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Teachers' digital competencies: a systematic review

Competencias digitales de los docentes: una revisión sistemática

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Abstract

This research analyzes teachers' digital competencies. The PRISMA 2020 methodology was used, allowing for the review of articles published between 2023 and 2026. Articles in English were selected as inclusion criteria. The search for articles was conducted in the Scopus and SciELO databases. The search terms were: "digital competence" AND "teachers". A total of 1,051 articles were retrieved, of which 12 were selected from Scopus and 8 from SciELO, for a total of 20 articles included in the analysis. The study concludes that teachers' digital competencies are fundamental for integrating technology into teaching, improving professional performance, and fostering meaningful learning and critical thinking. Their development depends on motivation, access to resources, and ongoing training, although areas such as digital content creation still need strengthening. Strengthening these competencies requires ongoing training programs, institutional support, and adequate infrastructure. Gaps persist related to technological access and the study of emerging technologies such as artificial intelligence, highlighting the need for further research for inclusive and sustainable digital education.

Keywords: Digital skills, strategies, gaps.

Resumen

La presente investigación analiza las competencias digitales de los docentes. Se utilizó la metodología PRISMA 2020, que permitió la revisión de artículos entre los años 2023 y 2026. En los criterios de inclusión, se seleccionaron artículos en idioma inglés. Se realizó la búsqueda de artículos en las bases de datos de Scopus y Scielo. Los términos de búsqueda fueron: "digital competence " AND "teachers". Para la realización de los resultados, se obtuvieron 1051 artículos, se seleccionaron 12 artículos de Scopus y 8 de la base de datos Scielo, siendo un total de 20 artículos para el análisis de resultados. Concluyendo que las competencias digitales docentes son fundamentales para integrar tecnologías en la enseñanza, mejorar el desempeño profesional, promover el aprendizaje significativo y el pensamiento crítico. Su desarrollo depende de la motivación, el acceso a recursos y la formación continua, aunque aún existen

áreas por fortalecer como la creación de contenidos digitales. Su fortalecimiento requiere programas de capacitación permanente, apoyo institucional e infraestructura adecuada. Persisten brechas vinculadas al acceso tecnológico y al estudio de tecnologías emergentes como la inteligencia artificial, lo que evidencia la necesidad de mayor investigación para una educación digital inclusiva y sostenible.

Palabras clave: Competencias digitales, estrategias, brechas.

Introduction

It is appropriate to begin by establishing a working definition of teachers' digital competencies. This concept encompasses the knowledge, skills, and capacities that enable the effective integration of digital technologies into teaching and learning processes, thereby facilitating the use of innovative resources, personalized instruction, and adaptation to rapidly evolving technological environments. The development of such competencies is fundamental to the implementation of advanced digital tools and to meeting the demands of contemporary education (Kukushkina et al., 2025).

In preparing future professionals, educators have encountered challenges directly tied to the cultivation of their own digital competencies. This stems from the increasingly demanding nature of the labor market, which requires digital literacy and ongoing skill updating, a reality that underscores the need to strengthen technological preparedness among teachers, a process that can begin within educational institutions themselves (Aliu et al., 2023). Strengthening digital competencies in higher education remains an ongoing challenge, as the use of technological resources for learning depends on levels of digital literacy and on teachers' ability to navigate technology-mediated educational settings (Campillo-Ferrer & Miralles-Martínez, 2023).

In Latin America, the development of teachers' digital competencies continues to present a pressing need in higher education, driven by the demand to strengthen the pedagogical integration of technologies and to promote training processes that can respond to the constant changes in digital educational environments (Flores et al., 2023).

Within this context, the digital competencies of basic education teachers pose challenges related to training and mastery of information and communication technologies, a situation that calls for reinforced capacity-building processes to improve their integration into educational practice (Montesano de Talavera et al., 2023).

Moreover, digital competencies allow teachers to use digital technologies effectively in teaching processes, to communicate, create content, manage information, and solve educational problems, thereby fostering learning experiences that align with contemporary technological demands (Keerthi & Maheswari, 2026).

