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Digital Technology in Differentiated English Language Teaching: A Systematic Review with Bibliometric Insights

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ABSTRACT

This study aimed to systematically review research on digital technology in differentiated English language teaching by integrating a systematic literature review with bibliometric mapping. The data were collected from Scopus and analyzed using PRISMA guidelines and VOSviewer. Results indicated that digital platforms, learning management systems, and adaptive technologies were central to personalization. Advanced technologies such as artificial intelligence, big data, and the Internet of Things are emerging but underutilized. These technologies are significant because they enable real-time adaptation and enhance learner-centered instruction, although institutional readiness, teacher competence, and infrastructure mediate their effectiveness. Bibliometric insights showed three clusters: pedagogical integration, institutional innovation, and data-driven personalization. This review contributes by linking pedagogy, science, and technology, offering a framework for scaling and sustaining digital differentiation in English language teaching. The findings are expected to guide educators, policymakers, and researchers toward effective and equitable technology-enhanced instruction.

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1. INTRODUCTION

The rapid development of digital technology provides new opportunities to overcome these challenges [1,2]. Tools such as learning management systems (LMS), e-learning platforms, adaptive learning software, and multimedia resources have enabled educators to streamline assessments, personalize learning pathways, and foster active participation [3,4]. More recently, advanced technologies such as artificial intelligence, big data, and the Internet of Things (IoT) have expanded possibilities for real-time analytics, automated feedback, and personalized learning environments that align with the principles of differentiated instruction [5,6]. From a science and technology perspective, these developments signify a transition from descriptive accounts of technology use toward data-driven and evidence-based models that offer greater precision in learner-centered differentiation.

Despite these advances, research and practice reveal significant barriers. Specifically, when we face differentiated instruction. Differentiated instruction has long been recognized as a pedagogical framework designed to address learner diversity in the classroom by modifying content, process, product, and learning environment according to students' readiness, interests, and learning profiles [7]. In English Language Teaching (ELT), we must find many strategies for teaching [8-15]. This is because learners often come from heterogeneous linguistic, cultural, and educational backgrounds, making differentiation essential to ensure inclusivity and learner engagement [16]. However, despite its theoretical promise, differentiated instruction faces persistent challenges in practical implementation, particularly in contexts where teachers must manage large classes with varied levels of proficiency and limited instructional resources [17].

First, teachers' levels of digital competence vary widely, and many educators struggle to integrate adaptive technologies into classroom practice effectively [18]. Second, preparing differentiated digital learning materials is time-intensive, often placing an unsustainable burden on teachers [16]. Third, infrastructure challenges (including inconsistent internet access, insufficient devices, and inadequate technical support) continue to constrain the scalability of digital differentiation, particularly in under-resourced contexts [19]. These gaps between theoretical potential and practical realities underscore the need for more systematic investigation of how digital technologies are applied in differentiated ELT and what institutional, pedagogical, and technological conditions influence their success.

The absence of a focused review of digital technology in differentiated ELT represents an important scholarly gap. Narrative reviews have provided valuable insights into the pedagogical potential of differentiation, and bibliometric studies have mapped general patterns in educational technology research [20,21]. However, there has been no comprehensive synthesis that integrates both systematic literature review (SLR) and bibliometric mapping to specifically address how digital technologies are conceptualized, implemented, and evaluated in the context of differentiated ELT. Without such a synthesis, educators and policymakers may lack the evidence base needed to guide technology adoption, curriculum innovation, and teacher professional development.

This study addresses that gap by conducting a systematic review, supported by bibliometric insights, on research concerning digital technology in differentiated English language teaching between 2015 and 2025. The systematic review component ensures methodological rigor through transparent inclusion and exclusion criteria, while the bibliometric analysis offers a scalable and objective overview of publication trends, collaborative networks, and emerging themes. Together, these approaches provide both depth and breadth, revealing not only the state of the art but also the directions in which the field is evolving.

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The novelty of this study lies in its integrated approach, which combines pedagogical analysis with science and technology perspectives. By examining the role of artificial intelligence, big data, IoT, and digital platforms within differentiated ELT, this review highlights both established practices and cutting-edge innovations. Moreover, by situating these findings within the broader context of institutional readiness (such as policy alignment, infrastructure, and teacher competence), the study provides a holistic framework for understanding the factors that enable or constrain digital differentiation. The impact of this review is threefold. First, it contributes to theoretical advancement by linking differentiation principles with emerging digital technologies in a coherent framework. Second, it informs practice by offering evidence-based recommendations for educators and institutions seeking to adopt digital differentiation strategies. Third, it supports policy by identifying areas where investment in teacher training and infrastructure is most needed. In doing so, this study responds to the increasing demand for scalable and sustainable solutions that leverage digital technology to enhance differentiated instruction in English language teaching.

2. METHODS

This study adopted a Systematic Literature Review (SLR) approach based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines [22]. The PRISMA framework was chosen because it provides a structured procedure for ensuring rigor and reproducibility in literature selection. **Figure 1** presents the PRISMA flowchart that guided the systematic review process. The diagram illustrates the four key stages (identification, screening, eligibility, and inclusion) that were followed to ensure methodological transparency and replicability in constructing the final dataset.

The process began with the identification phase, where bibliographic data were retrieved from the Scopus database on 12 August 2025. Scopus was selected because of its broad coverage of peer-reviewed journals and its reliability in indexing multidisciplinary educational research [23].

The initial search query, “Differentiated AND Digital Technology”, applied to article titles, abstracts, and keywords, produced 1009 records. A keyword filter was then used to exclude irrelevant publications, resulting in 263 candidate studies. The dataset was subsequently limited to publications from 2015 to 2025 to capture contemporary developments in digital technology applied to differentiated instruction, yielding 247 studies.

