

# Mapping the Challenges of 21st-Century Pedagogy: A Bibliometric Study

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## ABSTRACT

*This study examines the scholarly landscape concerning the challenges of 21st-century pedagogy through a bibliometric analysis of Scopus-indexed publications. Using a refined search strategy and applying inclusion criteria from 2010 to 2025, a total of 252 journal articles were analyzed. The findings show a significant increase in research output, with a notable surge after the COVID-19 pandemic, reflecting heightened global attention to digital learning, teacher readiness, online assessment, and equity in education. Keyword co-occurrence mapping reveals interconnected thematic clusters including digital pedagogy, 21st-century skills, instructional innovation, and emerging technologies such as artificial intelligence and immersive learning. Despite the increasing volume of research, notable gaps remain regarding empirical evidence, global representation, and holistic perspectives that integrate technological advancement with inclusive and human-centered pedagogy. The study recommends future research that strengthens methodological rigor, expands cross-contextual analyses, and explores sustainable frameworks for pedagogical transformation.*

Penelitian ini bertujuan memetakan lanskap ilmiah terkait tantangan pedagogi abad ke-21 melalui analisis bibliometrik terhadap publikasi yang terindeks Scopus. Dengan menggunakan strategi pencarian yang telah disempurnakan dan kriteria inklusi untuk periode 2010–2025, diperoleh 252 artikel jurnal yang dianalisis. Hasil penelitian menunjukkan peningkatan signifikan jumlah publikasi, terutama setelah masa pandemi COVID-19, yang mencerminkan meningkatnya perhatian global terhadap pembelajaran digital, kesiapan guru, penilaian daring, serta isu kesetaraan pendidikan. Pemetaan ko-okurensi kata kunci mengungkap kluster tematik yang saling terkait, seperti pedagogi digital, keterampilan abad ke-21, inovasi pembelajaran, serta teknologi yang sedang berkembang seperti kecerdasan buatan dan pembelajaran imersif. Meskipun tren publikasi meningkat, masih terdapat kesenjangan terkait bukti empiris, representasi global, dan pendekatan holistik yang mengintegrasikan teknologi dengan pedagogi yang inklusif dan berorientasi kemanusiaan. Penelitian ini merekomendasikan penguatan metodologi, perluasan kajian lintas konteks, dan eksplorasi kerangka pedagogi yang berkelanjutan.

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## 1. INTRODUCTION

21st century skills are essential for students to adapt to a rapidly changing world, ensuring their capability for continuous learning and problem-solving. 21st-century skills refer to a set of competencies vital for students to thrive in a rapidly changing world (Gresse von Wangenheim et al., 2021; Utari et al., 2020). These include critical thinking, communication, collaboration, creativity, and digital literacy, all of which support adaptability, lifelong learning, and effective problem-solving (Mor, 2025; Trilling & Fadel, 2013; Utari et al., 2020). In contrast, pedagogy in the twenty-first century describes the evolving methods and approaches used to teach and foster these skills (Ben-David Kolikant, 2019; Lorenzo & Gallon, 2019). Driven by technological progress, shifting societal needs, and new expectations for learners, contemporary pedagogy has moved beyond traditional instruction to embrace innovative practices that nurture the development of 21st-century skills (Asad & Nazir, 2025; Ben-David Kolikant, 2019; Sayadi & Pangandaman, 2025).

Education systems across the globe are required not only to provide knowledge acquisition but also to nurture higher-order thinking, creativity, problem-solving, collaboration, and adaptability—skills often referred to as *21st-century skills* (Mathew, 2024; Naik et al., 2024; Trilling & Fadel, 2013). This shift reflects a broader transformation in the philosophy and practice of teaching and learning, challenging educators, policymakers, and academic communities to rethink how pedagogy should respond to contemporary educational demands (Astuti et al., 2019; Liu & Thien, 2025). As a result, the concept of *21st-century pedagogy* has emerged as a field of intensified scholarly debate and inquiry, encompassing digital learning ecosystems, inclusive practices, learner agency, and competency-based approaches (J. Voogt & Roblin, 2012).

Despite the growing recognition of its importance, the implementation of 21st-century pedagogy continues to face multilayered challenges. The integration of technology, for example, has not automatically resulted in effective learning transformation (Nazarian et al., 2023; J. M. Voogt & Pareja Roblin, 2023). Many educators struggle with limited digital competence, insufficient pedagogical design knowledge, and lack of institutional support (Irfiana et al., 2023; J. M. Voogt & Pareja Roblin, 2023). Moreover, inequalities in access to digital resources have created gaps in learning opportunities, particularly highlighted during the COVID-19 pandemic when remote and hybrid learning became the primary mode of

delivery (OECD, 2019). These challenges indicate that advancing pedagogy for the 21st century is not merely a technical issue but also a cultural, structural, and epistemological one.

