JOURNAL OF e-LEARNING AND KNOWLEDGE SOCIETY

www.je-lks.org

VOLUME 20 | ISSUE NO. 3 | DECEMBER 2024

Focus on

Digital Transformation in Educational Research: Competencies, Resources and Challenges in the Context of ICT

EDITORS
FRANCISCO DAVID GUILLÉN-GÁMEZ
CARMEN LLORENTE-CEJUDO
MELCHOR GOMEZ
ANTONIO PALACIOS RODRIGUEZ

AN INTERNATIONAL AND OPEN ACCESS JOURNAL BY THE ITALIAN E-LEARNING ASSOCIATION

ISSN (online) 1971 - 8829 | ISSN (paper) 1826 - 6223

Photo cover by Pete Linforth da Pixabay

JOURNAL OF e-LEARNING
AND KNOWLEDGE SOCIETY
www.je-lks.org
ISSN (online) 1971 - 8829
ISSN (paper) 1826 - 6223

VOLUME 20 | ISSUE NO. 3 | DECEMBER 2024

PEER REVIEWED PAPERS SPECIAL ISSUE ON DIGITAL TRANSFORMATION IN EDUCATIONAL RESEARCH

PEER REVIEWED PAPERS PERMANENT CALL

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 20, No. 3 (2024)

EDITORIAL

Digital Transformation in Educational Research: Competencies, Resources and Challenges in the Context of ICT

Francisco David Guillén-Gámez
Faculty of Education Sciences, University of Malaga (Spain)

Carmen Llorente-Cejudo
Faculty of Education Sciences, University of Seville (Spain)

Melchor Gomez
Faculty of Teacher Training and Education, Autonomous University of Madrid (Spain)

Antonio Palacios Rodriguez
Faculty of Education Sciences, University of Seville (Spain)

(published: 18/12/2024)

DOI
https://doi.org/10.20368/1971-8829/1136092

CITE AS
Guillén-Gámez, F.D.., & Llorente-Cejudo, C., Gomez, M., & Palacios Rodriguez, A. (2024). Digital Transformation in Educational Research: Competencies, Resources and Challenges in the Context of ICT [Editorial]. *Journal of e-Learning and Knowledge Society*, 20(3), I-V. https://doi.org/10.20368/1971-8829/1136092

In the educational context, the integration of information and communication technologies (ICT) has revolutionized education by providing access to open educational resources (Nipa & Kermanshachi, 2020), collaborative learning resources or knowledge management platforms (Sharifov & Mustafa, 2020). Furthermore, thanks to technological advances, education as it is known today has also been transformed into virtual or blended learning (Cigdem & Oncu, 2024) or mobile learning (Dahal et al., 2022), allowing access to be democratized mainly to higher education.

But the integration of ICT in educational processes has facilitated greater benefits than those described so far. The use of ICT has also revolutionized the field of research in all its disciplines, providing researchers with unprecedented tools and resources that have transformed the way they conduct their research, collaborate with other scientists and disseminate their results (George & Salado, 2014). Furthermore, the integration of ICT in the teacher's research process has allowed not only access to more information, but also to improve the efficiency of the research itself, facilitating collaboration with other researchers, and facilitating broader and faster communication in the transfer of scientific results found (Molano-Bernal et al., 2022)

Firstly, the integration of ICT by teachers in their research work makes it possible to democratize access to an immense amount of research resources (Alvarado-Vélezi et al., 2023), where researchers have the opportunity to access digital databases, scientific journals, digital libraries from anywhere in the world (Ocholla & Ocholla, 2020). Secondly, the expansion of ICT has allowed the creation of new data analysis and processing software (Candraningrat et al., 2021). Thirdly, the integration of ICT has allowed the publication and dissemination of scientific findings to be much faster and broader (Molano-Bernal, et al., 2022). Fourthly, the use of digital resources in the management of bibliographic references in the field of research has strongly emerged (Ram & Paul, 2014). Last but not least, Generative AI tools represent new digital applications that can support and improve the scientific world (Al-Zahrani, 2023), such as the academic writing service with ChatGPT (Alenezi et al., 2023) as long as it is used ethically (Barros et al., 2023).

For all these reasons, the integration of ICT in teachers' research processes is vital in all areas of knowledge. If a researcher uses ICT in their research work, they can accelerate the scientific process and contribute in a relevant way to the generation of new knowledge. However, in order to use them, a teacher is required trained not only in digital competencies, but also and more specifically, in digital competencies oriented towards research and transfer of scientific knowledge. As stated by Guillén-Gámez & Mayorga-Fernández (2021), a teacher must develop three main dimensions in his/her academic tasks (teach, evaluate and research). Therefore, teachers must not only integrate educational technology into the curricular plans of their institution (Pozos, 2015), but also promote research and participation in innovation and research projects supported by digital resources (Twalib, 2012), with the purpose of being able to communicate the scientific results of their good pedagogical practices to the rest of the teaching community (Padilla-Hernández et al., 2020).

However, the scientific literature has generally shown that there is a difficulty on the part of teachers, since many of them have not received solid digital training, to be able to face the technopedagogical demands that are posed to them in their profession (Adetimirin, 2019). The studies carried out on teaching digital competence in higher education highlight that the majority of them have a low level (Dzikite et al., 2017), or at best intermediate (Cabero-Almenara et al., 2021), regardless of the area of knowledge to which the teaching staff belongs (Guillén-Gámez et al., 2020). What's more, most studies on digital competence have focused on one of the previously mentioned dimensions of the academic tasks of teachers, teaching, leaving aside the in-depth analysis of research work.

This special issue seeks to fill that gap. The collected studies not only seek to inspire teachers in their digital development, but also to create tools and good practices that help strengthen their technological skills in an increasingly digitalized world due to the emergence of artificial intelligence (AI). The findings of the studies that make up this special issue could encourage educational institutions to create educational policies that strengthen the research capacities of teachers, improving their digital skills and facilitating access to advanced technological resources in the context of educational research. There was great interest and an excellent response to this call for papers for the special issue, in which the research questions focused on:

- Are teachers digitally trained in research skills?
- What skills do teachers have to use digital resources developed for the research context?
- What factors influence the digital competencies of teachers in their research work?
- How do AI tools impact the digital skills of teachers in research work?

One of the strengths of this special issue is the diversity of methodological approaches it offers, as it includes research presented by authors who have used a wide variety of designs. These include studies with quantitative, qualitative and even mixed design approaches, which enriches the understanding of the topics discussed from multiple perspectives.

Firstly, this monograph collects the creation of several psychometric instruments focused on digital competences for research. Both studies have verified the reliability and validity of different latent factors which make up the instrument itself. ***Perdomo***'s research (2024) includes factors such as the "use of devices and software", the "Information Literacy", the "Digital Communication", the "Content Creation", the "digital Security", and "problem solving"; while the study by ***Guillén et al.*** (2023) included factors such as "digital skills to search for information, manage it, analyze it and communicate results", "digital ethics in digital research", digital flow in research work", and "anxiety towards the use of ICT resources for research ".

Secondly, several scientific studies (with India standing out for its notable influence) have investigated how digital tools and applications are adopted and used in research tasks, using causal models. For example, ***Gupta*** (2024) has presented a study which is focused on the adoption and use of AI tools by university teachers from India. For this purpose, the PLS-SEM model with the Unified Theory of Acceptance and Use of Technology (UTAUT) was used. Among the main findings, the authors indicated that teachers' intention to adopt AI tools for research work is positively influenced by performance expectancy, effort expectancy, social influence, computing self-efficacy, and personal innovation, as well as by their behavioral intention and facilitating conditions. In the same territorial context, ***Doddanavar et al.*** (2024) used a PLS-SEM model based on UTAUT theory and Task-Technology Fit (TTF) theories to examine how technology adoption of 1354 academics from private universities in South India influences research performance. The last study focused on this area was carried out by ***Singh et al.*** (2024) who also investigated the integration of digital resources by university professors from India in research work. However, they were not based on the UTAUT model, but on the instrument developed by Guillén-Gámez et al. (2023). Among the main findings, the authors identified that all the hypotheses of the study were accepted, except one of them, which analyzed the relationship between the quality of digital resources focused on research tasks and the integration of these tools in the research tasks of the teacher. In addition, the authors demonstrated that the model proposed by Guillén-Gámez et al. (2023) in the Spanish context is effective in other Higher Education contexts such as in India.

Third, the monograph brings together various empirical studies. ***G S et al.*** (2024) analysed the acquisition of digital research skills by university professors and researchers from India, through a longitudinal study with a five-year training course. The results revealed that modular training was effective in developing digital research skills. For their part, ***Victoria-Maldonado et al.*** (2024) analyzed the research skills of 340 researchers from Spain and Ecuador related to ICT, as well as the incidence of sex, stage of academic career development or time dedicated to research. Among the main findings, the authors did not identify differences in any of the variables analyzed, so they emphasize the need to continue to delve deeper into this topic in order to justify these results. Regarding qualitative designs, ***Kokoç*** (2024) analyzed the opinions of 14 secondary education teachers from Turkey about their digital skills in research studies using AI tools. Among the main conclusions of the teachers, the need to create training programs for teachers regarding this technology was identified, as well as to strengthen the technological infrastructure of the schools. Finally, the study by ***Behnamnia et al.*** (2024) examined the relationship between the integration of the AI-powered educational platform BrainPOP, teachers' digital competences, and the development of students' research skills in primary and secondary education in Tehran (Iran). The authors highlighted how AI tools such as BrainPOP can significantly improve the way students learn and develop their research skills.

The nine articles in this special issue offer a variety of approaches and methodologies, focusing particularly on the digital competences of higher education teachers in their research work. The diversity of analyses presented not only enriches the field of educational research, but also provides valuable practices for those teachers and researchers seeking to integrate these competences into their daily work. By highlighting how digital technologies, including generative artificial intelligence tools, can be effectively used to boost educational research and innovation, these findings invite reflection on the implementation of innovative strategies in academia. The use of artificial intelligence not only facilitates access to and analysis of large volumes of data, but also optimizes research processes, allowing teachers to explore new ways of generating knowledge. Therefore, it is proposed that the higher education environment not only responds to current needs, but also prepares researchers to face future challenges in a digital world that is increasingly advanced and automated.

References

Adetimirin, A. (2019). Female Lecturers' Perception of ICT Integration for Teaching and Learning in University of Ibadan, Nigeria. In M. Khosrow (Ed.), *Gender and Diversity: Concepts, Methologies, Tools, and Applications* (pp. 1624-1636). IGI Global. https://doi.org/104018/978-1-5225-6912-1.ch084.

Al-Zahrani, A. M. (2023). The impact of generative AI tools on researchers and research: Implications for academia in higher education. *Innovations in Education and Teaching International*, 1-15. https://doi.org/10.1080/14703297.2023.2271445

Alenezi, M. A. K., Mohamed, A. M., & Shaaban, T. S. (2023). Revolutionizing EFL special education: how ChatGPT is transforming the way teachers approach language learning. *Innoeduca. International Journal of Technology and Educational Innovation*, *9*(2), 5–23. https://doi.org/10.24310/innoeduca.2023.v9i2.16774

Alvarado-Vélezi, J. A., y Villacrés-Mallaii, M. B. (2023). Importancia y uso de las TIC para la investigación científica. *Revista ConCiencia*, *1*(1), 1-14.