During the screening stage, non-eligible document types were removed, including conference papers, book chapters, reviews, books, editorials, and conference reviews, leaving 170 articles. In the eligibility phase, non-English publications were excluded (Chinese = 16, Russian = 5, French = 4, German = 2). Further screening was applied to open access types to ensure data quality, and 106 studies advanced to full-text appraisal. The final inclusion phase confirmed 93 studies that met all predefined criteria: Peer-reviewed, indexed in Scopus, written in English, focused on differentiated teaching and learning with digital technology in ELT, and containing complete bibliographic metadata.

For the bibliometric analysis, VOSviewer software (version 1.6.20) was employed to construct and visualize bibliometric networks, including co-authorship, keyword co-occurrence, and citation patterns [24]. Detailed information regarding how to use bibliometrics is explained elsewhere [25-27].

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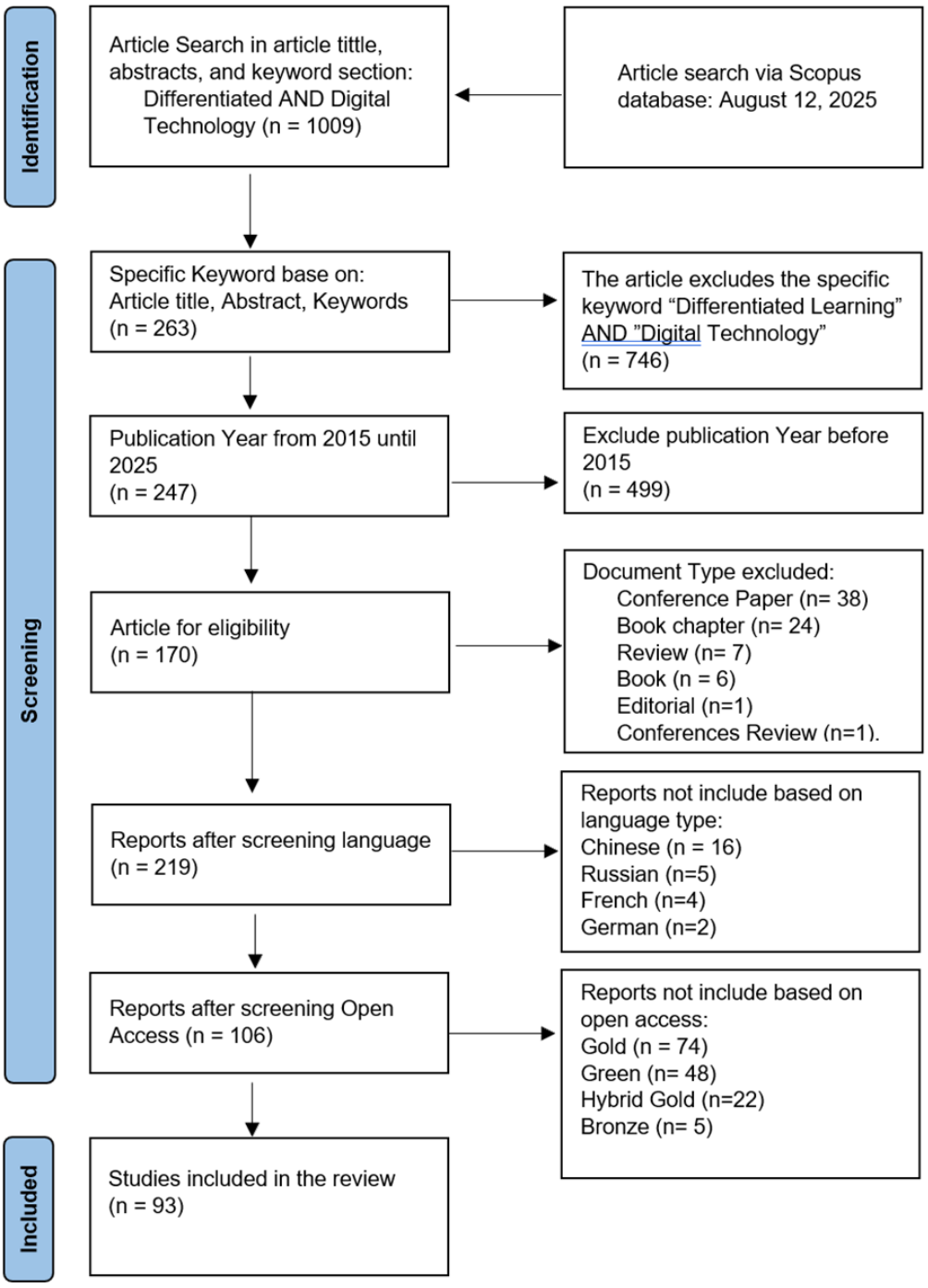

Figure 1. PRISMA Flowchart of Identification and Selected Studies.

3. RESULTS AND DISCUSSION

3.1. Bibliometric analysis results

Bibliometric analysis is recognized as one of the effective methods for mapping and understanding research trends within a particular field because it systematically examines publication patterns, collaboration networks, and thematic developments. **Table 1** presents previous studies that have applied bibliometric approaches across various topics, demonstrating how this method provides insights into the evolution of scholarship and identifies gaps for future inquiry.

The bibliometric analysis provides additional insights into the landscape of research. By mapping publication trends, co-authorship networks, and keyword co-occurrence,

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bibliometrics offers an objective overview that complements the qualitative synthesis of systematic review findings. This dual perspective is valuable because it reveals not only what individual studies report but also how the field is structured and evolving as a whole.

Table 1. Previous studies on bibliometric analysis.