In addition to technological shifts, the 21st-century pedagogical landscape has been shaped by global policy frameworks that emphasize learner-centered approaches, equity, and lifelong learning. UNESCO's *Futures of Education* report stresses the need for pedagogies that foster interconnectedness, ethics, and sustainable societies (Carney, 2022; UNESCO, 2021). Similarly, the OECD Learning Compass framework highlights the role of transformative competencies—knowledge, values, attitudes, and skills—in preparing students for uncertain futures (OECD, 2019). These frameworks signal that pedagogy should move beyond traditional instruction to embrace relational, humanistic, and future-oriented learning paradigms.

Given these evolving demands, the scholarly interest in *21st-century pedagogy* has increased substantially, yet the knowledge base remains fragmented. Research spans diverse approaches, including digital pedagogy, blended learning, inquiry-based learning, critical pedagogy, and personalized learning (Ben-David Kolikant, 2019; Lorenzo & Gallon, 2019; Mathew, 2024; Yasa et al., 2024). However, there is still limited systematic mapping of how these themes develop, intersect, and evolve globally. A bibliometric approach offers a robust method to examine the structure, productivity, and intellectual patterns within this expanding field. Bibliometric analysis enables researchers to identify dominant themes, emerging trends, influential authors, and research clusters, offering a comprehensive understanding of how academic conversations on 21st-century pedagogy have developed over time (Donthu et al., 2021). This approach is particularly relevant given the interdisciplinary nature of the field and the rapid growth of published literature.

Therefore, this study aims to map the scholarly landscape of challenges associated with 21st-century pedagogy using bibliometric techniques. By analyzing scientific publications indexed in major academic databases, this research seeks to: (a) identify publication trends, (b) examine conceptual and thematic clusters related to pedagogical challenges, and (c) highlight emerging research directions and knowledge gaps requiring further investigation. The findings of this study are expected to contribute to both theory and practice by offering an evidence-based overview of the evolving landscape of 21st-century pedagogy and informing future research and policy formulation.

## **2. Method**

This study employed a bibliometric research design to map the scholarly landscape and examine the challenges of 21st-century pedagogy. Bibliometric analysis is widely recognized as an evidence-based methodological approach for understanding the intellectual structure, thematic evolution, and publication trends within a research domain through quantitative analysis of indexed literature (Abdullah, 2022; Donthu et al., 2021; Singh et al., 2024). This method was considered appropriate due to the increasing volume of publications related to 21st-century pedagogy and the need for systematic mapping to identify dominant themes, existing gaps, and emerging research directions.

### **Data Source and Search Strategy**

Scopus was selected as the primary database because it offers extensive indexing coverage, high-quality peer-reviewed publications, and established relevance for bibliometric studies in education and social sciences (Kondrashev et al., 2024; Singh et al., 2024). The search process was carried out in December 2025. To ensure conceptual alignment with the focus of the study, a search string was developed iteratively through preliminary trials and refinement. The final search query used was:

*(TITLE-ABS KEY("21<sup>st</sup> century" OR digital AND pedago\*) AND TITLE-ABS KEY("challenge\*" OR "barrier\*" OR "problem\*" OR "limitation\*" OR "constraint\*"))*

The Boolean operators, truncation symbol (\*), and field-specific limits were intentionally applied to increase recall accuracy and capture variations of the terms pedagogy, pedagogical, and pedagogies. The initial search yielded 1,706 documents.

### **Screening and Inclusion Criteria**

To ensure relevance and focus, a set of inclusion criteria was applied. The filtered articles met the following conditions:

- (a) publication year between 2010 and 2025,
- (b) document type limited to peer-reviewed journal articles,
- (c) English-language publications, and
- (d) search field limited to article titles to ensure conceptual precision.

After applying these criteria, 252 articles remained eligible for analysis. These documents were downloaded in .csv format for further processing. Duplicate records and

incomplete metadata were also reviewed and cleaned manually using Microsoft Excel, ensuring data consistency across analytical tools.

#### **Data Processing and Analysis**

The bibliometric dataset was analyzed using a combination of three software tools:

- Microsoft Excel was used for preliminary descriptive analysis, dataset refinement, and organization of metadata.
- RStudio (Biblioshiny package) facilitated advanced bibliometric analysis, including performance metrics, co-word analysis, thematic evolution, and cluster identification.
- VOSviewer was used to generate visual science maps such as keyword co-occurrence networks, authorship collaboration patterns, and citation structures, enabling interpretation of research dynamics and thematic clusters.