In the twenty-first century, the digital era has made the use of information and communication technologies indispensable. The expansion of the digital world opens new possibilities for addressing and collaborating across numerous domains. Digital competence is one of the crucial skills that teaching staff must possess. The need to adequately acquire new information capabilities in the information society has been one of the primary drivers of curricular change. Although digital technologies are increasingly used in education, understanding how they can be leveraged to advance and improve effective pedagogical techniques remains essential. The development of digital teaching skills poses a challenge for teacher training and should be a priority for educational institutions and public education policies alike (Yadav, 2023).

Teachers' digital competencies are crucial for modern education, as they directly influence student engagement, address learning difficulties, and prepare teachers for the twenty-first-century labor market. Mastery of digital tools transforms educators from mere content transmitters into classroom

facilitators, ethical guides, and technological mediators (Leoste et al., 2022). In this regard, the general objective of the present study is to analyze teachers' digital competencies.

Methodology

A systematic review was conducted following the indicators of the PRISMA 2020 methodology. The keywords used were "digital competence" AND "teachers," with AND as the Boolean operator. Inclusion criteria encompassed publications from 2023 to 2026, and only articles written in English were considered. Exclusion criteria ruled out books, articles without access, and conference proceedings.

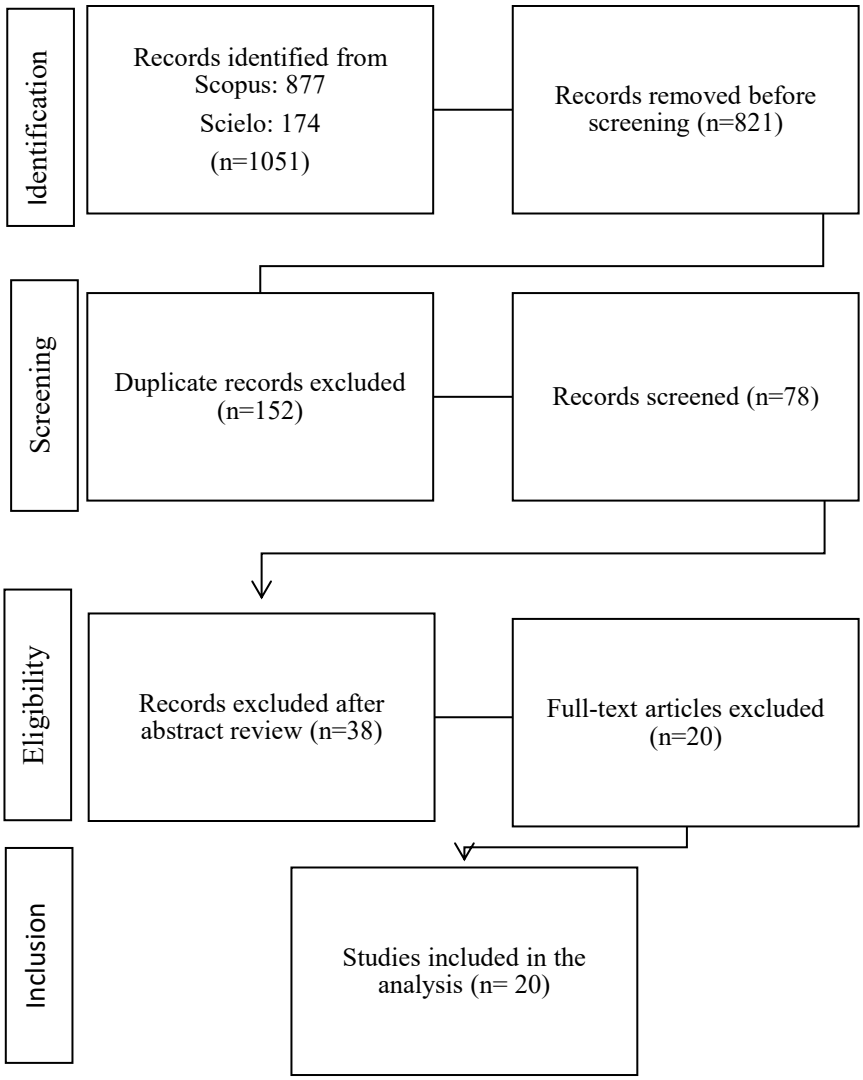
The search was performed in open-access databases, specifically Scopus and SciELO. From a total of 1,051 articles, 12 were selected from Scopus and 8 from SciELO, resulting in a final corpus of 20 articles for result analysis.