No	Title	Ref.
1	Bibliometric analysis using VOSviewer with Publish or Perish of computational thinking and mathematical thinking in elementary school	[28]
2	The research trend of statistical significance test: Bibliometric analysis	[29]
3	Computational bibliometric analysis of research on science and Islam with VOSviewer: Scopus database in 2012 to 2022	[30]
4	Digital transformation in special needs education: Computational bibliometrics	[31]
5	Bibliometric analysis of briquette research trends during the COVID-19 pandemic	[32]
6	Bibliometric analysis of research development in sports science with VOSviewer	[33]
7	Bibliometric analysis of high school keyword using VOSviewer indexed by Google Scholar	[34]
8	Problem based learning (PBL) learning model for increasing learning motivation in chemistry subject: Literature review with bibliometric analysis	[35]
9	Bibliometric analysis for understanding the correlation between chemistry and special needs education using VOSviewer indexed by Google	[36]
10	Correlation between meditation and Buddhism: Bibliometric analysis	[37]
11	Correlation between meditation and religion: Bibliometric analysis	[38]
12	Bibliometric analysis using VOSViewer with Publish or Perish of metacognition in teaching English writing to high school learners	[39]
13	Phytoremediation with Cucumis sativus: A bibliometric study	[40]
14	Correlation of metabolomics and functional foods research in 2020 to 2023: Bibliometric analysis	[41]
15	Nutritional research mapping for endurance sports: A bibliometric analysis	[42]
16	Exploring global research trends on the integration of information technology in pragmatic studies: A bibliometric analysis	[43]
17	Hazard identification, risk assessment, and determining control (HIRADC) for workplace safety in manufacturing industry: A risk-control framework complete with bibliometric literature review analysis to support sustainable development goals (SDGs)	[44]
18	Examining climate change issues for improving cross-generation awareness in 21st century agenda: A bibliometric approach	[45]
19	Bibliometric analysis using VOSviewer with Publish or Perish of identifying local legends through project-based learning for critical thinking skills in English	[46]
20	Bibliometric analysis of the integration of digital tools in marine conservation education	[47]
21	Bibliometric analysis using VOSviewer with Publish or Perish of CEFR-based comparison of English language teaching models for communication	[48]
22	Four years of the ASEAN Journal of Religion, Education, and Society (AJORES): A bibliometric analysis	[49]
23	Bibliometric data analysis of research on resin-based brake-pads from 2012 to 2021 using VOSviewer mapping analysis computations	[50]
24	Correlation between process engineering and special needs from bibliometric analysis perspectives	[51]
25	A bibliometric analysis of seed priming: Global research advances	[52]
26	Bibliometric analysis for understanding “science education” for “student with special needs” using VOSviewer	[53]
27	The use of zeolite material as a filtration media in waste treatment: Bibliometric analysis	[54]
28	Evaluation of assessment projects in English language education: A bibliometric review	[55]
29	Bibliometric analysis using VOSviewer with Publish or Perish of Chinese speaking skills research	[56]
30	Bibliometric analysis using VOSviewers with Publish or Perish of “academic reading”	[57]

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Table 1 (continue). Previous studies on bibliometric analysis.

No	Title	Ref.
31	Bibliometric analysis in chemistry education: Exploring system thinking skill in water treatment	[58]
32	Bibliometric analysis on artificial intelligence research in Indonesia vocational education	[59]
33	Past, current and future trends of salicylic acid and its derivatives: A bibliometric review of papers from the Scopus database published from 2000 to 2021	[60]
34	Techno-economic feasibility and bibliometric literature review of integrated waste processing installations for sustainable plastic waste management	[61]
35	Production of wet organic waste ecoenzymes as an alternative solution for environmental conservation supporting sustainable development goals (SDGs): A techno-economic and bibliometric analysis	[62]
36	Computing bibliometric analysis with mapping visualization using VOSviewer on "pharmacy" and "special needs" research data in 2017-2021	[63]
37	A bibliometric analysis of global trends in engineering education research	[64]

Table 2 presents a summary of previous bibliometric studies that have examined trends in differentiated instruction and educational technology. While these works highlight the growth of scholarship in the area, most remain general in scope or focus on broader trends in education and technology, without specifically analyzing the intersection of digital technology and differentiated ELT.

Table 2. Selected references on differentiated instruction and bibliometric analysis.

No	Judul	Ref.
1	Mapping research on differentiated instruction: A bibliometric review of the literature in the last 20 years	[65]
2	The trends of differentiated instruction research: Bibliometric analysis spanning 1961–2023	[66]
3	Differentiated instruction at higher education institutions: Bibliometric analysis	[67]
4	The trend of differentiated instruction research: Bibliometric and content analysis	[68]
5	Trend research mapping of differentiated instruction: A bibliometric analysis	[69]
6	Conceptual model of differentiated-instruction (DI) based on teachers' experiences in Indonesia	[70]
7	Bibliometric analysis of technology trends in education: Analysis from 2018 to 2022	[71]
8	Global research trends of digital learning media in science education: A bibliometric analysis	[72]
9	Digital leadership in education: A bibliometric analysis	[73]
10	How well developed are altmetrics? Cross-disciplinary analysis of the presence of alternative metrics in scientific publications	[74]
11	Clustering scientific publications based on citation relations: A systematic comparison of different methods	[75]
12	Bibliometric analysis of agile software development	[76]
13	The impact of social media in learning and teaching: A bibliometric-based citation analysis	[77]
14	Mental health research in response to the H1N1, Ebola, and COVID-19 outbreaks: A comparative bibliometric analysis	[78]
15	The gender gap in highly prestigious international research awards, 2001–2020	[79]

Figure 2 shows the analysis of scholarly contributions by country, highlighting the international landscape of research on differentiated teaching and learning with digital technology in English language teaching. The figure reveals that the United Kingdom, China, the United States, and the Netherlands dominate in terms of publications and citation impact, while emerging contributions are visible from countries such as Ethiopia, the Philippines, and Tanzania.

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The bibliometric evidence in **Figure 2** illustrates that digital technology for differentiated instruction in ELT has become a truly global research agenda, although concentrated leadership remains with a small group of countries. This concentration suggests that while technological solutions for differentiated instruction are being developed worldwide, their integration and evaluation often depend on strong research ecosystems in high-output nations. Importantly, countries with emerging outputs demonstrate strategic potential because collaboration linkages with leading nations enable the transfer of models and methods, thereby expanding the scope of differentiated practices across contexts.