Barros, A., Prasad, A., & Śliwa, M. (2023). Generative artificial intelligence and academia: Implication for research, teaching and service. *Management Learning*, *54*(5), 597-604. https://doi.org/10.1177/13505076231201445

Behnamnia, N., Hayati, S., Kamsin, A., Ahmadi, A., & Alizadeh, Z. (2024). Enhancing Students' Research Skills Through AI Tools and Teacher Competencies: A Mixed-Methods Study . *Journal of E-Learning and Knowledge Society*, *20*(3), 39-55. https://doi.org/10.20368/1971-8829/1135960

Cabero-Almenara, J., Guillén-Gámez, F. D., Ruiz-Palmero, J., y Palacios-Rodríguez, A. (2021). Digital competence of higher education professor according to DigCompEdu. Statistical research methods with ANOVA between fields of knowledge in different age ranges. *Education and Information Technologies*, *26*(4), 4691-4708. https://doi.org/10.1007/s10639-021-10476-5

Candraningrat, I., Abundanti, N., Mujiati, N., & Erlangga, R. (2021). The role of financial technology on development of MSMEs. *Accounting*, *7*(1), 225-230.

Cigdem, H., & Oncu, S. (2024). Understanding the Role of Self-Regulated Learning in Academic Success. A Blended Learning Perspective in Vocational Education. *Innoeduca. International Journal of Technology and Educational Innovation*, *10*(1), 45–64. https://doi.org/10.24310/ijtei.101.2024.17432

Dahal, N., Manandhar, N.K., Luitel, L., Luitel, B.C., Pant, B.P., & Shrestha, I.M. (2022). ICT tools for remote teaching and learning mathematics: A proposal for autonomy and engagements. *Advances in Mobile Learning Educational Research, 2*(1), 289-296. https://doi.org/10.25082/AMLER.2022.01.013

Doddanavar, I., Subramanyam, M. A., Dombar, D. V., Subramanyam, D. L., B R, D. L., & H S, D. C. (2024). Exploring technology adoption measures among academicians and its influence on their research practices and performance. *Journal of E-Learning and Knowledge Society*, *20*(3), 71-82. https://doi.org/10.20368/1971-8829/1136038

Dzikite, C., Nsubuga, Y. y Nkonki, V. (2017). Lecturers' Competencies in Information and Communication Technology (ICT) for Effective Implementation of ICT-Integrated Teaching and Learning in Textiles and Clothing Degree Programmes. *International Journal of Educational Sciences, 17*(1-3), 61-68. https://doi.org/10.1080/09751122.2017.1305756

G S, P., Chanda R. Coblentz, Muthukrishnan, P., & Kenneth, A. (2024). An ICT-integrated Modular Training Program Enhancing the Digital Research Skills of Research Scholars. *Journal of E-Learning and Knowledge Society*, *20*(3), 26-38. https://doi.org/10.20368/1971-8829/1135998

George Reyes, C.E., & Salado Rodríguez, L.I. (2019). Research competences with ICT in PhD students. *Apertura, 11*(1), 40- 55. http://dx.doi.org/10.32870/Ap.v11n1.1387

Guillén Gámez, F. D., Tomczyk, Łukasz, Colomo-Magaña, E., & Mascia, M. L. (2024). Digital competence of Higher Education teachers in research work: validation of an explanatory and confirmatory model . *Journal of E-Learning and Knowledge Society*, *20*(3), 1-12. https://doi.org/10.20368/1971-8829/1135963

Guillén-Gámez, F. D., & Mayorga-Fernández, M. J. (2021). Design and validation of an instrument of self-perception regarding the lecturers' use of ICT resources: to teach, evaluate and research. *Education and Information Technologies*, *26*(2), 1627-1646. https://doi.org/10.1007/s10639-020-10321-1

Guillén-Gámez, F. D., Ruiz-Palmero, J., & García, M. G. (2023). Digital competence of teachers in the use of ICT for research work: development of an instrument from a PLS-SEM approach. *Education and Information Technologies*, *28*(12), 16509-16529. https://doi.org/10.1007/s10639-023-11895-2

Guillén-Gámez, F. D., Ruiz-Palmero, J., Sánchez-Rivas, E., y Colomo-Magaña, E. (2020). ICT resources for research: an ANOVA analysis on the digital research skills of higher education teachers comparing the areas of knowledge within each gender. *Education and information technologies*, *25*(5), 4575-4589. https://doi.org/10.1007/s10639-020-10176-6

Gupta, K. P. (2024). Understanding Teachers' Intentions and Use of AI Tools for Research. *Journal of E-Learning and Knowledge Society*, *20*(3), 13-25. https://doi.org/10.20368/1971-8829/1135969

Molano-Bernal, L. C., Tibaduiza-Castañeda, L. P., Aguilera-Arango, G. A., Cañar-Serna, D. Y., y Barberá-Tomas, J. D. (2022). Las TIC como herramientas para la transferencia de tecnología y gestión del conocimiento en el sector agropecuario. *Revista Científica Agroecosistemas*, *10*(1), 88-95.

Nipa, T. J., & Kermanshachi, S. (2020). Assessment of open educational resources (OER) developed in interactive learning environments. *Education and Information Technologies*, *25*(4), 2521-2547. https://doi.org/10.1007/s10639-019-10081-7

Ocholla, D. N., & Ocholla, L. (2020). Readiness of academic libraries in South Africa to research, teaching and learning support in the Fourth Industrial Revolution. *Library Management*, *41*(6/7), 355-368. https://doi.org/10.1108/LM-04-2020-0067

Padilla-Hernández, A. L., Sánchez, V. M. G., y López, M. A. R. (2020). Evolución de la competencia digital docente del profesorado universitario: incidentes críticos a partir de relatos de vida. *Educar*, *56*(1), 109-127. https://doi.org/10.5565/rev/educar.1088

Perdomo, B., & Morales, O. A. (2024). Design and validation of a questionnaire to assess digital skills for research. *Journal of E-Learning and Knowledge Society*, *20*(3), 83-89. https://doi.org/10.20368/1971-8829/1136008

Pozos, K. V. (2015). *Evaluación de necesidades de formación continua en competencia digital del profesorado universitario mexicano para la sociedad del conocimiento* [Doctoral dissertation, Universidad Autónoma de Barcelona, España]. TDX. http://hdl.handle.net/10803/382466

Ram, S., & Paul Anbu K, J. (2014). The use of bibliographic management software by Indian library and information science professionals. *Reference Services Review*, *42*(3), 499-513. https://doi.org/10.1108/RSR-08-2013-0041

Sharifov, M., & Mustafa, A. S. (2020). Review of Prevailing Trends, Barriers and Future Perspectives of Learning Management Systems (LMSs) in Higher Institutions. *The Online Journal of New Horizons in Education*, *10*(3), 166-173.

Singh, S., Singh, P., Kaur, V., Sood, P., & Pant, S. (2024). Integration of digital resources in research work by Indian Higher Education teachers: PLS-SEM analysis. *Journal of E-Learning and Knowledge Society*, *20*(3), 56-70. https://doi.org/10.20368/1971-8829/1136035

Torelló, O. M., y Pérez, K. V. P. (2012). Las Competencias Pedagógicas Y Digitales Del Docente Universitario. Un elemento nuclear en la calidad docente e institucional. *Revista del Congrés Internacional de Docència Universitària i Innovació (CIDUI)*, *1*(1), 1-21.

Twalib, S., Lynton, A., Buttsworth, A., Boyes, C., Goessmann, F., Ricketts, M., y Lynton, S. (2012). *Survey report: ICT in the Research Workflow*. Curtin Univeristy, 1-20.

SPECIAL ISSUE ON
DIGITAL TRANSFORMATION
IN EDUCATIONAL RESEARCH

- PEER REVIEWED PAPERS -

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 20, No. 3 (2024), pp. 1-12

Digital competence of Higher Education teachers in research work: validation of an explanatory and confirmatory model

Francisco D. Guillén-Gámez[a,1], Łukasz Tomczyk[b],
Ernesto Colomo-Magaña[a], Maria Lidia Mascia[c]

[a]*Department of Didactics and Educational Organization, University of Málaga (Spain)*

[b]*Institute of Education, Jagiellonian University (Poland)*

[c]*Department of History, Humanities and Education, University of Sassari (Italy)*

(submitted: 12/6/2024; accepted: 4/9/2024; published: 23/9/2024)

Abstract

This article demonstrates the validity and reliability of an instrument to evaluate the level of digital competence of Higher Education (HE) teachers in the use of digital resources in research work. The initial instrument was made up of a total of 22 items classified into four dimensions: (DIM. 1. Digital skills to search for information, manage it, analyze it and communicate results; DIM. 2. Digital ethics in digital research; DIM. 3. Digital flow in research work; DIM. 4. Anxiety towards the use of ICT resources for research). The instrument was applied to a final sample of 1709 teachers from different higher education institutions in Spain, from an initial sample of 1740. Reliability was measured using Cronbach's Alpha and composite reliability. To check the validity of the instrument, the validity of understanding and exploration of dimensionality was analyzed using Exploratory Factor Analysis (EFA), and the instrument was adjusted for the different models using Confirmatory Factor Analysis (CFA). IBM SPSS V.24 software was used for the AFE and AMOS V.24 software was used for the AFC. The result of the reliability analyzes were adequate and, in relation to construct validity, the results found a good fit of the model, both in internal validity and factorial invariance. The final version of the instrument consists of 12 items.

KEYWORDS: Digital Competence, Research Work, Instrument, SEM, Teachers, Higher Education

DOI
https://doi.org/10.20368/1971-8829/1135963

CITE AS
Guillén-Gámez, F.D., Tomczyk, Ł., Colomo-Magaña, E., & Mascia, M.L. (2024). Digital competence of Higher Education teachers in research work: validation of an explanatory and confirmatory model. *Journal of e-Learning and Knowledge Society*, *20*(3), 1-12.
https://doi.org/10.20368/1971-8829/1135963

1. Introduction

The digital competence of university teachers is an area that is closely linked to many of the challenges currently faced by the higher education sector, both from a local and global perspective (Agustí et al., 2023; Tomczyk & Fedeli, 2022). An adequate level of digital competence of teachers is not only one of the determinants of the level of digital maturity achieved by educational institutions (Michel & Pierrot, 2023; Mabić & Garbin Praničević, 2021; Jiménez Sabino & Cabero, 2021), but is also indicative of the level of adaptation of key HE stakeholders to the stage of development of the information society (Dzib Goodin et al., 2015). Research on the level of digital competence of HE teachers has become particularly important in the period of pandemic e-learning (Tomczyk et al., 2021; Demeshkant et al., 2020), in which thought has been given to how information and communication technologies (ICTs) are used in the teaching process. Research over the past few years has shown varying levels of preparation of university teachers for the use of ICT, whether in achieving teaching goals, creating digital learning materials or other activities typical of an academic environment (Schröter & Grafe, 2020; Weninger, 2022). A review of the literature in preparing teachers to use ICT

[1] corresponding author - email: davidguillen@uma.es

effectively in their professional work, which includes more than just teaching activities (Guillén-Gámez & Mayorga-Fernández, 2021), forces the research question to be posed - to what extent are contemporary university teachers prepared to make full use of ICT capabilities in their professional work?