### **3. RESULT AND DISCUSSION**

#### **Publication Trend**

Figure 1 illustrates the annual growth of publications related to the challenges of 21st-century pedagogy between 2010 and 2025. The trend demonstrates a clear upward trajectory, showing how scholarly attention to this topic has progressively intensified over the last 15 years. The pattern can be categorized into three distinct phases. The first phase (2010–2016) marks the initial emergence, with consistently low publication numbers (1 to 8 annually). During this period, research primarily addressed practical technology use, such as slowmation as a digital technology, Teachers' perspectives on digital tools for pedagogic, Combining pedagogy with digital technologies (Dunn et al., 2012; Masterman & Manton, 2011; Vratulis et al., 2011).

The second phase (2017–2019) marks a transitional growth stage, where incremental increases become noticeable. Publications rose gradually, reaching approximately 11 documents in 2019. This period aligns with broader educational innovation trends, including the rise of digital learning ecosystems (Makarova & Makarova, 2018; OECD, 2019; Sailin & Mahmor, 2018). Although the increase remained modest, it indicates growing recognition of the complexity and practical challenges in implementing 21st-century pedagogy in diverse educational settings.

The third phase (2020–2023) represents the pandemic-driven acceleration stage, where a significant spike in research activity is observed. The pandemic accelerated the

adoption of blended learning models, combining face-to-face and online education, which showed promising results in terms of student performance and satisfaction (Fitria et al., 2025; Srok et al., 2024; Sullivan, 2021). This shift aligns with the sudden and large-scale transition to remote, online, and hybrid learning during the COVID-19 pandemic (Çakmak, 2022; Crawford et al., 2020; Gierhart, 2023). Scholars increasingly examined pressing pedagogical challenges such as digital equity, student engagement in virtual environments, teacher technological readiness, and assessment adaptations. The pandemic functioned as a catalyst that moved 21st-century pedagogy from theoretical debate into urgent practical implementation and problem-solving research.

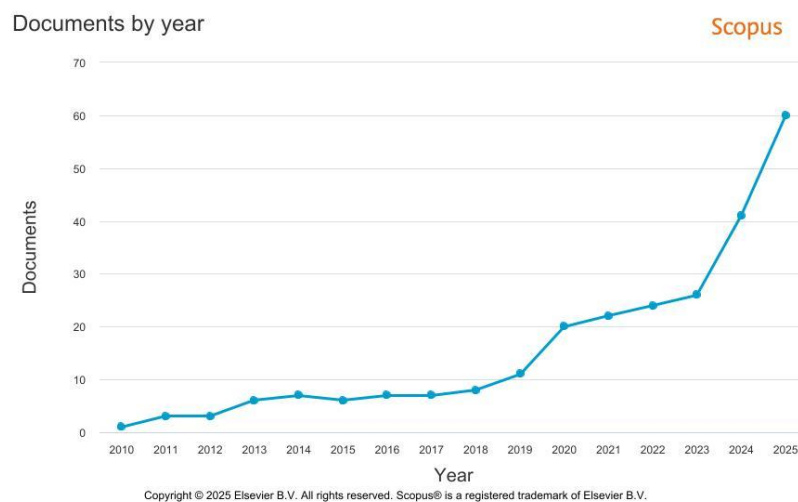


Figure 1. Annual Publication Years

The fourth phase (2024–2025) reflects the post-pandemic expansion stage, where publications surged dramatically, reaching the highest peak of over 60 articles in 2025. This escalation suggests a transition from emergency response research toward long-term pedagogical innovation and systemic reform. Research in this phase appears to focus on resilience-building, policy reorientation, and sustainable digital pedagogy integration, indicating a consolidation of lessons learned during the pandemic (Kasperski et al., 2022; Robandi et al., 2025; Sánchez Rojo et al., 2024; Slade et al., 2024).

In addition to the steady growth in publication volume, citation patterns further illustrate the increasing academic relevance of research on 21st-century pedagogy. As shown in the citation overview (Figure 2), the corpus of 252 analyzed documents has collectively generated **4,644 citations**, indicating strong scholarly engagement with the topic. Citation activity remained minimal in the earlier years, reflecting the limited number of studies available and the emerging nature of the field. However, similar to the publication trend,



A central observation from the map is that the term “pedagogy” appears as the core node, indicating its foundational role in linking discussions around education, teaching practices, and learning innovation. Closely connected to this core are keywords such as *education*, *digital pedagogy*, and *digital learning*, showing that the discourse on pedagogy in the 21st century is heavily shaped by the integration of digital technologies and instructional reforms.