Figure 3 illustrates the co-occurrence of keywords extracted from the dataset, demonstrating the thematic prominence of terms such as "digital technologies," "digitalization," "education," and "differentiated instruction." These keywords appear frequently and exhibit strong link strengths, confirming that digital technology is a central node in the literature on differentiated ELT.

Create Map

Verify selected countries

Selected	Country	Documents	Citations	Total link strength
☑	united kingdom	12	293	962
☑	netherlands	6	176	576
☑	south africa	5	80	485
☑	united states	10	521	451
☑	switzerland	5	380	432
☑	china	21	506	302
☑	ethiopia	2	23	282
☑	philippines	2	14	263
☑	tanzania	2	14	263
☑	canada	2	209	197
☑	germany	10	104	196
☑	denmark	3	36	157
☑	india	3	103	155
☑	belgium	2	17	140
☑	ukraine	4	23	128
☑	sweden	2	13	120
☑	france	2	10	116
☑	south korea	5	53	95
☑	russian federation	11	77	75
☑	kazakhstan	4	65	68

Figure 2. Analysis of Scholarly Contributions by Country.

Create Map

Verify selected keywords

Selected	Keyword	Occurrences	Total link strength
☑	digital technologies	6	7
☑	digitalization	6	7
☑	technology	4	6
☑	artificial intelligence	2	5
☑	big data	2	5
☑	education	3	5
☑	digital transformation	6	4
☑	e-learning	2	4
☑	medication label	2	4
☑	smart pillbox	2	4
☑	students	3	4
☑	tuberculosis	4	4
☑	innovation	3	3
☑	technological innovation	3	3
☑	differentiated instruction	2	2
☑	digital literacy	3	2
☑	iot	2	2
☑	covid-19	3	1
☑	digital health	2	1
☑	digital technology	5	1

Figure 3. Co-occurrences of Keywords.

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Figure 4 provides a network visualization of keywords, highlighting the clusters that link digital technologies to educational and pedagogical concepts. The figure demonstrates that digital technologies are closely tied to education and digital transformation, while differentiated instruction appears as a smaller but integral node.

The visualization in **Figure 4** supports the observation that digital technologies function as thematic hubs connecting multiple concepts. Interestingly, while terms such as "e-learning" and "blended learning" orbit around these hubs, they do not achieve the same density of linkages, suggesting that they are treated as subcategories rather than central concepts. This implies that the field has achieved consensus on the necessity of digital technologies for differentiation but has yet to fully theorize and empirically validate the mechanisms by which specific subtools contribute to differentiated outcomes.

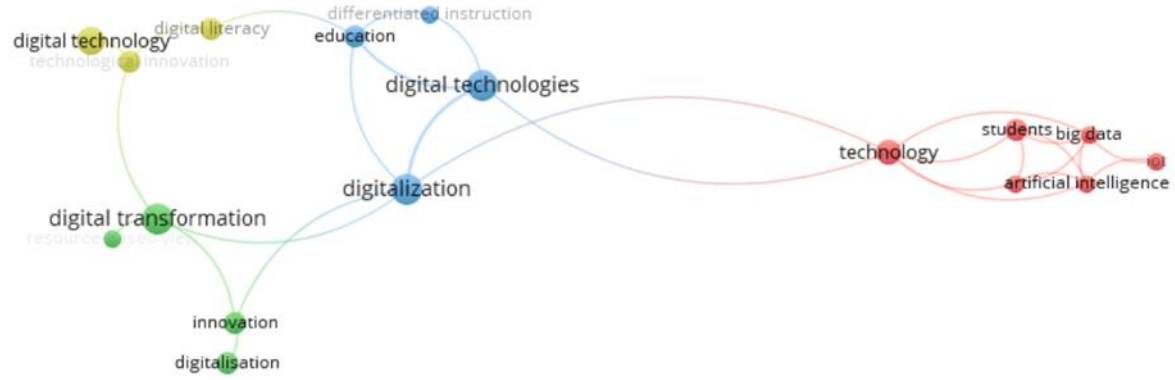

Figure 4. Network visualization of keywords.

Figure 5 illustrates the network visualization of countries involved in publications, highlighting collaborative linkages among leading and emerging nations. While China and the United States contribute the largest number of outputs, the United Kingdom shows the strongest international collaborations. These networks are significant because advanced technologies such as artificial intelligence, big data, and the IoT often require robust research ecosystems and cross-institutional collaboration to be effectively developed and implemented.

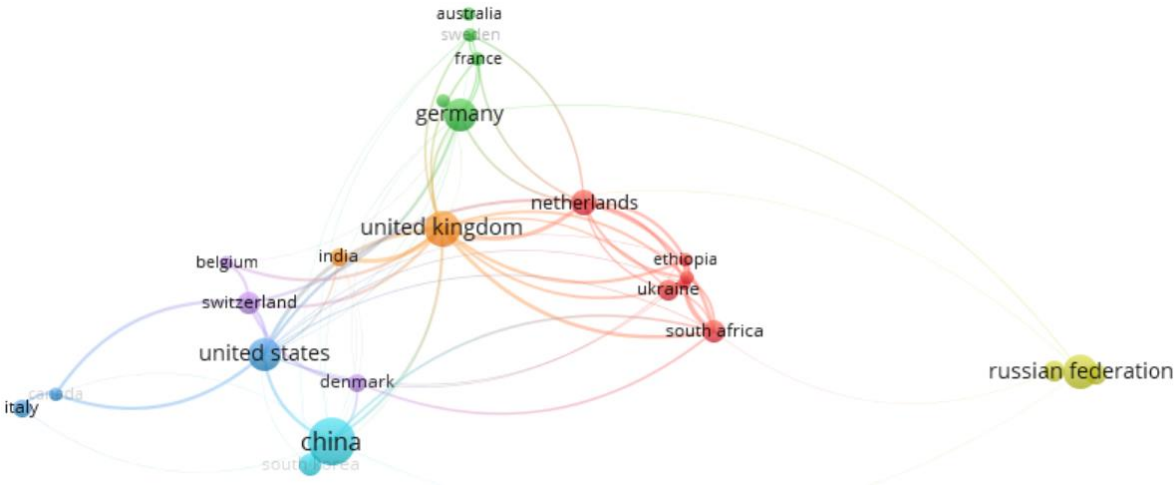

Figure 5. Network Visualization of Countries that are Involved.