Posing such a question is entirely appropriate in the context of conducting effective qualitative and quantitative research using ICT.

This article is a study that fills an existing empirical gap in the diagnosis of research process-oriented digital competences among Spanish university teachers.

The dynamic development of digital tools used in higher education brings many opportunities for academics. The intensive implementation of new media into research processes is now not only a necessity, but also a challenge (Degn, 2023; Medeshova, 2023). The topic of effective digitalization of HE becomes a starting point for discussions on strengthening the functioning of the specific sector as a whole. Given one of the overarching missions that is associated with universities, namely, to conduct research, the challenge arises to what extent to combine the potential of ICT with strengthening the digital competences of academics. Having an adequate level of digital competence in this group is a prerequisite for planning, implementing and communicating research results. Considering the acceleration process of e-services development, special attention should be paid to the fact of preparation for effective functioning of modern scientists in the information society (Rosak-Szyrocka, 2024; Popescu et al., 2020). Adequate preparation to effectively exploit the potential of new media requires, according to the model proposed by the staff of the Spanish research centre InnoEduca (Guillén-Gámez et al., 2023; 2024), having four main pillars in the form of:

1. digital literacy in terms of finding information, managing it, analyzing it and communicating results;
2. awareness of digital ethics in research;
3. ability to apply digital workflow in research work;
4. low anxiety in using ICT resources for research.

The proposed model is based on profiling *digital competences* under a specific group of new media users (Guillén-Gámez et al., 2023), in which ICTs provide a basis for increasing the effectiveness of activities while changing attitudes towards new media with respect for ethics. The theoretical model adopted goes beyond the previous perception of teacher digital competence as skills narrowed down to the didactic or communication layer (Tomczyk et al., 2022). The present research is a unique attempt to understand the stage at which Spanish universities are at, where human capital characterized by adequately developed key competences is the main determinant of development.

The model proposed by Guillén-Gámez (2023) has a base pillar consisting of skills related to: finding the information necessary to conduct research, processing research data, producing research reports both addressed to professionals and research communications of a journalistic nature. Below is an infographic showing the research model used in the article.

Figure 1 - Scree Plot Graph. Own elaboration in Co-pilot.

An important component of this dimension is the skills of searching, processing, storing and sharing information. An important component of the first dimension is the ability to use software to process and organise qualitative data using popular software such as Atlas.ti, Nvivo, Ethnograph, Hyperresearch, Maxqda, QDA MINER, NUD*IST (Woods et al., 2016). Skills of this type are particularly useful for researchers anchored in the humanities and social sciences (Suyo-Vega et al., 2022). In the first pillar, Spanish researchers (Guillén-Gámez et al., 2023) highlight issues of skill in using audio and video editors to collect qualitative data. The ability to use software such as Adobe Premiere, iMovie, Windows Movie Maker, Audacity provides the ability to quickly archive statements in which audio and video are the focus of research (Birdsall & Tkaczyk, 2019). Without this skill, many important contexts may be missed, resulting in distorted conclusions. Among the determinants of baseline skills for any researcher, the ability to use statistical packages, such as: SPSS, EXCEL, JAMOVI, AMOS, R, Minitab (Bala, 2016). Among the key skills for any researcher is the ability to build a theoretical framework and interpret the collected results in relation to research conducted by other authors. To this end, the ability to search databases with scientific studies such as ScienceDirect, ProQuest, PsycINFO, Redalyc.org, Scielo, Academia.edu become a starting point in the process of preparing the research process, or attempting to summarize previous research developments in a given area (Harari et al., 2020). Knowledge of individual scientific databases in the Spanish model is combined with knowledge of the use of Boolean operators (AND, NOT, OR, XOR), which, when skilfully implemented, make it possible to speed up the data retrieval process while exploiting the potential of the most popular sites where researchers' work is archived (Chapman & Ellinger, 2019). In the adopted core competency model, an important element of the first pillar is the use of bibliographical managers (Mendeley Zotero Endnote, Refworks), which facilitate the creation of footnotes and also organise the papers of other authors (Butros & Taylor, 2010). The final two elements for this area are the skilful use of social media to promote and consult research findings, as well as to network with other researchers working in a similar area of research (Kavoura, 2014).

The second technical dimension of research is defined as *Digital ethics in digital research*. Research ethics is a starting point in all research, however, in the age of intensive digitalization it takes on particular importance due to the relative ease of intentional or accidental violation of the prevailing rules. In the proposed model, digital ethics refers to the issue of respecting copyright (Imfeld, 2003), the violation of which exposes researchers to legal and social consequences. An important skill in this category is the use of guidelines related to the structure of the article, including those related to the description of the research procedure, as well as the formatting of references sections according to APA v.7; Chicago, Harvard and others (Lipson, 2011). In digital ethics, it is not only the aforementioned technical formatting of research reports that is of particular importance, but also the verification of the originality of sources cited by other authors (Lawrence et al., 2001). The ability to verify data is linked to issues of being able to assess the quality of the journals in which the research results are presented. This issue is particularly important in the context of the need to weed out scientific reports from journals referred to as predatory journals (Severin & Low, 2019; Sarfraz et al., 2020). A final subcategory for digital ethics is the ability to assess the level of convergence of one's own with articles by other researchers. Such an activity requires competence in the use of software that searches for plagiarism levels (including self-plagiarism) (Bretag & Mahmud, 2009). Such an activity allows one to clearly identify the convergence of the definitions used and review the research in relation to other articles.

The third dimension entitled *Digital flow in research work* is a set of skills attributed to the motivational sphere of increasing research productivity through the use of ICT. According to the theory of J. V.Dijk (Scheerder et al., 2017) relating to increasing the level of digital competence, the motivational aspects are the starting point for effective inclusion, increasing the level of digitization, or increasing efficiency through the use of ICT in professional and private life (Van Laar et al., 2017).In this category, ICT use is linked to the visibility of achieving benefits through the implementation of ICT in the research process (Clark, 2010). The process of satisfaction with the use of new media in conducting quantitative and qualitative research is in realia with having an appropriate level of techno-optimism (Königs, 2022; Tomczyk et al., 2021), which becomes a major motivational factor for experimenting with new software to support research data collection and processing. The third pillar also includes a belief related to the motivation to use the software due to the achievement of goals relating to increased visibility through publication in prestigious journals (Stosic, 2017). It is worth noting at this point that many journals identified as prestigious have a requirement to use specific software, which allow research results to be presented in a standardized way. The final element in this category is the positive attitude towards exploring new software due to the increased efficiency of data analysis and effective dissemination. This category is also interesting in the context of supporting the development of research competences of academics and can be used as a starting point for designing solutions to support researchers in academia.

The last dimension of the theoretical framework proposed in this study is related to *anxiety towards the use of ICT resources for research*. It is a dimension that is linked not only to attitudes towards ICT, but more importantly to the emotional dimension that can be encapsulated in technopesimism (Tomczyk et al., 2021). Negative emotions and attitudes related to the use of ICT in education, is a relatively well-studied sphere (Moreira-Fontán et al., 2019; Adtani et al., 2023; Atiqah et al., 2024) and accounts for the frequency and effectiveness of the use of software capabilities in contemporary education. Within this category, several items related to the feeling of overwhelm that occurs in researchers who are forced by circumstances to have to learn new software to support the research process were identified. The issue of bitterness due to the changing coefficients describing the influence of journals also appears in this category (Pajić, 2015; Mason & Singh, 2022). The need to control parameters of this kind for some researchers appears as a waste of time, with no impact on the real level of research being conducted. For the fourth category, there also appears to be a determinant in the form of fatigue resulting from the need to control the impact of one's own research output on the level of recognition (Egghe, 2010) and the associated need to build a scientific profile in the media targeting scientists. The situation of having to increase one's own digitally mediated reputation can evoke a range of negative emotions and translate into a low evaluation of the contemporary model of evaluation of scientists. For the last category, a statement related to the occurrence of nervousness when there is a need to teach others how to use popular statistical packages was also proposed. This situation is related to the uneven level of digital skills related to the operation of software supporting the data analysis process among scientists. The fourth category also has a diagnostic indicator that generally summarizes negative attitudes towards ICT in the process of conducting research and reporting results. The last category, unlike the previous ones, marks the proposed theoretical framework's greater emphasis on the problems arising from the ubiquity of the digitization of the research process and the consequent need to accept or deny the typical activities undertaken in an increasingly digitalized higher education.

This paper fills an empirical gap on the digital competences necessary to function in an increasingly digitalized scientific environment. The study is part of an attempt to build an adequate and modern theoretical framework based on the diagnosis of elementary skills. The article also fills an empirical gap in terms of geographical focus. Currently, large-scale diagnoses of this type are rare and do not cover all the pillars outlined in the theoretical section above.

2. Method

2.1 Design and sample

A non-experimental ex post facto design was used. The type of sampling was non-probabilistic and intentional. The data are selected from a database belonging to the authors of 1740 Higher Education (HE) teachers belonging to the Spanish territory. To gather the necessary information, the main researcher of the study contacted the teachers via email, providing them with a link so they could complete a survey. Prior to beginning the questionnaire, teachers were informed about the importance of maintaining the confidentiality of the data. Table 1 shows the distribution of teachers by gender and age. In addition, teachers reported that they had participated in an average of 3.84±4.14 years in research projects in the last five years, as well as 50.84% of their working time was dedicated to research tasks.

2.2 Preliminary analyzes for the sample of participants

According to Kline (2023), there are some important things to keep in mind when validating a survey. First, missing data occurs when participants do not answer a question. We used Google Forms for the survey and marked all questions as required, which helped reduce unanswered responses. Second, we identify outliers using the Mahalanobis distance (D2). According to Kline (2023), it is suggested to eliminate observations with a p value less than 0.001 in the calculations of the distances P1 and P2. In this study, we removed 31 observations with p values reported by AMOS software. The final sample was 1709 participants.

2.3 Instrument

In this study, an instrument is created through a structural equation model (SEM) with covariances. This model arises from the causal model created by the main author (Guillén-Gámez et al., 2023) which mediates the integration of ICT in the teacher's research work, based on a series of endogenous and exogenous factors, classified into the following factors: digital skills to search for information, manage it, analyze it and communicate the results; digital ethics in digital research; digital flow in research work; anxiety towards using ICT resources for research; quality of ICT resources related to research; and intention to use ICT for research work. An SEM model was chosen for this study since the objective was to describe and understand the relationships between the factors, without necessarily implying an explicit causal interpretation as is the PLS-SEM model. After several initial tests, it has been decided not to take into consideration three factors from the PLS-SEM version, since both factors were grammatically prepared to be causal factors, and furthermore, they have not met sufficient psychometric properties to be included in an SEM model. The scale used to assess the digital perceptions of teacher-researchers was a seven-level Likert scale, where a score of 1 represented the lowest rating and a score of 7 indicated the highest.