Table 1 presents the search strings employed to guide the analysis. These strings, related to the research categories, were prioritized in English and combined with the Boolean operator AND as a search mechanism to refine the unit of analysis to teachers.

Table 1. *Search strings used in database searches.*

Database	Search terms	Results	Selected
Scopus	"digital competence " AND ‘’teachers’’	877	12
Scielo	"digital competence " AND ‘’teachers’’	174	8
		1051	20

Figure 1. *PRISMA flow diagram.*



Results and discussion

The main findings of the analysis of teachers' digital competencies are presented below, organized around four thematic axes: the importance of digital competencies in teaching practice, teachers' perception and level of digital competencies, strategies for strengthening these competencies, and the challenges and gaps in research on the subject.

Table 2. *Implications of teachers' digital competencies.*

No.	Author	Implications of digital competencies
1	Suwono & Prasetyo (2026)	Strengthening teachers' digital competencies requires professional development programs that integrate technological training, pedagogical support, and spaces for reflective practice. Frameworks such as DigCompEdu contribute to the effective use of technologies in

		teaching, while strategies such as mentoring, microteaching, and self-directed learning foster the ongoing development of digital skills. Persistent challenges related to infrastructure and specialized training influence the consolidation of these competencies in educational settings.
2	Joshi et al. (2026)	Teachers' levels of digital competence are influenced by factors such as motivation to use technologies and access to digital resources. Although there is a high willingness to use ICT in teaching, infrastructure limitations and resource availability may constrain the development of more advanced digital capabilities within educational practice.
3	Tian et al. (2026).	Teachers' digital competence can be understood multidimensionally, encompassing aspects such as digital awareness, technological skills, application of digital resources, social responsibility in virtual environments, and professional development. Its assessment allows for the identification of varying levels of teacher preparedness in response to the demands of educational digitalization, particularly in contexts with unequal access to resources and training opportunities.
4	Gentner et al. (2026).	Strengthening teachers' digital competencies requires organizational conditions that facilitate the incorporation of educational technologies, including adequate infrastructure, training spaces, peer support, and time availability for training and pedagogical innovation. These elements promote more effective implementation of digital tools in educational practices.
5	Lee et al. (2026)	In Uzbekistan, medical education teachers report high levels of digital competence, particularly in using technologies for teaching and selecting digital resources; however, improvement needs persist in areas such as digital content creation, personalized learning, and ongoing professional development.
6	Pérez-Escoda et al. (2026).	Strengthening teachers' digital competencies requires training programs oriented toward the critical use of social media, the management of misinformation, and the integration of digital resources that foster student learning and digital competence development.
7	Topal & Geçer. (2024)	Gaps in teachers' digital competencies are associated with inequalities in access to technological infrastructure, digital resources, and training opportunities, especially in contexts marked by socioeconomic and territorial disparities, which limits inclusive educational technology integration.
8	Berková et al. (2024)	Teachers' perceptions and uses of digital tools vary according to factors such as age, gender, and teaching area, reflecting different levels of digital competence and attitudes toward technological integration in educational practice.
9	Shiang et al. (2024).	Developing digital competencies is fundamental for promoting critical analysis, responsible use of digital media, and the formation of citizens capable of evaluating information in increasingly complex digital environments.