Figure 6 presents the conceptual framework developed in this study, linking pedagogical foundations, digital integration, advanced technologies, and methodological mapping. The

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framework positions AI, big data, and IoT as extensions of digital integration, moderated by institutional readiness and evaluated through bibliometric and systematic evidence.

The framework depicted in **Figure 6** underscores the necessity of aligning advanced technologies with pedagogical principles and institutional contexts. It illustrates that while AI, big data, and IoT expand the technical possibilities of differentiation, their success depends on institutional readiness, teacher competence, and ethical considerations. In other words, technological sophistication alone does not guarantee educational improvement; rather, technologies must be embedded within holistic systems that connect pedagogy, infrastructure, and capacity building.

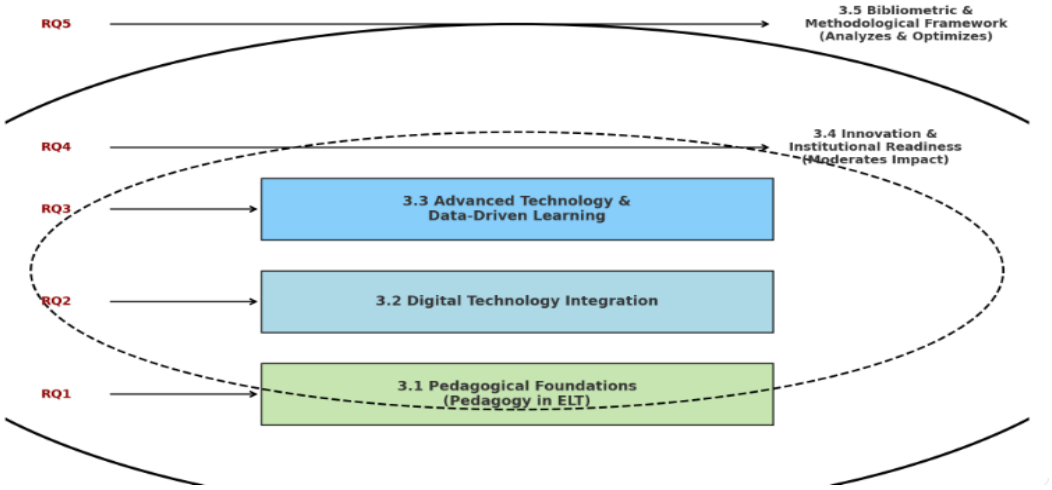

Figure 6. Conceptual Framework of Linking Pedagogical Foundations, Technology, and Methodological Mapping.

From the bibliometric results, several patterns stand out. First, research activity increased significantly between 2019 and 2023, coinciding with the global shift to online learning during the COVID-19 pandemic. This surge demonstrates how external pressures accelerate innovation and research dissemination. Because of the pandemic, institutions rapidly adopted digital platforms, and researchers responded by documenting both successes and challenges. The bibliometric spike, therefore, reflects not only technological advancement but also contextual urgency.

Second, collaboration networks reveal unequal participation across regions. African and Southeast Asian countries appear in the dataset but with limited link strength, indicating weaker integration into global research networks. This imbalance matters because digital differentiation is especially relevant in diverse and multilingual contexts often found in these regions. Without stronger research participation, innovations risk being driven primarily by Western and East Asian contexts, potentially overlooking the realities of under-resourced classrooms.

Third, thematic clusters suggest that while digital integration and institutional innovation are well represented, data-driven personalization remains underdeveloped. Keywords such as “artificial intelligence” and “big data” appear in the map but with lower frequency and weaker connections compared to general terms like “education” and “digital technologies.” This confirms findings from the systematic review that advanced technologies are still in exploratory stages. The bibliometric evidence is significant because it demonstrates that these themes are present but not yet mainstreamed, offering a roadmap for future research to deepen exploration in this area.

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The bibliometric findings also align with gaps identified in the systematic review. One recurring gap is the lack of attention to assessment practices. Despite the availability of digital assessment tools and the centrality of assessment in differentiation, keywords related to assessment are rare. This indicates that while technologies are used to deliver content, their potential for supporting differentiated assessment remains underexplored. Another gap is equity and access, which is similarly absent from the keyword clusters despite its importance in determining who benefits from digital differentiation. These absences reveal a disjunction between the challenges reported in individual studies and the priorities reflected in aggregate research trends.

Bibliometric evidence further highlights the methodological diversity of the field. Studies in technologically advanced contexts often employ experimental or quasi-experimental designs to test the impact of AI or adaptive platforms. In contrast, studies from emerging contexts are more likely to use descriptive surveys or case studies to report on challenges of implementation. This methodological imbalance suggests that future research should aim for greater variety across contexts, combining rigorous experimental approaches with situated qualitative analyses to provide both breadth and depth.

Finally, bibliometric analysis contributes to the impact of this review by positioning digital technology in differentiated ELT within broader scientific and technological discourses. The clustering of terms around innovation and digital transformation shows that differentiated ELT is not isolated but part of wider conversations about the future of education in the digital age. Because bibliometric mapping provides a bird's-eye view, it validates the relevance of the topic within educational research and highlights its alignment with global trends in digital science, artificial intelligence, and learning analytics.