Table 1 - Sample distribution.

	Sample		Age	
	Teachers	*Percentage (%)*	*Mean*	*Typical deviation*
Male	969	56.69%	49.61	29.03
Female	740	43.31	48.15	9.13

2.4 Procedure and verification of assumptions

The study followed the advice of Hair et al. (2010) to evaluate the psychometric properties of an instrument. It is suggested to collect samples between five and ten times the number of items in the questionnaire. In this study, a ratio greater than 124 was obtained, which exceeds the author's recommendations. The recommendation of Hinkin et al. (1997) was followed by randomly dividing the sample into two subgroups to verify the internal structure of the instrument. 902 subjects were used for the exploratory factor analysis (EFA) and the rest for the confirmatory factor analysis (CFA). IBM SPSS V.24 software was used for the AFE and AMOS V.24 software was used for the AFC.

For the first type of analysis, an Oblimin rotation technique was applied together with the Principal Axis Factorization method. In the second type of analysis, a structural equation modeling approach was employed using the polychoric correlation matrix, and robust estimators were used along with the maximum likelihood method. Convergent validity, which determines the certainty that the proposed items measure the same latent factor, was also evaluated using the average of the variance extracted values (AVE), following the guidelines of Cheung and Wang (2017). For discriminant validity, the MSV (maximum squared shared variance) index was examined.

Once adequate validity was established, multivariate normality was examined. This analysis consisted of comparing the Mardia coefficient with an acceptable threshold determined by the formula p(p+2) (Raykov & Marcoulides, 2008), where p represents the number of items. The validation of this assumption was carried out by contrasting the multivariate kurtosis obtained in SPSS-AMOS with the kurtosis calculated using the formula suggested by Ping & Cunningham (2013). The calculation was carried out considering the final 12 items of the instrument. The application of the formula yielded a value of 168, while the multivariate kurtosis index obtained in SPSS Amos Mardia was 14.483. Therefore, by observing that the Mardia coefficient was lower than the value provided by the formula, it was concluded that the assumption of multivariate normality was confirmed.

The last procedure was to check the internal consistency of the instrument, where different reliability coefficients were used such as Cronbach's Alpha and Composite Reliability (CR).

3. Results

3.1 Comprehension validity: statistical analysis of the items

In a first review, three types of dispersion measures were calculated. According to the scientific literature, the use of kurtosis and asymmetry coefficients is recommended, which should be within the range of ±1.5 (Pérez & Medrano, 2010). Likewise, in this evaluation, Meroño et al. (2018) suggest eliminating those elements with a standard deviation less than 1. In this context, the following items were excluded for future analysis: 1.4 and 2.2. As can be seen, items 2.4 and 2.5 are at the limit regarding skewness and kurtosis in order to meet the criteria established by the authors. However, these items meet the criteria of Meroño et al. (2018), therefore, the authors have decided to maintain this in the next analyses, paying special attention to the behavior of these items and how they contribute to the rest of the instrument. As can be seen in Table 2, all elements meet this criterion.

Finally, and within this type of validity, Asencio et al. (2017) advises checking the unidimensionality of the instrument through the correlation between the different dimensions of the instrument. The factorial correlation matrix in Table 3 shows how the correlations between factors range from small effect sizes to medium effects. For example, it is observed that there is a moderate correlation between dimension number 2 (Digital ethics in digital research) and dimension number 1 (Digital skills to search for information, manage it, analyze it and communicate results). A moderate relationship was also evident between dimension number 2 (Digital ethics in digital research) and dimension number 4 (Anxiety towards the use of ICT resources for research). The rest of the relationships obtained small weights.

3.2 Construct validity: exploratory Factor Analysis

Once the relationships between pairs of dimensions were verified, the unidimensionality of the instrument was analyzed through the EFA. For this, the Oblimin rotation method and the maximum likelihood method were used, since it was evident that multivariate normality existed through the Mardia coefficient. To check the adequacy of the items to their corresponding latent factors, Barlett's sphericity and the KMO index (Kaiser-Meyer-Olkin) were checked, whose values were adequate (KMO=0.814; χ^2=4320.000; sig.< 0.05).

Figure 2 illustrates the scree plot used to determine the final number of factors. It was observed that the number of factors in the scale was four. Table 3 presents the eigenvalues, explained variance, and cumulative variance of four factors with eigenvalues whose eigenvalues exceed the value one. According to the analysis and the values found in Table 3, it was found that the total variance of the 16 items was 59.36%.

Specifically, and as seen in Table 4, the first factor represents the highest percentage of true scores of the instrument (27.35%) and was dimension number 1 (digital skills to search for information, manage it, analyze it and communicate the results). The second factor with the highest percentage of variance (12.83%) was dimension number 4 (Anxiety about using ICT resources for research). The third factor was dimension number 3 (Digital Flow in research work), which explained 10.47% of the variance. The fourth factor was represented by dimension number 2 (Digital ethics in digital research) with 8.70% of the variance.

Table 2 - Central tendency and dispersion measurement statistics.

		TD	A	K
DIM. 1. Digital skills to search for information, manage it, analyze it and communicate results				
1.1	I know how to use software for the analysis of qualitative data (Atlas.ti, Nvivo, Ethnograph, Hyperresearch, Maxqda, QDA MINER, NUD*IST)	1.81	1.34	.55
1.2	I know how to use audio and video editors to create and edit collected information through interviews, focal groups, etc. (Adobe Premiere, iMovie, Windows Movie Maker, Audacity)	2.17	.02	-1.40
1.3	I have abilities necessary for analysing quantitative data (SPSS, EXCEL, JAMOVI, AMOS, R, Minitab)	2.04	-.59	-.93
1.4	I know how to search in scientific data bases (ScienceDirect, ProQuest, PsycINFO, Redalyc.org, Scielo, Academia.edu...)	1.40	-1.66	2.42
1.5	I know how to use Boolean operators (AND, NOT, OR, XOR) to refine my searches for scientific articles.	2.24	-.84	-.82
1.6	I have the skills to use bibliographical managers (Mendeley Zotero Endnote, Refworks) those which allow me to store bibliographic references and use such references in my studies following different citation rules.	2.12	-.44	-1.16
1.7	I have abilities in managing my scientific social media, add my published studies and/or consult their reading statistics	1.87	-.72	-.59
1.8	I usually use scientific social media to interact with other investigators.	2.00	.24	-1.15
DIM. 2. Digital ethics in digital research				
2.1	I apply the rules of copyright when I share the results of my studies through scientific social media.	2.33	-.35	-1.43
2.2	Before sending a study for its' publication, I digitally check it and apply the publication rules employed in every editorial/journal (APA v.7; Chicago, Harvard…)	1.64	-2.05	3.14
2.3	I check the original source, and the results of a study referenced by other authors in their original publications.	1.45	-1.41	1.47
2.4	I check that the bibliography selected for my study comes from journals with a certain grade of scientific prestige (for example, that they use paired revision "double blind")	1.44	-1.79	-3.00
2.5	I check that in my studies there is no self-plagiarism or plagiarism of other studies.	1.53	-1.79	2.58
DIM. 3. Digital flow in research work				
3.1	I find it gratifying to use ICT resources in my investigation works	1.51	-1.09	.80
3.2	I find it enjoyable to use software for the analysis of data both quantitative (SPSS, JAMOVI, R…) and qualitative, Atlas.ti, Nvivo…) to complete my research.	2.15	-.25	-1.30
3.3	I am motivated by the thought that by using digital software for data design and analysis I can more easily publish my scientific achievements in high-impact journals.	2.01	-.43	-1.00
3.4	I like to learn new digital resources that are going to allow me to analyse data and/or communicate the results in some software afterwards.	1.67	-1.17	.56
DIM. 4. Anxiety towards the use of ICT resources for research				
4.1	*It overwhelms me to think that I have to learn to use digital resources to collect data and analyse it with some software afterwards.	1.96	.61	-.88
4.2	*It makes me anxious to have to be constantly checking the impact indexes of the journals for if the quartile has increased or decreased.	2.13	.06	-1.35
4.3	* I get tired of having to constantly use ICTs to position and share my scientific publications and improve my digital reputation through the h-index and/or the i-index10.	2.09	.08	-1.31
4.4	* I get nervous when I have to teach a colleague and/or student some ICT resource related to research (Mendeley, SPSS, AMOS, Google form, Atlas.ti...).	1.73	1.21	.52
4.5	*In general, I would prefer not to have to learn or use ICT resources for my research.	1.66	1.43	1.26

Note: TD: standard deviation; A: asymmetry; K: kurtosis. Own elaboration. *Inverse items

Table 5 shows the latent dimensions obtained with their respective items, which show their factor weights. Items 1.1, 1.3, 1.5 and 2.1 were also eliminated when they showed coefficients below 0.4, as recommended by Lloret-Segura et al. (2014). For factor number 1 (digital skills to search for information, manage it, analyze it and communicate the results), this dimension included items 1.7, 1.8, 1.6 and 1.2. The second factor (Anxiety to use ICT resources for research) items 4.2, 4.3, 4.4, 4.1 and 4.5. The third factor (Digital Flow in research work) included items 3.3, 3.2, 3.4 and 3.1. The last factor (Digital ethics in digital research) included items 2.3, 2.4 and 2.5. The minimum value of the saturation values of the items was the minimum 0.437 and the maximum value 0.891. The rotation has converged in eight iterations.

3.3 Construct validity (confirmatory)

A CFA was carried out in order to evaluate the adequacy of the structure obtained in the EFA to measure the desired construct (Bandalos & Finney, 2016). The objective was to develop an instrument that was as simple and clear as possible, with fewer items, without compromising its reliability or validity. We began by evaluating the first model based on the latent structure obtained in the EFA. However, Table 6 showed that this model did not meet some of the fit criteria recommended by Hu and Bentler (1999), which led to the creation of a second model. In this new model, items that showed an excessively high correlation with other items of the instrument were eliminated, following Byrne's (2013) recommendation on modifications of indices (MIs) of correlations between items. Specifically, the following items were eliminated: 1.6, 3.1, 4.4 and 4.5. The indices analyzed have been the following: CMIN/DF (Mean Chi Square/Degree of Freedom), CFI (Comparative Fit Index) TLI (Tucker-Lewis index), NFI (Nomed Fix Index), IFI (incremental Fit Index), y RMSEA (Root Mean Square Error of Approximation).

Figure 3 presents the conclusive factor model derived from the CFA, along with findings related to the interaction between the underlying factors and their individual components. Furthermore, the normalized correlation coefficients are represented in Figure 1, which were obtained from the CFA results.