10	Hamdan et al. (2024)	Implementing learning projects centered on digital literacy, educational uses of AI, and active methodologies supports the strengthening of digital competencies and pedagogical innovation in higher education.
11	Arslankara et al., (2024)	Strengthening teachers' digital competencies requires continuous, collaborative, and personalized professional development programs that promote the pedagogical integration of technology and the responsible use of digital tools in the classroom.
12	Igboanugo (2024).	Preparedness to integrate digital technologies into teaching depends primarily on access to training opportunities and competence development, with no significant gender-related differences among teachers.
13	Ruyffelaert (2024).	Training in digital skills enables teachers to integrate technology-based resources into teaching and learning, thereby strengthening their professional performance and educational support for students.
14	Wijayanti et al. (2024)	Teachers' digital competencies in areas such as assessment, artificial intelligence, preparation for emerging technologies, and post-pandemic educational challenges remain areas of concern.
15	Hirsch & Rubach (2024).	Strengthening teachers' digital competencies requires the combination of diverse pedagogical strategies during initial training, as their application fosters the development of the technological and pedagogical knowledge necessary for effectively integrating technology into teaching.
16	Cazurro (2024)	Training in teachers' digital competencies is fundamental to ensuring quality digital education, facilitating student integration into the knowledge society, and promoting safe and effective learning environments in digital contexts.
17	Wahyuni et al. (2024)	Teachers' digital competencies contribute to more appropriate technology use in educational settings and support practices that reduce sedentary behaviors in early childhood, benefiting students' psychomotor development and well-being.
18	Gogollari et al. (2024)	Limitations persist regarding teachers' digital competencies, teaching strategies, and institutional structures necessary for the sustainable implementation of digital education, indicating areas requiring further attention and development.
19	Feng & Sumettikoon (2024).	There remains a limited understanding of how different dimensions of teachers' digital literacy relate to one another in specific areas such as English language teaching, highlighting the need for further evidence to strengthen professional development.
20	Lyu & Luo. (2024)	Digital competencies contribute to teachers' job performance by fostering psychological empowerment and professional satisfaction, aspects that enhance the quality of their educational work.

Importance of digital competencies in teaching practice

The development of digital competencies holds considerable significance for teachers. In the first place, it promotes teachers' own critical analysis; in addition, it helps convey responsible use of digital media to students (Shiang et al., 2024). This training in digital competencies enables teachers to integrate

technological resources into teaching-learning processes, thereby strengthening their professional performance and educational support for students (Ruyffelaert, 2024).

Such strengthening of teachers' digital capacities requires the combination of various pedagogical strategies during initial training, as their application supports the development of the technological and pedagogical knowledge necessary for effective technology integration in teaching (Hirsch & Rubach, 2024). In this way, training in teachers' digital competencies proves fundamental to guaranteeing quality digital education and to facilitating safe and effective learning environments in digital contexts (Cazurro, 2024).

Finally, although it may seem counterintuitive, proper pedagogical use of teachers' digital competencies also contributes to reducing sedentary behaviors in early childhood, thereby benefiting students' psychomotor development and well-being (Wahyuni et al., 2024). It is in this teaching act that teachers develop their psychological empowerment and professional satisfaction, aspects that strengthen the quality of their educational work (Lyu & Luo, 2024).

Teachers' perception and level of digital competencies

Teachers' level of digital competence is influenced by factors such as motivation to use technologies and access to digital resources. Although there is a high willingness to use ICT in teaching, infrastructure constraints and resource availability may limit the development of more advanced digital skills within educational practice (Joshi et al., 2026). Teachers' digital competence can be understood multidimensionally, encompassing digital awareness, application of digital resources, social responsibility in virtual environments, and professional development. Its assessment allows for the identification of varying levels of teacher preparedness vis-à-vis the demands of educational digitalization, particularly in contexts with unequal access to resources and training opportunities (Tian et al., 2026).

Although medical education teachers report elevated levels of digital competence, especially in using technologies for teaching and selecting digital resources, improvement needs persist in digital content creation, personalized learning, and ongoing professional development (Lee et al., 2026). Teachers' perceptions and uses of digital tools differ according to factors such as age, gender, and teaching area, reflecting varying levels of digital competence and attitudes toward technological integration in educational practice (Berková et al., 2024).

