

Evolution of Digital Teaching Transformation over Three Decades: A Bibliometric Analysis of 1,292 Publications (1992–2026)

Chou, Hou Ting

Doctoral Student, Department of Education, National Chengchi University, Taipei

Ko, Yu Ching

Doctoral Student, Department of Education, National Chengchi University, Taipei

Research Overview

This study investigates the 34-year evolution of digital teaching research using VOSviewer to analyze 1,292 Scopus publications. By identifying core clusters and shifting frontiers from 1992 to 2026, it elucidates the paradigm shift from basic ICT infrastructure to complex, teacher-centered pedagogical transformation, offering insights for global initiatives.

Purpose of Study

The primary objective of this research is to visualize the longitudinal development of digital learning as an academic domain. Specifically, the study aims to:

1. **Map the Intellectual Landscape:** To visualize how research themes have branched out and interconnected from the early 1990s to the present AI-integrated era.
2. **Identify Core Mediating Variables:** To examine the central role of "Professional Development" as a catalyst that bridges the gap between technological availability and classroom practice.
3. **Analyze Historical Trajectories:** To track the thematic shift from hardware-centric integration to human-centric variables such as teacher self-efficacy and digital competence.
4. **Provide Policy Insights:** To offer evidence-based recommendations for national digital initiatives by aligning local implementation strategies with long-term global scholarly trends.

Research Methods

This study employs a quantitative scientometric approach. Data were retrieved from the Scopus database, which is renowned for its rigorous peer-review standards and extensive coverage of social science literature. A comprehensive search string was developed using Boolean operators: ("Digital Learning" OR "Educational Technology") AND ("Teacher" OR "Pedagogy") AND ("Professional Development" OR "Self-efficacy" OR "Competence"). The search was limited to articles and reviews published between 1992 and 2026 to capture a complete generational cycle of technology in education. **To ensure data integrity, a thesaurus file was applied during the VOSviewer process to merge synonymous terms and exclude irrelevant general descriptors.** The final dataset of 1,292 publications was processed using VOSviewer 1.6.20. Two primary techniques were applied: Keyword Co-occurrence Analysis to identify thematic hotspots, and Bibliographic Coupling to categorize the underlying intellectual clusters and sub-fields within the corpus.

Results and Discussion

4.1 The Dominant Pillars and the Mediating Strength of PD

The visualization results highlight "Educational Technology" as the primary foundational node of the network. However, the most significant finding lies in the prominence of "Professional Development," which recorded 143 occurrences and an exceptionally high Total Link Strength. This suggests that while technology provides the tools, Professional Development (PD) serves as the "connective tissue" of the field. **The centrality of PD indicates its role as a prerequisite for any technological intervention; without robust PD, the "Educational Technology" node remains isolated from actual pedagogical change.**

4.2 The Interplay of Competence and Self-efficacy

Beyond frequency, the density of the network reveals a strong correlation between "Teacher Competence" and "Self-efficacy." As the timeline progresses toward 2026, these two variables increasingly cluster with "Digital Learning," suggesting that the current research frontier is no longer satisfied with functional literacy. Instead, it seeks to understand the psychological readiness and internal motivation of educators as they navigate AI-driven environments.

4.3 Longitudinal Paradigm Shift: From "Integration" to "Learning"

Through **Overlay Visualization**, a clear chronological paradigm shift was identified across three distinct eras:

- **The Foundational Phase (1992–2005):** Research was characterized by terms like **"Technology Integration"** and "Computer-assisted Instruction." During this period, the focus was predominantly on "access"—bringing hardware into schools and ensuring basic functional literacy.
- **The Integration Phase (2006–2019):** Themes expanded into "Blended Learning" and "ICT Competence," reflecting a more nuanced understanding of how tools could supplement traditional pedagogy.
- **The Empowerment Phase (2020–2026):** The research frontier has decisively moved toward **"Digital Learning"** and "Artificial Intelligence." This indicates a shift from focusing on the "tool" (Integration) to focusing on the "essence of the act" (Learning). Modern research emphasizes adaptive learning environments and the psychological readiness of teachers, such as self-efficacy and resilience in digital contexts.

4.4 Cluster Insights and Pedagogical Implications

The bibliographic coupling analysis divided the literature into **four major clusters**. The **Red Cluster**, being the largest, demonstrates the inextricable link between **Educational Technology, Professional Development, and Teacher Education**. Discussion of these clusters reveals that successful digital transformation depends on moving beyond "one-off" training sessions toward sustained, collaborative professional growth. This aligns with the "human-centric" turn in recent literature, where the teacher's role is redefined from a content deliverer to a designer of digital learning experiences.

Conclusion

This longitudinal analysis of 34 years of scholarly work provides a high-level roadmap for future digital learning initiatives. First, the shift from "Integration" to "Learning" suggests that policies must evolve from hardware-driven metrics to

pedagogy-driven outcomes. Second, the enduring centrality of Professional Development (143 occurrences) proves that teacher growth is the only sustainable path for digital reform. For projects like Taiwan's "Digital Learning Refinement Project," the evidence suggests a pivot toward enhancing teacher self-efficacy and data-informed instruction. In conclusion, the global academic trajectory confirms that the future of educational technology is not found in the machines themselves, but in the professional agency and pedagogical transformation of the teachers who use them. **Ultimately, this study advocates for a "Pedagogy-First" policy framework in the post-pandemic digital era.**

Keywords

Digital Learning, Teacher Professional Development, Bibliometric Analysis, VOSviewer, Pedagogical Transformation.