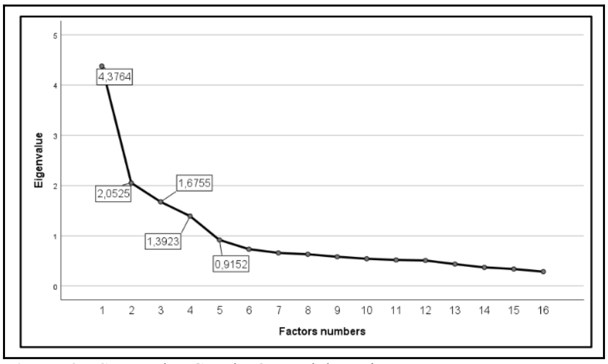

Figure 2 - Scree Plot Graph. Own elaboration.

Table 3 - Factor correlation matrix (λ = 1).

Factor	DIM. 2	DIM. 3	DIM. 4	DIM. 1
DIM. 2	1.000			
DIM. 3	.295	1.000		
DIM. 4	.380	.269	1.000	
DIM. 1	.348	.130	.249	1.000

Note: own elaboration

Table 4 - Eigenvalue and Explained Variance Table.

Factors	Total (Eigenvalue > 1)	% variance	% accumulated
1	4.376	27.353	27.353
2	2.053	12.828	40.181
3	1.676	10.472	50.653
4	1.392	8.702	59.355

Note: own elaboration

Table 5 - Rotated factor loadings.

	Factors			
Items	1	2	3	4
1.7	.891			
1.8	.730			
1.6	.467			
1.2	.437			
4.2		.735		
4.3		.733		
4.4		.626		
4.1		.587		
4.5		.466		
3.3			.828	
3.2			.695	
3.4			.653	
3.1			.509	
2.3				.724
2.4				.584
2.5				.577

Note: own elaboration

Table 6 - Model goodness-of-fit indicators.

Modelos	χ^2	C.M./df	CFI	IFI	TLI	NFI	RMSEA	90% CI
1º	739.779	7.549	.837	.838	.800	.818	.90	.084 - .096
2º	185.185	3.940	.947	.947	.925	.931	.060	.051 - .070

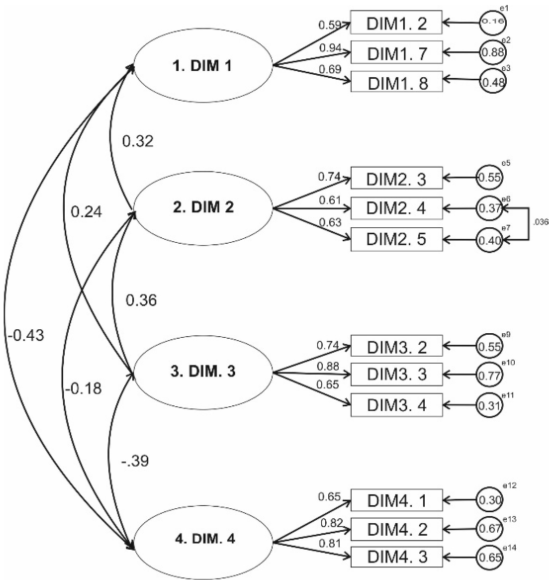

Figure 3 - Diagram of Confirmatory Factor Analysis.

The properties of this last model were also evaluated through convergent validity through several techniques. On the one hand, the AVE (Average Variance Extracted) coefficient was used, which must be greater than or equal to the threshold of 0.50, in recommendations by Hair et al. (2010) and Henseler et al. (2015). After carrying out the analysis, it was found that the AVE coefficients for the dimensions of the instrument had an acceptable level of convergent validity: DIM. 1 (.51), DIM. 2 (.50), DIM. 3 (.54) and DIM.4 (.54). On the other hand, the MSV index (Maximum Squared Shared Variance) was used to evaluate discriminant validity, which must be less than the AVE value for each factor (Fornell & Larcker, 1981). When examining the results, the discriminant validity between them is maintained: DIM. 1 (.088), DIM.2 (.088), DIM.3 (.059) and DIM. 4 (.036).

3.4 Reliability analysis

According to the literature, various techniques are used to evaluate the reliability of the instruments (Souza et al., 2017). According to Mallery (1999), it is preferred that the Cronbach's alpha value be close to or greater than .70. since a value less than .50 is generally unacceptable. These coefficients were calculated with CFA sample of study participants. The Composite Reliability (CR) index was very satisfactory: DIM.1 (.74), DIM. 2 (.74), DIM. 3 (.78) and DIM. 4 (.78). Cronbach's alpha also obtained values close to 7 or higher: DIM. 1 (.68), DIM. 2 (.70), DIM. 3 (.76) and DIM. 4 (.76). The total value of the instrument is .72 (taking into consideration that there are inverse items which must be changed in direction when doing the calculations).

4. Conclusions

The educational system is now completely digitalized, teachers at all levels are required to have digital skills, which are necessary to be able to do their jobs to the best of their ability. Most work processes now have a digital flow, and the same thing has happened to teaching, learning and research in the academic field. HE teachers cannot exempt themselves from this demand, also because nowadays the sharing of knowledge and science, travels through the main online search engines and within computerized databases containing articles from all the research institutions of the world (Ribeiro et al., 2023). Even the system of evaluation of a teacher's career no longer takes place only locally, but globally evaluation and recognition take place through the publication of articles on specific sites designated for this purpose.

For all the reasons listed, also in the light of the digital acceleration that took place during COVID-19, educational systems are called upon to provide adequate training and to have streamlined and effective tools available to detect the presence of the required digital competence (Saidy & Sura, 2020). Digitalization is a complex process; it can often create stress and anxiety for the teachers, in anyway, multifarious factors influence teachers' digitalization, and they can be individual or contextual (Cataudella et al., 2021). For example, Maican and colleagues (2019) find that teachers with higher levels of seniority in the academic field were more anxious and had lower levels of technology self-efficacy and, in general, they had a less favorable attitude towards the use of online technologies, focused on low performance and effort expectancy, low levels of hedonic motivation, and, consequently, low intention to use these applications in the future.

Digitization in doing research, in processing data, in creating a bibliography according to precise criteria and by means of specific computer programs, are aspects in which specific digital skills are necessary, otherwise one runs the risk of being cut off from a system that has precise 'digital' rules. In general, the main goal is to support the well-being of the HE teacher and help they're in being able to easily and daily use tools that can give feedback on what are their work and the results of their research.

The tool we present in this paper aims to be able to detect in advance what digital gaps are present among HE teachers so that we can intervene promptly with specific and appropriate support, so that we can also help designers to think more and more from the perspective of accessibility and usability of systems. The study shown good psychometric properties of the instrument. To validate the scale, various techniques were used: comprehension, construct, convergent and discriminant validity. The initial selection consisted of 22 items. First, the dispersion values were reviewed to adjust the successive correlations of the items, following the recommendations of Pérez & Medrano (2010) and Meroño et al. (2018). In addition, the Bartlett test was applied to perform the Exploratory Factor Analysis (EFA) and the principal axis factorization method with oblimin rotation was used. After the EFA study, a scale of 16 items distributed in four dimensions was developed. Two CFA models were tested where the second version was satisfactory, with a final version of 12 items. For this process, several fit indices were used, and the results were compared with the acceptable values indicated by Hu & Bentler (1999) and Kline (2011). When evaluating these indices, several models were created, and the final model showed that the results obtained were within the acceptable ranges specified in the literature. Furthermore, the discriminant and convergent validity of the instrument was verified, finding satisfactory values in both the Average Extracted Variance (AVE) index and the Maximum Shared Variance (MSV) index, as recommended by Hair et al. (2010) and Fornell and Larcker (1981).

In addition to evaluating and concluding on the psychometric properties of this measurement instrument, it is essential to consider future lines of research and its practical applications. To advance in this field, it is important to explore new samples and contexts to corroborate the robustness and generalizability of the instrument. This involves conducting longitudinal studies to observe its stability and consistency over time, as well as its sensitivity to changes in different settings and populations. As future work, it is particularly interesting to apply the questionnaire to a population of future teachers. These individuals, in their role as researchers in the classroom, must explore and refine the teaching-learning process for their future students. To do this, they need to develop advanced digital skills, crucial in contemporary educational research. Assessing these competencies in future teachers not only provides valuable data on their preparation and skills, but also identifies areas where specific training interventions are required. The implementation of this design in both national and international contexts allows a cross-cultural comparison, revealing differences and similarities in the formation of digital competencies in research work between different educational systems. This can inform educational policies and teacher training strategies at a global level, promoting a more homogeneous and effective approach in the preparation of Higher Education teachers.

Datasets and reproducibility

Datasets will be published as an addendum to the main paper.

Acknowledgements

This paper arises from the second doctoral thesis carried out by Francisco David Guillén-Gámez as a PhD student, attached to the Doctoral Program in Education of the Autonomous University of Madrid (UAM).

References

Adtani, R., Arora, R., Raut, R., & Neelam, N. (2023). ICT in higher education: learning as usual or a “new normal”?. *Higher Education, Skills and Work-Based Learning*, 13(4), 846-860.

Agustí López, A. I., Martí Aras, A., Rodríguez Martín, A., & Gabarda Méndez, C. (2023). Personality, Burnout and Digital Competence in university professor, An approach to the current reality. *Innoeduca. International Journal of Technology and Educational Innovation*, 9(2), 162–176. https://doi.org/10.24310/innoeduca.2023.v9i2.15063

Asencio, E. N., García, E. J., Redondo, S. R., & Thoilliez, B. (2017). *Fundamentos de la investigación y la innovación educativa*. Unir Editorial.

Atiqah, S. N., Hanafiah, M. H., Ismail , H., & Kandappan, B. (2024). Preparing instructors to transition to online distance learning: a pandemic panacea?. *Innoeduca. International Journal of Technology and Educational Innovation*, 10(1), 5–28. https://doi.org/10.24310/ijtei.101.2024.16820

Bala, J. (2016). Contribution of SPSS in Social Sciences Research. I*nternational Journal of Advanced Research in Computer Science*, 7(6), 250-254.

Bandalos, D. L., & Finney, S. J. (2018). Factor analysis: Exploratory and confirmatory. In T*he reviewer's guide to quantitative methods in the social sciences* (pp. 98-122). Routledge.

Birdsall, C., & Tkaczyk, V. (2019). Listening to the archive: sound data in the humanities and sciences. *Technology and Culture*, 60(2), S1-S13.

Bretag, T., & Mahmud, S. (2009). Self-plagiarism or appropriate textual re-use?. *Journal of Academic Ethics*, 7, 193-205.

Butros, A., & Taylor, S. (2010, October). Managing information: evaluating and selecting citation management software, a look at EndNote, RefWorks, Mendeley and Zotero. In *Netting knowledge: two hemispheres/one world: proceedings of the 36th IAMSLIC Annual Conference* (pp. 17-21). USA: IAMSLIC.

Byrne, B.M. (2013). *Structural equation modeling with AMOS: Basic concepts, 15 applications, and programming.* Routledge.