Preparedness to integrate digital technologies into teaching depends primarily on access to training opportunities and competence development, with no significant gender-related differences among teachers (Igboanugo, 2024). There remains a limited understanding of how different dimensions of teachers' digital literacy relate to one another in specific areas such as English language teaching, underscoring the need for further evidence to strengthen professional development (Feng & Sumettikoon, 2024).

Strategies for strengthening teachers' digital competencies

At the strategic level, strengthening teachers' digital competencies requires programs that foster ongoing professional development, including technological training, pedagogical support, and spaces for reflective practice. Frameworks such as DigCompEdu contribute to this development while also improving student learning. Strategies such as mentoring, microteaching, and self-directed learning likewise support the continuous development of digital skills (Suwono & Prasetyo, 2026). Strengthening teachers' digital competencies demands institutional conditions that facilitate the incorporation of educational technologies, including adequate infrastructure, training spaces, peer support, and time availability for training and pedagogical innovation. These elements enable more effective implementation of digital tools in educational practices (Gentner et al., 2026).

Strengthening teachers' digital competencies further requires training programs oriented toward the critical use of social media, the management of misinformation, and the integration of digital resources that support learning (Pérez-Escoda et al., 2026). Implementing learning projects centered on digital literacy,

educational uses of artificial intelligence, and active methodologies fosters digital competencies and pedagogical innovation in higher education (Hamdan et al., 2024).

Strengthening teachers' digital competencies also calls for continuous, collaborative, and personalized professional development programs that promote the pedagogical integration of technology and the responsible use of digital tools in classrooms (Arslankara et al., 2024).

Challenges and gaps in research on teachers' digital competencies

Gaps in teachers' digital competencies are associated with inequalities in access to technological infrastructure, digital resources, and training opportunities, especially in contexts shaped by socioeconomic and territorial disparities, which limits inclusive educational technology integration (Topal & Geçer, 2024). Further research is still needed on teachers' digital competencies in areas such as assessment, artificial intelligence, preparation for emerging technologies, and post-pandemic educational challenges (Wijayanti et al., 2024).

In light of the foregoing, limitations persist regarding teachers' digital competencies, teaching strategies, and the institutional structures necessary for the sustainable implementation of digital education, areas that clearly require greater attention and development (Gogollari et al., 2024).

Conclusions

With respect to the importance of digital competencies in teaching practices, the review concludes that they are relevant for integrating technologies into educational processes, for strengthening the performance of education professionals, and for promoting the development of meaningful learning, critical thinking, and responsible use of digital resources by students.

Regarding teachers' perception and levels of digital competence, the evidence indicates that the development of these skills depends on factors such as motivation, access to technological resources, and training opportunities. Although many teachers exhibit favorable levels of digital competence, areas still require strengthening, particularly digital content creation and ongoing professional updating.

Concerning strategies to strengthen teachers' digital competencies, it is important to promote continuous training programs that are collaborative and contextually grounded, accompanied by adequate infrastructure and institutional support to facilitate effective technology integration into educational practice.

Finally, with regard to challenges and gaps in research on teachers' digital competencies, limitations persist related to unequal access to technological resources, preparation for emerging technologies, and the study of new areas such as artificial intelligence and digital assessment. These needs underscore the importance of continued research that contributes to strengthening inclusive and sustainable digital education.

In this regard, the study proposes strengthening teachers' digital competencies through strategies focused on digital content creation and the effective use of generative artificial intelligence for designing teaching-learning activities, thereby reducing the time spent on educational activity preparation.