Bibliometric insights confirm that research on digital technology in differentiated ELT is expanding, globalizing, and diversifying, but also reveal enduring gaps in assessment, teacher cognition, and equity. The evidence underscores that while digital technologies and pedagogical innovation are central themes, advanced technologies such as AI, big data, and IoT remain underrepresented. Institutional readiness and teacher competence are acknowledged but not yet deeply theorized in bibliometric terms. These findings support the systematic review's argument that the field is maturing but requires deliberate attention to neglected areas if digital differentiation is to achieve its full potential.

3.2. Digital Technology Integration in ELT

The prominence of "digital technologies" and "digitalization" indicates that research in this domain consistently situates differentiation within broader digital transformation agendas. In practice, this means that teachers increasingly rely on mainstream digital platforms (such as LMS and e-learning environments) to design and deliver differentiated instruction. These tools enable modularization of content, flexible sequencing of tasks, and the use of multimedia resources to cater to diverse learner profiles [80,3]. For instance, teachers may release different sets of grammar exercises through LMS release conditions or use multimedia presentations to address varied learning styles, thereby operationalizing differentiation principles of content, process, and product.

However, the bibliometric evidence also reveals that the keyword "digital technology" itself has relatively weak link strength despite frequent use. This suggests that many studies invoke the term in general terms without specifying how particular digital tools translate into differentiated outcomes. As a result, while digital technology is a common label, detailed pedagogical mechanisms remain under-theorized. This gap is consistent with findings from systematic review studies that argue for more explicit mapping of digital tools to

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differentiation strategies [20]. Without such specificity, the field risks treating technology as a black box rather than as a set of features and practices with measurable impacts on learner outcomes.

Beyond LMS and e-learning, blended learning environments have also become a frequent context for differentiated ELT. Blended learning combines face-to-face instruction with online activities, offering teachers opportunities to group learners dynamically, provide asynchronous practice, and use digital assessment tools to monitor progress [4]. From a science and technology perspective, blended learning represents an application of digital integration that bridges physical and virtual spaces, enabling adaptive feedback loops through data collected online and acted upon in real classrooms.

Adaptive learning platforms provide another layer of digital technology integration. These systems rely on algorithmic tracking of learner interactions to adjust task difficulty and sequence automatically. Within differentiated ELT, adaptive systems operationalize the principle of readiness-based instruction by ensuring that students encounter tasks suited to their current proficiency level [19]. The systematic review evidence suggests that while adaptive learning platforms are not yet widespread, their potential for tailoring instruction at scale makes them an important focus for future practice and research [18].

Nevertheless, integration challenges remain. Teachers frequently report difficulties in designing differentiated materials that fully exploit digital platforms. The time and expertise required to prepare varied resources can exceed the capacity of many educators, especially when institutional support is limited [16]. Moreover, infrastructure disparities (such as unstable internet connectivity and insufficient access to devices) further constrain the effectiveness of digital integration, particularly in low-resource contexts [19]. These findings underscore the importance of coupling technological innovation with professional development and infrastructural investment to ensure sustainable integration.

From a technological science perspective, the integration of digital technologies into differentiated ELT can be seen as a layered ecosystem. At the infrastructure layer, platforms such as LMS provide the environment for modularized delivery. At the pedagogical layer, adaptive and blended approaches allow teachers to align content with learner diversity. At the data layer, analytics provide feedback loops that inform instructional decisions. Together, these layers illustrate how digital technologies are not simply add-ons but integral components of a system that enables differentiated learning at scale.

Despite the maturity of digital technology integration in differentiated ELT, gaps remain evident. First, the literature underrepresents the role of assessment practices (formative and summative) in digital differentiation. Although LMS platforms frequently include assessment functions, few studies detail how assessment data informs differentiated grouping or content adjustment. Second, equity and access issues are rarely foregrounded, even though digital differentiation depends heavily on infrastructure availability. Finally, teacher cognition (including beliefs, attitudes, and self-efficacy toward digital differentiation) is mentioned less frequently in bibliometric mapping, indicating a need for further empirical investigation. These gaps highlight the necessity of aligning pedagogical principles with technological affordances and ensuring that technology-supported differentiation addresses not only instructional efficiency but also fairness and inclusivity.

3.3. Advanced Technologies (AI, Big Data, IoT)

The prominence of countries with strong digital infrastructure and research investment suggests that the adoption of advanced technologies in differentiated ELT is closely tied to national capacities. This observation aligns with findings from the systematic review, which

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show that the application of AI and data-driven approaches remains concentrated in technologically advanced regions [5]. However, collaborations with emerging economies indicate the potential for transfer and contextual adaptation, signaling a gradual diffusion of innovations across diverse educational settings.

Artificial intelligence (AI) has gained increasing attention in the literature as a tool for enabling real-time adaptation and personalized feedback in ELT. AI-driven platforms can analyze learner input, predict proficiency trajectories, and recommend tailored resources, thereby operationalizing readiness-based differentiation at scale [6]. For example, natural language processing models embedded in writing platforms provide individualized grammar corrections, while AI chatbots can simulate conversational practice aligned with a learner's proficiency level. From a science and technology perspective, AI represents a shift from static instructional design to dynamic systems capable of continuous recalibration based on learner performance.

Yet, the systematic review reveals that despite its potential, AI integration in differentiated ELT remains limited in scope and scale. Many studies describe pilot projects or conceptual proposals rather than fully implemented classroom applications. Challenges include the lack of teacher training in AI literacy, ethical concerns about data privacy, and uncertainty about how AI-generated insights should be integrated into pedagogical decision-making [18]. Moreover, the literature often highlights technological capabilities without sufficiently addressing their pedagogical alignment, leading to risks of adopting AI as a novelty rather than as a meaningful enabler of differentiation.

Big Data analytics offer another promising avenue for supporting differentiated ELT. By aggregating and analyzing large-scale learner data, big data systems can identify patterns of engagement, highlight at-risk learners, and inform groupings based on proficiency levels or learning behaviors [5]. In blended or online learning environments, clickstream data and usage logs can reveal which learners benefit from certain activities, allowing teachers to adjust content delivery. This evidence-based feedback loop exemplifies how science and technology principles of data-driven modeling can inform pedagogy, transforming differentiation from an intuitive process into a measurable and replicable practice.