Chapman, K., & Ellinger, A. E. (2019). An evaluation of Web of Science, Scopus and Google Scholar citations in operations management. *The International Journal of Logistics Management*, 30(4), 1039-1053.

Cheung, G. W., & Wang, C. (2017). Current approaches for assessing convergent and discriminant validity with SEM: issues and solutions. *Academy of Management Proceedings*, 2017(1), 12706. https://doi.org/10.5465/AMBPP.2017.12706abstract

Clark, T. (2010). On 'being researched': Why do people engage with qualitative research?. *Qualitative Research*, 10(4), 399-419.

Degn, L. (2023). Digitalization as a Strategic Goal—The Missed Potential of Profiling Danish Universities in the Digitalization Era? *Digital Transformations in Nordic Higher Education*, 197–215. https://doi.org/10.1007/978-3-031-27758-0_9

Demeshkant, N., Potyrala, K., & Tomczyk, L. (2020). Levels of academic teachers digital competence: Polish case-study. In 2020). *Proceedings of the 28th International Conference on Computers in Education* (pp. 591-601).

Dzib Goodin, A., Castevich, J., Hogan, D. L., Sanders, L., Slovec, K., & Yelizarov, D. (2015). Staff Development learning environment for tutoring and research in higher education levels. *Innoeduca. International Journal of Technology and Educational Innovation*, 1(1), 10–16. https://doi.org/10.20548/innoeduca.2015.v1i1.27

Cataudella, S., Carta, S. M., Mascia, M. L., Masala, C., Petretto, D. R., Agus, M., & Penna, M. P. (2021). Teaching in times of the COVID-19 pandemic: A pilot study on teachers' self-esteem and self-efficacy in an italian sample. *International Journal of Environmental Research and Public Health*, 18(15), 8211. https://doi.org/10.3390/ijerph18158211

Egghe, L. (2010). The Hirsch index and related impact measures. *Annual review of information science and technology*, 44(1), 65-114.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of marketing research*, 18(1), 39-50. https://doi.org/10.1177/002224378101800104

Granić, A., & Marangunić, N. (2019). Technology acceptance model in educational context: A systematic literature review. *British Journal of Educational Technology*, 50(5), 2572-2593. https://doi.org/10.1111/bjet.12864

Guillén-Gámez, F. D., & Mayorga-Fernández, M. J. (2021). Design and validation of an instrument of self-perception regarding the lecturers' use of ICT resources: to teach, evaluate and research. *Education and Information Technologies*, 26(2), 1627-1646. https://doi.org/10.1007/s10639-020-10321-1

Guillén-Gámez, F. D., Ruiz-Palmero, J., & García, M. G. (2023). Digital competence of teachers in the use of ICT for research work: development of an instrument from a PLS-SEM approach. *Education and Information Technologies*, 1-21. https://doi.org/10.1007/s10639-023-11895-2

Guillén-Gámez, F. D., Gómez-García, M., & Ruiz-Palmero, J. (2024). Competencia digital en labores de Investigación: predictores que influyen en función del tipo de universidad y sexo del profesorado. *Pixel-Bit, revista de medios y educación*, 69, 7-34. https://doi.org/10.12795/pixelbit.99992

Jiménez Sabino, M. J., & Cabero Almenara, J. (2021). The technological, pedagogical and content knowledge of Andalusian university professors on ICT. Analysis from the TPACK model. *Innoeduca. International Journal of Technology and Educational Innovation*, 7(1), 4–18. https://doi.org/10.24310/innoeduca.2021.v7i1.11940

Hair, J., Black, W., Babin, B., & Anderson, R. (2010). *Multivariate data analysis*. Prentice-Hall: USA.

Harari, M. B., Parola, H. R., Hartwell, C. J., & Riegelman, A. (2020). Literature searches in systematic reviews and meta-analyses: A review, evaluation, and recommendations. *Journal of Vocational Behavio*r, 118, 103377.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the academy of marketing science*, 43(1), 115-135. https://doi.org/10.1007/s11747-014-0403-8

Hinkin, T. R., Tracey, J. B., & Enz, C. A. (1997). Scale construction: Developing reliable and valid measurement instruments. *Journal of Hospitality & Tourism Research*, 21(1), 100-120. https://doi.org/10.1177%2F109634809702100108

Hu, L., & Bentler, P.M. (1999). Cutoff criteria for fit indexes in covariance structure 17 analysis: Conventional criteria versus new alternatives. *Structural Equation 18 Modeling: A Multidisciplinary Journal*, 6(1), 1-55. https://doi.org/10.1080/10705519909540118

Imfeld, C. (2003). Playing Fair with Fair Use? The Digital Millennium Copyright Act's Impact on Encryption Researchers and Academicians. *Communication law and Policy*, 8(1), 111-144.

Kavoura, A. (2014). Social media, online imagined communities and communication research. *Library review*, 63(6/7), 490-504.

Kline, R. B. (2023). *Principles and practice of structural equation modeling*. Guilford publications.

Königs, P. (2022). What is techno-optimism?. *Philosophy & Technology*, 35(3), 62-67.

Lawrence, S., Pennock, D. M., Flake, G. W., Krovetz, R., Coetzee, F. M., Glover, E., ... & Giles, C. L. (2001). Persistence of web references in scientific research. *Computer*, 34(2), 26-31.

Lipson, C. (2011). *Cite right: a quick guide to citation styles--MLA, APA, Chicago, the sciences, professions, and more*. Chicago: University of Chicago Press.

Lloret-Segura, S., Ferreres-Traver, A., Hernández-Baeza, A., & Tomás-Marco, I. (2014). El análisis factorial exploratorio de los ítems: una guía práctica, revisada y actualizada. *Anales de psicología/annals of psychology*, 30(3), 1151-1169. https://doi.org/10.6018/analesps.30.3.199361

Mabić, M., & Garbin Praničević, D. (2021). Digital Maturity of Higher Education Institutions in Bosnia and Herzegovina: Teachers’ Assessment. *ENTRENOVA - ENTerprise REsearch InNOVAtion*, 7(1), 160–169. https://doi.org/10.54820/rakw8731

Maican, C. I., Cazan, A. M., Lixandroiu, R. C., & Dovleac, L. (2019). A study on academic staff personality and technology acceptance: The case of communication and collaboration applications. *Computers & Education*, 128, 113-131. https://doi.org/10.1016/j.compedu.2018.09.010

Mallery, P. (1999). SPSS for Windows step by step: A simple guide and reference. Wind. Step by step a simple guid. Ref. Needham Height. MA Allyn Bacon.

Mason, S., & Singh, L. (2022). When a journal is both at the ‘top’and the ‘bottom’: the illogicality of conflating citation-based metrics with quality. *Scientometrics*, 127(6), 3683-3694.

Medeshova, A., Özerbaş, M., Akimova, S., & Kurmasheva, D. (2023). Innovative pedagogical strategies for effective digitalization of education in the universities. *Pedagogy and Psychology*, 57(4), 25-34. https://doi.org/10.51889/2960-1649.2023.15.4.011

Meroño, L., Calderón Luquin, A., Arias Estero, J. L., & Méndez Giménez, A. (2018). Diseño y validación del cuestionario de percepción del profesorado de Educación Primaria sobre el aprendizaje del alumnado basado en competencias (# ICOMpri2). *Revista Complutense de Educación*, 29 (1), 215-235. http://dx.doi.org/10.5209/RCED.52200

Michel, C., & Pierrot, L. (2023). Modelling Teachers’ Digital Maturity: Literature Review and Proposal for a Unified Model. In 1*5th International Conference on Computer Supported Education* (Vol. 2, pp. 535-542). SCITEPRESS-Science and Technology Publications.

Moreira-Fontán, E., García-Señorán, M., Conde-Rodríguez, Á., & González, A. (2019). Teachers' ICT-related self-efficacy, job resources, and positive emotions: Their structural relations with autonomous motivation and work engagement. *Computers & Education*, 134, 63-77. https://doi.org/10.1016/j.compedu.2019.02.007

Nunally, J. C. (1978). *Psychometric Theory* (2º ed.). McGraw-Hill.

Pajić, D. (2015). On the stability of citation-based journal rankings. *Journal of Informetrics*, 9(4), 990-1006.

Pérez, E. R., & Medrano, L. A. (2010). Análisis factorial exploratorio: bases conceptuales y metodológicas. *Revista Argentina de Ciencias del Comportamiento (RACC)*, 2(1), 58-66.

Ping, L., & Cunningham, D. (2013). A*pplication of structural equation modeling in educational research and practice* (Vol. 7). M. S. Khine (Ed.). Rotterdam: SensePublishers.

Popescu, M.-F., Chiripuci, B.-C., Orîndaru, A., Constantin, M., & Scrieciu, A. (2020). Fostering Sustainable Development through Shifting Toward Rural Areas and Digitalization - The Case of

Romanian Universities. *Sustainability*, 12(10), 4020. https://doi.org/10.3390/su12104020

Raykov, T., & Marcoulides, G. A. (2008). *An introduction to applied multivariate analysis*. New York: Routledge.

Ribeiro, B., Meckin, R., Balmer, A., & Shapira, P. (2023). The digitalisation paradox of everyday scientific labour: How mundane knowledge work is amplified and diversified in the biosciences. *Research Policy*, 52(1), 104607. https://doi.org/10.1016/j.respol.2022.104607

Rosak-Szyrocka, J. (2024). The Era of Digitalization in Education where do Universities 4.0 Go? *Management Systems in Production Engineering*, 32(1), 54-66. https://doi.org/10.2478/mspe-2024-0006

Saidy, C., & Sura, T. (2020). When everything changes over night: what we learned from teaching the writing practicum in the era of Covid-19. *Teaching/Writing: The Journal of Writing Teacher Education*, 9(1), 21, 1-6.

Sarfraz, Z., Sarfraz, A., Anwer, A., Nadeem, Z., Bano, S., & Tareen, S. (2020). Predatory journals: A literature review. *Pakistan Journal of Surgery and Medicine*, 1(1), 42-51.

Scheerder, A., Van Deursen, A., & Van Dijk, J. (2017). Determinants of Internet skills, uses and outcomes. A systematic review of the second-and third-level digital divide. *Telematics and informatics*, 34(8), 1607-1624.

Schröter, T., & Grafe, S. (2020). Digital Literacy and Digital Competency of University Teachers. A Systematic Analysis of Frameworks. In *Innovate Learning Summit* (pp. 144-157). Association for the Advancement of Computing in Education (AACE).

Severin, A., & Low, N. (2019). Readers beware! Predatory journals are infiltrating citation databases. *International Journal of Public Health*, 64, 1123-1124.

Souza, A. C. D., Alexandre, N. M. C., & Guirardello, E. D. B. (2017). Psychometric properties in instruments evaluation of reliability and validity. *Epidemiologia e servicos de saude*, 26, 649-659.

Stosic, L. (2017). Does the use of ICT enable easier, faster and better acquiring of knowledge. *International Journal of Innovative Research in Education*, 4(4), 179-185.