References

Aliu, J., Aghimien, D., Aigbavboa, C., Oke, A., Ebekozien, A., & Temidayo, O. (2023). Empirical investigation of discipline-specific skills required for the employability of built environment graduates. *International Journal of Construction Education and Research, 19*(4), 460–479. https://doi.org/10.1080/15578771.2022.2159589

Arslankara, V. B., Arslankara, E., Asan, I., Külekçi, M., & Seferoğlu, S. S. (2024). Professional development for K-12 educators. *En Effective Computer Science Education in K-12 Classrooms* (pp. 263–292). https://doi.org/10.4018/979-8-3693-4542-9.ch010

Berková, K., Kubišová, A., Frendlovská, D., Krpálková Krelová, K., Krpálek, P., & Vacínová, T. (2024). The relation among vocational teachers' use of digital and mobile tools and socio-demographic factors.

International Journal of Interactive Mobile Technologies, 18(24), 82–99. https://doi.org/10.3991/ijim.v18i24.50867

Campillo-Ferrer, J.-M., & Miralles-Martínez, P. (2023). Impact of an inquiry-oriented proposal for promoting technology-enhanced learning in a post-pandemic context. *Frontiers in Education, 8,* 1204539. https://doi.org/10.3389/feduc.2023.1204539

Cazurro Barahona, V. (2024). La regulación del derecho a la educación digital. *Revista de Educación y Derecho,* (2), 82–114. https://doi.org/10.1344/REYD2024.2-Extraordinario.49174

Feng, L., & Sumettikoon, P. (2024). An empirical analysis of EFL teachers' digital literacy in Chinese higher education institutions. *International Journal of Educational Technology in Higher Education, 21*(1), 42. https://doi.org/10.1186/s41239-024-00474-1

Flores, D. K., Raposo, M., & Cajamarca, M. (2023). Proposals for the development of the digital competence of university teachers: A systematic literature review. *Proceedings of the 13th International Conference on Virtual Campus (JICV 2023). IEEE Xplore.* https://doi.org/10.1109/JICV59748.2023.10565677

Gentner, S. T., Seifried, J., Rausch, A., & Deutscher, V. (2026). Are trainee teachers less prone to implement new educational technologies than in-service teachers? Determinants of implementing a simulation-based environment. *Empirical Research in Vocational Education and Training, 18*(4). https://doi.org/10.1186/s40461-026-00206-x

Gogollari, A., Mitchell, S., & Guttormsen, S. (2024). Swiss medical schools' experiences with online teaching during the COVID-19 pandemic in light of international experiences. *BMC Medical Education, 24(*1), 242. https://doi.org/10.1186/s12909-024-05218-3

Hamdan, A., Singh, A. D., & Kovilpillai, J. S. (2024). Navigating the scholarship of teaching and learning in Malaysia and beyond: A reflective journey of three practitioners in higher education. Scholarship of Teaching and Learning (SoTL) in Asian Higher Education (pp. 197–220). *IGI Global.* https://doi.org/10.4018/979-8-3693-3727-1.ch011

Hirsch, A.-K., & Rubach, C. (2024). Exploring the interplay between teaching strategies and digital competencies beliefs among pre-service teachers: A longitudinal study. *Education Sciences, 14*(12), 1342. https://doi.org/10.3390/educsci14121342

Igboanugo, B. I. (2024). Role of gender in teachers' preparedness to integrate digital technology in chemistry instruction in Nigeria. *Journal of Chemical Education, 101*(12), 5280–5287. https://doi.org/10.1021/acs.jchemed.4c00768

Joshi, B. M., Khatiwada, S. P., Acharya, U., Pradhan, J. B., & Joshi, D. R. (2026). Impact of university teachers motivational and material access on digital skills. *Discover Education, 5*(1). https://doi.org/10.1007/s44217-026-01543-5

Keerthi, V., & Maheswari, M. M. U. (2026). Integrating digital literacy into higher education curriculum: A need analysis on the gap in digital literacy skills among engineering students. *Discover Education, 5*(1), 172. https://doi.org/10.1007/s44217-026-01130-8