Nevertheless, the systematic review indicates that big data applications in ELT remain underexplored. Although many platforms collect extensive data, few studies explicitly report how this information is harnessed to refine differentiated instruction. Issues of data governance, interoperability across platforms, and teacher capacity to interpret analytics remain barriers [3]. These findings underscore the importance of developing institutional policies and professional development programs that equip teachers to interpret data responsibly and translate insights into differentiated strategies.

The IoT adds a further layer of possibility by connecting physical classroom environments with digital platforms. IoT devices (such as smart boards, connected tablets, and sensor-based monitoring systems) can collect multimodal data on learner interactions, participation, and even affective states. In differentiated ELT, such technologies could enable teachers to receive real-time feedback on student engagement, allowing immediate instructional adjustments. For example, sensors that track response times in group discussions could identify students requiring additional scaffolding, while IoT-enabled adaptive environments could adjust task difficulty or provide supplementary resources automatically.

However, the integration of IoT in differentiated ELT is still at an exploratory stage, with most studies emphasizing potential rather than empirical validation [19]. Barriers include high costs, infrastructure requirements, and concerns about surveillance and the ethical implications of constant data collection. From a pedagogical standpoint, IoT raises questions

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about how multimodal data should be interpreted and whether teachers are equipped to act on these insights in real time. Without clear frameworks, there is a risk that IoT may generate data overload rather than actionable intelligence for differentiation.

Despite these challenges, the convergence of AI, big data, and IoT within differentiated ELT illustrates a broader trend toward smart education ecosystems. These ecosystems integrate multiple layers of technology to provide continuous, adaptive, and personalized learning experiences. From a science and technology perspective, such integration represents the evolution of differentiated instruction from teacher-dependent strategies toward hybrid human, machine systems that extend teachers' capacity to respond to learner diversity. Importantly, the literature emphasizes that these technologies are not substitutes for teachers but amplifiers of instructional capacity, enabling differentiation at scales previously unattainable.

Overall, the literature reveals both opportunities and limitations in the adoption of advanced technologies for differentiated ELT. The opportunities lie in the capacity of AI, big data, and IoT to provide real-time, data-driven personalization that enhances learner engagement and achievement. The limitations arise from insufficient pedagogical frameworks, ethical concerns, and infrastructural inequalities that constrain equitable access. Therefore, future research must focus on bridging the gap between technological innovation and practical implementation, ensuring that advanced technologies contribute to inclusive, ethical, and pedagogically sound differentiation in ELT.

3.4. Institutional Readiness & Teacher Competence

The integration of digital technology into differentiated English language teaching is not only a matter of technological availability but also of institutional readiness and teacher competence. Across the 93 reviewed studies, institutional contexts consistently emerged as decisive factors that shaped the success or failure of digital differentiation. Although advanced technologies such as artificial intelligence and big data provide technical opportunities, their impact depends heavily on whether institutions have established the infrastructure, policy frameworks, and professional development mechanisms to sustain their use [19,20].

Institutional readiness encompasses multiple dimensions, including digital infrastructure, policy alignment, administrative support, and financial investment. Studies from high-resource contexts such as the United Kingdom, the Netherlands, and Switzerland highlight that robust infrastructure and supportive policies accelerate adoption because they reduce barriers for teachers and provide consistent platforms for practice [5]. In contrast, studies from emerging economies, such as Ethiopia and the Philippines, reveal that even when teachers demonstrate enthusiasm for digital differentiation, weak connectivity, insufficient devices, and fragmented policy support undermine the sustainability of implementation [16]. These findings indicate that institutional readiness acts as a mediating factor between technological potential and practical outcomes.

Teacher competence represents another critical dimension. Digital differentiation requires teachers not only to understand pedagogical strategies but also to operate digital platforms, analyze data, and design adaptive materials. This combination of pedagogical and technological literacy is often referred to as technological pedagogical content knowledge (TPACK), and it is essential for realizing the promise of differentiation in digital contexts [18]. Teachers who lack sufficient digital skills often default to traditional instructional methods, thereby limiting the transformative capacity of technologies. Conversely, teachers who are

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confident in both pedagogy and technology demonstrate greater creativity in designing differentiated pathways and in leveraging analytics to inform grouping and scaffolding.

Evidence from the reviewed studies shows that teacher workload is another recurring challenge. Designing differentiated materials within digital platforms requires significant time investment, especially when tasks must be tailored across multiple proficiency [4]. Without institutional mechanisms to support workload management (such as collaborative planning teams, resource banks, or automated adaptive systems), teachers may experience burnout, reducing their willingness to sustain digital differentiation practices. This finding is consistent with broader educational research indicating that teachers' adoption of technology is influenced not only by competence but also by perceived workload and institutional support.

Professional development programs play a key role in building teacher competence and reducing workload stress. Effective programs are characterized by ongoing training, hands-on practice, and alignment with institutional goals. For example, studies highlight that one-off workshops often fail to produce sustained changes because teachers require continuous support to integrate new technologies into their routines [80]. Moreover, professional development that links directly to classroom practice (such as lesson study models or peer mentoring) tends to be more effective because it contextualizes digital differentiation strategies within real teaching scenarios. This demonstrates that teacher competence is not merely a matter of individual capacity but is socially constructed within institutional cultures of collaboration and support.

From a policy perspective, institutional readiness also involves setting priorities for digital transformation. Some institutions explicitly embed digital differentiation into strategic plans, curriculum guidelines, and assessment frameworks. This top-down commitment ensures that teachers' efforts are supported by systemic alignment, thereby reducing tensions between innovation and accountability [3]. In contrast, institutions without clear policies often leave digital differentiation as an optional or peripheral practice, resulting in uneven implementation and inconsistent outcomes. The bibliometric analysis further confirms that countries with explicit national strategies for digital education tend to produce higher-quality research and practice on differentiated ELT.