One of the most prominent clusters relates to digital transformation in education. Terms such as *digital literacy*, *digital competence*, *digital tools*, and *digital education* form a dense network, suggesting that the shift towards technology-mediated learning environments is one of the most frequently discussed themes. The presence of *digital divide* and *equity* indicates that access, readiness, and capability remain critical challenges in the global adoption of digital pedagogy.

Another key thematic area centers on teaching and learning strategies. Keywords such as *collaborative learning*, *inquiry-based learning*, *project-based learning*, *critical pedagogy*, and *professional development* suggest that research extends beyond technological aspects and includes pedagogical redesign aimed at fostering critical thinking, engagement, and learner autonomy. The appearance of *STEM education*, *computational thinking*, and *21st-century skills* reflects alignment with global education frameworks emphasizing competence-based learning.

A notable thematic thread is the emergence of COVID-19 and remote learning, positioned near clusters related to *virtual learning*, *higher education*, and *digital transformation*. This placement reinforces earlier findings that the pandemic accelerated research interest, particularly around emergency remote teaching, teacher adaptation, and the sustainability of online learning models.

Finally, terms such as *artificial intelligence*, *virtual reality*, *sustainability*, and *digital humanities* appear on the map as emerging or future-oriented concepts. Although less frequent, their presence suggests a developing trajectory where innovations like AI-supported teaching, immersive learning environments, and interdisciplinary digital fields are beginning to shape the next phase of pedagogical research.

### Research Gap and Future Research Recommendations

The findings from the publication trend, citation patterns, and thematic cluster mapping indicate that although research on 21st-century pedagogy has expanded significantly, several gaps remain within the existing body of literature. These gaps reflect conceptual, methodological, and contextual limitations that provide direction for future inquiry.

One noticeable gap relates to the limited depth of empirical evidence supporting many pedagogical innovations. While digital pedagogy, collaborative learning, and inquiry-based approaches frequently appear in the literature, much of the research remains theoretical or conceptual (Caparoso & Orleans, 2024; Wynn, 2025; Yasa et al., 2024). This suggests a need for more rigorous empirical studies such as longitudinal research, controlled intervention studies, and mixed-method designs to examine how emerging pedagogical practices translate into measurable student outcomes across diverse learning environments.

Another gap concerns the focus on technology rather than pedagogy as a systemic construct. While terms such as *digital literacy*, *artificial intelligence*, and *virtual learning* dominate the map, themes related to equity, ethics, student well-being, and socio-emotional learning appear less frequently (Ayanwale et al., 2025; Nurhikmah et al., 2024; Saig & Hershkovitz, 2024). This suggests that pedagogical debates may be evolving faster in technological dimensions than in human-centered or values-based frameworks. Future studies should therefore integrate holistic perspectives by examining how technology intersects with inclusion, emotional development, sustainability, and humanistic education principles.

Methodologically, the map reveals a limited presence of future-oriented scenario modeling and policy-level research, despite the growing urgency for long-term transformation. Research agendas may therefore expand toward foresight studies, learning analytics, AI-driven instructional design, and systemic reform modeling to anticipate future educational demands beyond post-pandemic responses. Based on these gaps, several recommendations emerge. Future research should:

- (1) strengthen empirical evidence through experimental and longitudinal designs;
- (2) expand cross-regional and comparative research to address global inequality;
- (3) integrate multidisciplinary perspectives bridging technology, ethics, well-being, and socio-cultural dimensions; and

- (4) explore forward-looking frameworks including AI pedagogy, immersive learning environments, and policy transformation models.

#### **4. CONCLUSION**

The findings of this bibliometric study show that research on the challenges of 21st-century pedagogy has experienced substantial growth, with publication and citation patterns indicating increasing scholarly attention, particularly after the COVID-19 pandemic accelerated digital learning adoption and exposed gaps in teacher preparedness, equity, and instructional design. The thematic mapping further highlights how digital pedagogy, learning technologies, 21st-century skills, innovative instructional approaches, and issues related to digital access and competence form interconnected research areas shaping the discourse, while emerging concepts such as artificial intelligence, immersive learning, and computational thinking signal a shift toward more advanced and future-oriented pedagogical models. Despite this progress, gaps remain in empirical evidence, global representation, and holistic approaches that balance technological advancement with human-centered values, student well-being, and inclusive learning. These insights point to the need for continued research that deepens methodological rigor, expands cross-regional perspectives, and explores sustainable frameworks for transforming pedagogy in ways that respond to evolving educational demands and prepare learners for increasingly complex and digitally mediated futures.

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