Suyo-Vega, J. A., Meneses-La-Riva, M. E., Fernández-Bedoya, V. H., Ocupa-Cabrera, H. G., Alvarado-Suyo, S. A., da Costa Polonia, A., ... & Gago-Chávez, J. D. J. S. (2022). University teachers' self-perception of digital research competencies. A qualitative study conducted in Peru. *Frontiers in Education* (Vol. 7, p. 1004967)

Tomczyk, Ł., & Fedeli, L. (2022). Digital Literacy for Teachers. *Lecture Notes in Educational Technology*. Springer Nature Singapore. https://doi.org/10.1007/978-981-19-1738-7

Tomczyk, Ł., Fedeli, L., Włoch, A., Limone, P., Frania, M., Guarini, P., Szyszka, M., Mascia, M. L., & Falkowska, J. (2022). Digital Competences of Pre-service Teachers in Italy and Poland. *Technology, Knowledge and Learning*, 28(2), 651–681. https://doi.org/10.1007/s10758-022-09626-6

Tomczyk, Ł., Jáuregui, V. C., de La Higuera Amato, C. A., Muñoz, D., Arteaga, M., Oyelere, S. S., ... & Porta, M. (2021). Are teachers techno-optimists or techno-pessimists? A pilot comparative among teachers in Bolivia, Brazil, the Dominican Republic, Ecuador, Finland, Poland, Turkey, and Uruguay. *Education and Information Technologies*, 26(3), 2715-2741.

Tomczyk, L., Potyrala, K., Demeshkant, N., & Czerwiec, K. (2021). University teachers and crisis e-learning : Results of a Polish pilot study on: attitudes towards e-learning, experiences with e-learning and anticipation of using e-learning solutions after the pandemic. *2021 16th Iberian Conference on Information Systems and Technologies (CISTI)*. https://doi.org/10.23919/cisti52073.2021.9476521

Van Laar, E., Van Deursen, A. J., Van Dijk, J. A., & De Haan, J. (2017). The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in human behavior*, 72, 577-588.

Weninger, C. (2022). Skill versus social practice? Some challenges in teaching digital literacy in the university classroom. *Tesol Quarterly*, 56(3), 1016-1028.

Woods, M., Paulus, T., Atkins, D. P., & Macklin, R. (2016). Advancing qualitative research using qualitative data analysis software (QDAS)? Reviewing potential versus practice in published studies using ATLAS. ti and NVivo, 1994–2013. *Social science computer review*, 34(5), 597-617.

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 20, No. 2 (2024), pp. 13-25

Understanding teachers' intentions and use of AI tools for research

Kriti Priya Gupta[1]

Symbiosis Centre for Management Studies, NOIDA Campus, Symbiosis International (Deemed University) - Pune (India)

(submitted: 22/6/2024; accepted: 18/9/2024; published: 24/9/2024)

Abstract

The rapid advancement of artificial intelligence (AI) has led to the development of a wide array of tools which are transforming the education industry. The study investigates the adoption and use of AI tools by teachers within higher education institutions (HEIs), using the context of India. By employing an extended Unified Theory of Acceptance and Use of Technology (UTAUT) model, the study empirically examines the influence of two technological attributes (i.e. performance expectancy and effort expectancy), two contextual factors (i.e. social influence and facilitating conditions) and two personal characteristics (i.e. personal innovativeness and computer self-efficacy) on teachers' behavioral intention to use AI tools for research work. The primary data were collected from 331 teachers working with HEIs in the Delhi-National Capital Region (NCR) of India. PLS-SEM technique was used to analyze the data. The causal model included performance expectancy, effort expectancy, social influence, facilitating conditions, personal innovativeness, and computer self-efficacy as exogeneous variables; and behavioral intention to adopt AI tools and actual use of AI tools as endogenous variables. The findings indicate that teachers' intention to adopt AI tools for research work is positively influenced by performance expectancy, effort expectancy, social influence, computer self-efficacy and personal innovativeness. Further, their actual use of AI tools is influenced by their behavioral intention and facilitating conditions. The model explained 70.2% variation in behavioral intention and 39.2% variation in actual use of AI tools. The study provides further verification of the effectiveness of the UTAUT framework in the context of using emerging technologies in the education sector. Findings from this study provide beneficial insights for HEIs and developers of AI tools.

KEYWORDS: Artificial Intelligence, Academic Research, UTAUT, Teachers, Higher Education Institutions.

DOI
https://doi.org/10.20368/1971-8829/1135969

CITE AS
Gupta, K.P. (2024). Understanding teachers' intentions and use of AI tools for research. *Journal of e-Learning and Knowledge Society*, *20*(3), 13-25. https://doi.org/10.20368/1971-8829/1135969

1. Introduction

Academic research is a fundamental component of higher education, which plays a pivotal role in advancing knowledge and fostering innovation. The quality and productivity of academic research are paramount goals for higher education institutions (HEIs). Thus, writing and publishing research papers are key research-related activities for teachers in HEIs. However, today's academic environment faces various challenges such as increasing competition and limited resources (Edvardsen et al., 2017). Technology and digital tools have the potential to significantly enhance research quality and productivity as they can help overcome the difficulties encountered while publishing scientific papers, such as data collection, data analysis, citation management, academic writing and copyediting (Brunetti et al., 2022).

The rapid advancement of artificial intelligence (AI) has led to the development of a wide array of tools which are transforming the education industry (Marsh, 2023; Greco & Cinganotto, 2023). AI is not only enhancing traditional teaching methods but also revolutionizing the way research is conducted in HEIs (Al-Mughairi & Bhaskar, 2023). AI tools have become increasingly prevalent, offering innovative solutions to streamline and enhance the research process. For example, ChatGPT can be used as an advanced language model to generate ideas and research questions which can help teachers determine the direction of the research study (Sok & Heng, 2023). Grammarly can help improve the quality of academic writing by providing suggestions for grammar, spelling

[1] corresponding author - email: kritipriyag@gmail.com

and clarity (Aljuaid, 2024). By offering paraphrasing capabilities, HumanizeAI can help researchers to avoid plagiarism and improve the readability of their research papers. AI tools (such as Semantic Scholar) can quickly identify relevant papers, significantly speeding up the literature review process (Atkinson, 2023).

Despite the numerous benefits of AI tools in academic research, there is a paucity of empirical studies investigating the factors influencing teachers' adoption of these tools. Though there is an extensive body of literature examining teachers' acceptance and use of various technologies within teaching and learning contexts, there remains a notable gap in empirical studies that are specifically focused on the adoption of AI tools for research purposes. Previous studies have largely explored teachers' use of technologies in contexts such as online distance learning (Atiqah et al., 2024); e-learning (Sánchez-Prieto et al., 2019), mobile learning (Hu et al., 2020), learning management systems (LMS) (Alharbi et al., 2022), learning analytics (El Alfy & Kehal, 2024), and technology-enhanced teaching through virtual reality applications (Gupta and Bhaskar, 2023), Google classrooms (Oguguo et al., 2023), and cloud services (Wang et al., 2017).

Though some recent studies (e.g. Guillén-Gámez et al., 2023) have examined the factors influencing the integration of technological tools in research work, the specific context of using AI tools for academic research remains underexplored in the literature. The absence of empirical research in this area represents a critical gap in the literature, that needs to be addressed. Understanding the unique challenges and motivators associated with the adoption of AI tools for research work of teachers is essential as it can help design institutional policies and create conducive environments that support the integration of AI technologies in research activities. By addressing these factors, universities can enhance their research output, thereby maintaining a competitive edge in the academic landscape. Understanding how AI tools are adopted by teachers can help leverage their full potential, ultimately improving the quality and efficiency of academic research.

Thus, the present study explores the factors that influence teachers' acceptance and use of AI tools for their research work, by employing the Unified Theory of Acceptance and Use of Technology (UTAUT) as the theoretical lens. Premised in the context of Indian HEIs, the study attempts to answer the following research questions:

- RQ1: How do technological characteristics of AI tools (i.e. performance expectancy and effort expectancy) influence teachers' behavior towards using these tools for research?
- RQ2: How do contextual factors (i.e. social influence and facilitating conditions) influence teachers' behavior towards using AI tools for research?
- RQ3: How do teachers' individual characteristics (i.e. personal innovativeness and computer self-efficacy) influence their behavior towards using AI tools for research?

The remaining paper is structured as follows: section 2 describes the theoretical framework and section 3 discusses the methodology used in the study. The results are presented and discussed in sections 4 and 5 respectively. Finally, the study is concluded in section 6.

2. Theoretical framework

A few studies have explored the applications and implications of using AI tools for academic research. For example, Shtykalo and Yamnenko (2024) discussed the capabilities of various freely available AI tools that can perform tasks related to academic activities, including research and analysis. Perkins and Roe (2024) examined the impact of generative AI tools on academic research by focusing on their implications for qualitative and quantitative data analysis. Casal and Kessler (2023) examined the issues pertaining to research ethics, human judgements and accuracy, within the context of using AI chatbots (such as ChatGPT) in academic research.

The conceptual framework of the present study is grounded in the UTAUT model (Venkatesh et al., 2003). The UTAUT framework includes four constructs (namely, performance expectancy, effort expectancy, social influence and facilitating conditions) that determine users' behavior towards the acceptance and use of a technology. Performance expectancy (PE) and effort expectancy (EE) constitute the technological attributes, whereas social influence (SI) and facilitating conditions (FC) represent the contextual or environmental factors. The users' behavioral outcomes within the UTAUT are conceptualized by two constructs i.e. behavioural intention (BI) and actual use (AU). BI refers to the degree to which an individual has formulated conscious plans to adopt a technology, whereas AU (or usage behavior), refers to the extent to which an individual utilizes the technology in his/her activities (Venkatesh et al., 2003). Several studies in the recent past have used the UTAUT framework to understand the adoption of AI-based technologies in various educational contexts (Chatterjee & Bhattacharjee, 2020; Lin et al., 2022). For example, Wu et al. (2022) examined students' willingness to accept AI-assisted learning environments by using an integrated framework of UTAUT and perceived risk theory. Tian et al. (2024) utilized the UTAUT model to investigate the acceptance of AI Chatbot technology among students.

Clifford (2024) employed the UTAUT framework to investigate the HEI teachers' intention towards adopting AI from a pedagogical perspective.

In order to gain a comprehensive understanding of teachers' behavior towards using AI tools, we extend the UTAUT framework by two variables namely, computer self-efficacy (CSE) and personal innovativeness (PI), that represent teachers' personal characteristics. The proposed model is depicted in Figure 1 and the hypotheses are discussed below.