Equity and access remain pressing concerns. Institutional readiness must include policies to ensure that all learners benefit from digital differentiation, regardless of socioeconomic background or geographic location. Several studies caution that without deliberate strategies, digital technologies may exacerbate rather than reduce inequalities because learners with better access to devices and connectivity disproportionately benefit from adaptive systems [6]. For example, in large urban schools, differentiated digital resources may enhance personalization, while in rural schools with poor connectivity, students may be excluded from such opportunities. This reinforces the need for institutions to invest not only in infrastructure but also in inclusive policies that guarantee equitable access.

Teacher cognition (teachers' beliefs, attitudes, and self-efficacy toward digital differentiation) also plays a central role. Bibliometric evidence shows that while "digital literacy" frequently appears as a keyword, "teacher cognition" is relatively underrepresented. Yet, studies indicate that teachers' beliefs about the value of digital differentiation strongly influence their willingness to adopt new technologies [16]. Teachers who perceive digital tools as enhancing their capacity to meet student needs are more likely to experiment and persist despite challenges. Conversely, teachers who view technology as an additional burden often resist integration. This suggests that institutional readiness must extend beyond material support to include cultural change that fosters positive attitudes toward innovation.

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Importantly, the reviewed studies emphasize that institutional readiness and teacher competence are interdependent. Even highly skilled teachers may struggle in contexts with inadequate infrastructure, while strong infrastructure cannot guarantee effective differentiation without competent teachers. The conceptual framework presented earlier (see **Figure 6**) illustrates this interdependence by positioning institutional readiness as a moderator between technological potential and pedagogical practice. This highlights the need for integrated strategies that build capacity at both institutional and individual levels.

The literature demonstrates that institutional readiness and teacher competence are not secondary considerations but fundamental determinants of whether digital technology achieves its potential in differentiated ELT. Institutions must provide infrastructure, supportive policies, and professional development because these elements create enabling environments in which teachers can translate technological affordances into pedagogical practices. Teachers, in turn, must cultivate digital competence, pedagogical adaptability, and positive beliefs about technology because these capacities determine how effectively tools are implemented in classrooms. Together, these factors underscore that digital differentiation is as much an institutional and human endeavor as it is a technological one.

3.5. Overall Insights from the Review

This review synthesized systematic and bibliometric evidence on digital technology in differentiated English language teaching. By combining a PRISMA-guided literature review with bibliometric mapping, the study provided both depth and breadth in understanding how digital tools are applied, how advanced technologies are emerging, and how institutional and teacher factors shape implementation.

The findings indicate that digital technologies such as learning management systems, e-learning platforms, and blended learning environments have become central enablers of differentiated ELT. These platforms support modularized delivery, flexible sequencing, and the integration of multimedia, thereby making it possible to address diverse learner profiles. However, their pedagogical contribution remains limited because many studies describe digital technology in general terms without specifying how tools operationalize differentiation. This lack of clarity matters because differentiation requires explicit strategies that align technology functions with learner needs.

Advanced technologies such as artificial intelligence, big data, and the IoT show significant promise because they enable real-time analytics, adaptive feedback, and multimodal data collection. They are important because they transform differentiation from an intuitive, teacher-driven process into a data-informed and scalable practice. Yet, the review reveals that these technologies are still underutilized, often appearing in pilot studies or conceptual discussions rather than widespread classroom applications. The slow uptake occurs because institutional readiness and teacher competence remain bottlenecks. Institutions without reliable infrastructure and supportive policies struggle to sustain innovation, and teachers without adequate digital literacy are unable to translate technical potential into meaningful pedagogy.

Bibliometric insights confirmed that the field is maturing, with rising publication trends, strong collaboration networks, and thematic clustering around digital integration, institutional innovation, and personalization. Nevertheless, important gaps persist. Assessment practices, equity and access, and teacher cognition remain marginal in bibliometric maps, even though they are repeatedly cited as challenges in individual studies. This misalignment suggests that while digital differentiation is expanding, research priorities

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have not yet fully addressed the issues most critical for sustainable and inclusive implementation.

The contribution of this review is threefold. Theoretically, it connects differentiated instruction with science and technology by framing digital tools, AI, big data, and IoT as layered enablers within pedagogical ecosystems. Practically, it provides educators with evidence-based strategies for leveraging digital platforms while highlighting the importance of professional development and workload management. From a policy perspective, it underscores the need for institutional investment in infrastructure, equity, and teacher training because these conditions determine whether digital differentiation succeeds.

Future research should focus on developing frameworks that explicitly link assessment, teacher cognition, and equity with digital differentiation, ensuring that technology enhances inclusivity rather than reinforcing disparities. Studies should also move beyond exploratory designs to test scalable models in diverse contexts, bridging the gap between innovation and practice.

Digital technology has become indispensable for differentiated ELT, and advanced technologies expand the boundaries of what is possible. However, their impact depends on alignment with pedagogy, institutional readiness, and teacher competence. This review contributes a comprehensive framework that integrates pedagogical, technological, and institutional perspectives, offering a roadmap for future research and practice. Because education systems worldwide face increasing learner diversity, the effective use of digital technology in differentiation is not only desirable but necessary for achieving equitable and sustainable learning outcomes.

4. CONCLUSION

This study systematically reviewed digital technology in differentiated English language teaching, supported by bibliometric insights. The findings demonstrate that digital platforms such as learning management systems and blended learning environments are widely applied, while advanced technologies, including artificial intelligence, big data, and the IoT, remain underutilized. Institutional readiness and teacher competence strongly influence success because technology alone cannot guarantee effective differentiation. Overall, the review provides an integrated framework linking pedagogy, technology, and institutional support, offering direction for future research and practice toward more equitable and sustainable differentiated instruction.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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