamental role of technological attitudes. The Technology Acceptance Model (TAM) suggests that perceived usefulness and ease of use influence usage intentions. As research has advanced, the focus has shifted to ICT enactment, highlighting ICT self-efficacy as a key mechanism linking attitudes to actual teaching behaviors. The Technological Pedagogical Content Knowledge (TPACK) framework explains how teachers integrate technology with pedagogy and subject content. Post-pandemic studies further highlight teachers' emotional resilience, agency, and identity shifts as critical conditions for sustained ICT integration. These individual-level explanations remain insufficient unless situated within the interactional and institutional contexts.

### 2.2. Instructional Interaction Level

In L2 classrooms, effective integration depends on alignment with teaching objectives, learning tasks, and teacher-student interaction modes. When technology is only used for demonstration, its role in facilitating language learning is limited. In contrast, when ICT supports authentic communication and feedback mechanisms, its potential can be fully realized. Instructional interaction operates as a recursive feedback loop through which classroom outcomes inform subsequent decisions. Interactional alignment functions as a key mesosystem mechanism that converts teachers' individual readiness into observable pedagogical practice.

### **2.3. School and Institutional Level**

Infrastructure, technical support, time resources, and managerial attitudes play an important role. Institutional support is not limited to equipment; it includes troubleshooting and resource sharing. Indifferent institutional attitudes and weak incentive systems can suppress adoption even when hardware is available. From an ecological perspective, these institutional conditions operate at the exosystem level, shaping teachers' instructional possibilities indirectly by configuring the resources and professional conditions.

### **2.4. Sociocultural and Policy Level**

National or regional educational policies and societal cultural attitudes provide a value framework. Differences in the understanding of "what constitutes effective teaching" across different cultural contexts influence teachers' expectations. These macro-level influences function as part of the macrosystem, providing normative orientations that shape institutional arrangements.

### **2.5. Student Level**

Student factors such as digital literacy, engagement, and feedback enter the recursive feedback loop of ICT-integrated teaching. Empirical studies suggest that interactional and affective characteristics of learners can significantly constrain teachers' sense of agency. Disparities in access to devices and home internet stability directly condition participation opportunities, thereby influencing task design and interaction quality. Student-related factors operate as cross-level moderators that influence the sustainability of teachers' ICT integration.

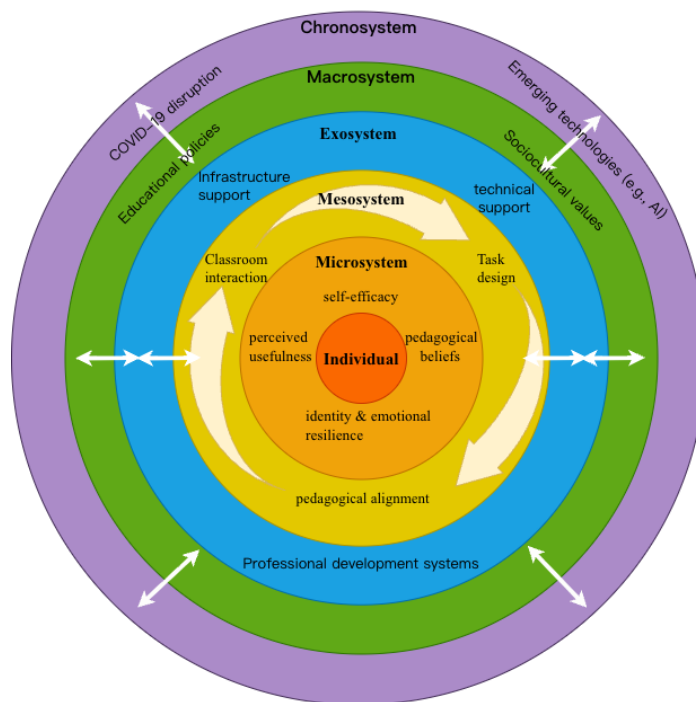
## **3. Toward a Multi-Level Ecological Framework**

Factors previously scattered can be integrated into a multi-level structure: Microsystem: Teachers' digital competence, self-efficacy, and beliefs. Mesosystem: Instructional interaction and professional collaboration. Exosystem: School systems, resource allocation, and management structures. Macrosystem: Educational policies and cultural values. Chronosystem: Impact of the pandemic and emerging technologies like AI.

At the microsystem–mesosystem interface, teachers' competence is translated into practice through task design. The exosystem shapes these possibilities indirectly by configuring teachers' action space. Across systems, student responses operate as critical feedback mechanisms. The chronosystem captures how temporal disruptions reconfigure these pathways, reshaping constraints and affordances across levels.

### **Figure 1**

*An Ecological Framework for Understanding L2 Teachers' ICT Integration*



#### 4. Method

This study adopts a theory-driven integrative review. Relevant literature was retrieved from the Web of Science (WOS) database, covering peer-reviewed articles from 2015 to 2025. A thematic synthesis approach was employed to map findings onto the ecological systems theory.

#### 5. Conclusion

Findings indicate that L2 teachers' ICT integration unfolds within a multi-level ecosystem. Individual resources require alignment with classroom interaction patterns in the mesosystem to be sustained. Exosystem-level supports condition mesosystem environments, while student feedback feeds back into teachers' confidence. This study advances research from factor-based classification toward a mechanism-oriented understanding of L2 teachers' ICT integration.

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