Kukushkina, V., Kachalova, S., Kazachkova, O., & Styuflyaev, V. (2025). Virtual Technologies in the Educational Environment as a Factor of Development: Empirical Analysis of Effectiveness and Implementation. En *Proceedings of the 2025 5th International Conference on Technology Enhanced Learning in Higher Education* (TELE 2025) (pp. 80–84). *IEEE Xplore.* https://doi.org/10.1109/TELE66816.2025.11212006

Lee, H., Khabibullaev, S., & Tuychiev, S. (2026). Current levels and needs of digital competence among medical teachers in Uzbekistan: A multi-institutional assessment and future directions. *BMC Medical Education, 26(*1), 922. https://doi.org/10.1186/s12909-026-09288-3

Leoste, J., Lavicza, Z., Fenyvesi, K, Tuul M. & Õun, T. (2022) Enhancing Digital Skills of Early Childhood Teachers Through Online Science, Technology, Engineering, Art, Math Training Programs in Estonia. *Front. Educ. 7*:894142. https://doi.org/10.3389/feduc.2022.894142

Lyu, Y., & Luo, J.-H. (2024). The relationship between digital literacy and job performance of university teachers: The chain mediating effect of psychological empowerment and job satisfaction. *Current Psychology, 43(*45), 34496–34510. https://doi.org/10.1007/s12144-024-06971-w

Montesano de Talavera, M., Reis, M. L., Prieto, A., & Zorzal, R. (2023). Competencias digitales de los profesores de educación básica: una mirada reciente desde una formación en línea. *Publicaciones, 53*(1). https://doi.org/10.30827/publicaciones.v53i1.27985

Pérez-Escoda, A., Ortega-Fernández, E., & Martínez-Otón, L. (2026). Enhancing teachers' digital competence for combating disinformation and fake news through the use of social media in classroom. *Journal of New Approaches in Educational Research, 15*(1), Article 4. https://doi.org/10.1007/s44322-026-00051-6

Ruyffelaert, A. (2024). La formación en el uso de recursos digitales: un estudio de caso en la formación de profesores de francés en la Universidad de Granada. *Synergies Espagne, 17,* 279–301. https://dialnet.unirioja.es/servlet/articulo?codigo=10263642

Shiang, L. S., Ping, J. K., & Seng, T. M. (2024). Comparative analysis of social media literacy model among young adults in Malaysia. *International Journal of Media and Information Literacy, 9*(2), 463–478. https://doi.org/10.13187/ijmil.2024.2.463

Suwono, H., & Prasetyo, S. D. (2026). Enhancing teacher competencies through innovative professional development practices focusing on sustainable learning environments. *Discover Education, 5*(1), 419. https://doi.org/10.1007/s44217-026-01451-8

Tian, T., Huang, S., Yu, H., Wei, S., & Yu, H. (2026). Development and initial psychometric evaluation of a digital competence scale for kindergarten teachers in Western China. *BMC Psychology, 14*(1), 809. https://doi.org/10.1186/s40359-026-04551-0

Topal, A. D., & Geçer, A. K. (2024). Technology and education: Diversity and equality in a digital world. En *Creating Positive and Inclusive Change in Educational Environments* (pp. 83–110). https://doi.org/10.4018/979-8-3693-5782-8.ch004

Yadav, S. (2023). *Digital Skills of Teachers: A Necessity for the Technology-Enabled Human Resource of the Education Sector in the Fast Transform*. Handbook of Research on Establishing Digital Competencies in the Pursuit of Online Learning (pp.187-207). https://doi.org/10.4018/978-1-6684-7010-7.ch010

Wahyuni, D., Nasuka, Setyawati, H., Sulaiman, & Pratama, R. S. (2024). Factors influencing sedentary behavior and its impact on early childhood psychomotor skills. *Retos, 61*, 130–140. https://doi.org/10.47197/retos.v61.108879

Wijayanti, A., Dwiningrum, S. & Saptono, B. (2024). Digital Literacy in Elementary Schools Post COVID-19: A Systematic Literature Review. *International Journal of Learning, Teaching and Educational Research, 23*(12), 96–112. https://www.ijlter.net/index.php/ijlter/article/view/2147

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