PE and BI

PE refers to the degree to which an individual believes that using a technology can assist in achieving task-oriented goals (Venkatesh et al., 2003). Prior studies indicate that PE plays a key role in shaping teachers' behavior towards using technologies. Buabeng-Andoh and Baah (2020) found that PE has a significant influence on teachers' attitude towards using learning management system. El Alfy and Kehal (2024) demonstrated that PE has a positive influence on educators' attitude and behavioural intention to use learning analytics. For teachers, the expectation that AI tools will improve their research productivity, can be a strong motivator for adopting such tools. AI tools such as Semantic Scholar, Google Scholar, and Grammarly can significantly enhance research productivity of teachers, by expediting literature searches and improving writing quality. These performance enhancements can motivate teachers to use AI tools for their research work. Hence, we posit that:

H1: PE has a significant positive influence on teachers' BI to adopt AI tools for research work

EE and BI

EE is defined as the degree of ease associated with the use of a technology (Venkatesh et al., 2003). Extant studies have demonstrated that EE is a key predictor of BI to adopt technologies in various educational contexts such as mobile learning (Hu et al., 2020; Raza et al., 2022) and Google classrooms (Jakkaew & Hemrungrote, 2017). Prior research on e-learning and using digital tools in educational contexts highlights that ease of use significantly influences teachers' decisions to adopt technologies (Teo 2011; Sánchez-Prieto et al., 2019; Atiqah et al., 2024). EE addresses the cognitive and physical effort required to use a technology. The intuitive and user-friendly interfaces of AI tools can minimize these efforts and provide more accessibility to teachers who may not have advanced technical skills. When teachers will perceive that AI tools are easy to learn and use, they will be more likely to incorporate them into their research workflows. Hence, we postulate that:

H2: EE has a significant positive influence on teachers' BI to adopt AI tools for research work

SI and BI

SI refers to the degree to which an individual perceives that relevant persons who are important for him/her expect that he/she should use a particular technology (Venkatesh et al., 2003). Studies in the educational sector have highlighted the importance of social influence in the adoption of new technologies such as AI-enabled warning systems in higher education (Raffaghelli et al., 2022), and AI-enabled language online e-learning products (Lin et al., 2022). Teachers are often influenced by their colleagues' attitudes and behaviors regarding technology use (El Alfy & Kehal, 2024; Buabeng-Andoh & Baah, 2020). If their peers, seniors and members in broader research community advocate for the use of AI tools, they are more likely to adopt those tools for their own research work. Hence, we propose that:

H3: SI has a significant positive influence on teachers' BI to adopt AI tools for research work

FC, BI and AU

FC refers to the degree to which an individual believes that necessary resources exist to support the use of a technology (Venkatesh et al., 2003). Prior studies on educational technology adoption consistently shows that FC including technical support, access to resources, and training programs significantly impact teachers' intention to use technology as well as their actual usage behavior (Teo, 2011; Strzelecki, 2023). Kocaleva et al. (2015) observed that FC had the strongest effect on e-learning acceptance and use by teaching staff in HEIs. Hu et al. (2020) demonstrated that the FC significantly influences teachers' behavioural intention and use behaviour regarding mobile technologies in higher education. Access to reliable technical infrastructure (e.g., high-speed internet, computers), and supportive institutional policies that encourage the use of AI tools, is crucial for motivating teachers to use these tools. When teachers perceive that these resources and institutional support are readily available, they will be more likely to adopt and use AI tools for their research work. Hence, we posit that:

H4: FC has a significant positive influence on teachers' BI to adopt AI tools for research work

H5: FC has a significant positive influence on teachers' AU of AI tools for research work

CSE and BI

CSE refers to an individual's belief in his/her capability to successfully perform tasks using a computer (Compeau & Higgins, 1995). It encompasses confidence in using various computer applications and information technologies such as AI tools. Research in educational settings has found that CSE is a significant predictor of teachers' intention to use technology (Joo et al., 2018; Alharbi & Drew, 2018). For example, Zhao and Zhao (2021) found that teachers' CSE influences the ease of using a technology, which in turn helps in shaping a positive attitude towards the technology. Gupta and Bhaskar (2023) concluded that teachers' CSE positively influences teachers' intention to use virtual reality applications for teaching purposes. Effective use of AI tools often involves integrating them into existing research workflows, which requires certain technical skills. Teachers with high CSE are more likely to explore and effectively leverage the AI tools to meet their specific research needs. Hence, we propose that:

H6: CSE has a significant positive influence on teachers' BI to adopt AI tools for research work

PI and BI

Within the context of technology adoption, PI refers to the willingness of an individual to try out innovative technologies on his/her own (Agarwal & Prasad, 1998). It is a trait that reflects openness to new experiences and a proactive approach to adopting emerging technologies. Prior studies suggest that innovative teachers are more likely to integrate digital tools into their academic activities (Mazman Akar, 2019; Lopez-Perez, 2019; Gupta & Bhaskar, 2023). Loogma et al. (2012) demonstrated that PI significantly influenced teachers' adoption of e-learning platforms. Gökçearslan et al. (2022) concluded that individual innovativeness is a significant predictor of teachers' acceptance of Internet of Things (IoT) technologies in educational contexts. Teachers who are innovative are driven by their inherent tendency to experiment with new solutions, such as AI tools. Therefore, they are more likely to see the potential benefits of AI tools and incorporate them into their research processes. Hence, we postulate that:

H7: PI has a significant positive influence on teachers' BI to adopt AI tools for research work

BI and AU

Prior research demonstrates a strong correlation between intention to adopt a technology and its actual use (Nikolopoulou et al., 2020; Budhathoki et al., 2024). The relationship between BI and AU has also been demonstrated in the context of technology adoption by teachers. Teo (2011) found that teachers' intention to use technology significantly predicted their actual use in the classroom. Siyam (2019) demonstrated the positive relationship between teachers' acceptance and actual use of technology. Teachers who recognize the benefits and have a positive intention towards AI tools are more likely to use them effectively. Hence, we propose that:

H8: Teachers' BI has a significant influence on their AU of AI tools.

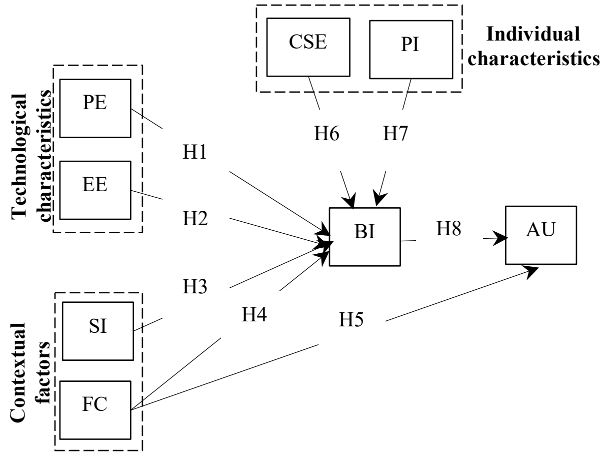

Figure 1 - Proposed Model.

3. Methodology

3.1 Measures

The items for measuring the constructs in the proposed model were adopted from prior studies (see Annexure 1). The items for PE, EE, SI and BI were adapted Strzelecki (2023). The items for PI and CSE were adapted from Sun and Jeyraj (2013) and Zhao et al. (2020) respectively. The items for FC and AU were adapted from Budhathoki et al. (2024). A five-point Likert response ranging from 1 (strongly disagree) to five (strongly agree) was used to measure all the items.

3.2 Sample and Data Collection

We conducted a survey in 24 HEIs in the National Capital Region (NCR) of Delhi, India. The teachers teaching in various undergraduate and graduate programs served as our target respondents. The convenience sampling technique (Saunders, 2012) was used to select the HEIs as well as the teachers. Convenience sampling is a relatively fast and easy approach to achieve the required sample size (Lopez and Whitehead, 2013). Though, convenience sampling sometimes suffers from the limitation of under-representing or over-representing particular groups within the target population, it is commonly used by researchers as it offers an effective approach of data collection in terms of time and cost (Bornstein et al., 2013). Hence, we employed convenience sampling technique in the present study.

A self-administered structured questionnaire was used as the survey instrument to collect primary data from the target respondents. The questionnaire comprised questions on the demographic characteristics of the teachers, as well as the items for measuring various research constructs. The initial draft of the questionnaire was checked for face validity through pilot testing with ten academicians and researchers.

For the final survey, 400 teachers were contacted out of which 353 responded for filling the questionnaire. After removing unviable responses, 331 usable questionnaires were obtained. Hence the final sample size of our study was 331. The sample consisted of 65.9% females and 34.1% males. The mean age of female respondents was 41±1.22 years, and the mean age of male respondents was 48.4±1.12 years.

4. Results

We employed Structural Equation Modelling (SEM) to analyze the data and test the proposed hypotheses. There are two widely used SEM techniques i.e. co-variance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM). The choice of appropriate SEM technique depends upon the sample size, normality characteristics, and purpose (Hair et al., 2016). Since the major focus of our study is testing relationships among various constructs in the proposed model, we employed the PLS-SEM technique. SmartPLS 4 software was used to employ the PLS-SEM technique.

4.1 Measurement Model

Firstly, the measurement model was assessed through confirmatory factor analysis (CFA) to evaluate the reliability and validity of the model constructs. Table 1 indicates the results of reliability and convergent validity of the constructs. As can be observed from Table 1, all items had significant loadings ($p<0.001$) with their respective constructs. Moreover, the standardized loadings of all items were greater than 0.5, indicating adequate convergent validity (Hair et al., 2016). Additionally, the average variance extracted (AVE) of all the latent constructs was greater than 0.5, further confirming the validity of the constructs (Fornell & Larcker, 1981). Further, the Cronbach's alpha (CA) and composite reliability (CR) of all constructs were greater than 0.70, ensuring the reliability and internal consistency of the constructs (Hair et al., 2016).

To assess the discriminant validity of the constructs, we employed two approaches, namely Fornell and Larcker criterion (see Table 2) and heterotrait–monotrait (HTMT) criterion (see Table 3). As can be observed from Table 2, the square roots of AVE values of all constructs were greater than the inter-construct correlations; which confirmed the discriminant validity of the constructs (Fornell & Larcker, 1981). Moreover, the HTMT ratios were less than 0.85 (see Table 3), further confirming the discriminant validity (Henseler et al., 2015).

4.2 Structural Model

After confirming the reliability and validity of the constructs, the proposed hypotheses were tested through the structural model. The significance and strength of the relationships between the underlying factors of our proposed model was assessed by answering the following questions: (1) How much variation is explained by the exogenous variables in the endogenous variables? and (2) What is the contribution of each exogenous variable in predicting the variance of the endogenous variables?

The coefficient of determination (R^2) was used to answer the first question, while the second question was answered by analyzing the path coefficients, levels of significance and effect sizes.

Figure 2 indicates that 70.2% variance in behavioural intention is explained by the factors – performance expectancy, effort expectancy, social influence, facilitating conditions, computer self-efficacy and personal innovativeness. Further, 39.2% variance in actual use of AI tools is explained by behavioural intention and facilitating conditions.

Table 4 indicates the path coefficients of the hypothesized relationships (β), along with the corresponding levels of significance (p-values) and effect sizes (f^2). The hypothesis 1 (H1) tests whether performance expectancy significantly affects the behavioral intention of teachers regarding the use of AI tools for research. The results ($t = 4.281$, $\beta = 0.216$, p-value < 0.001) confirm the significance of this relationship, thereby providing support for H1. The hypotheses H2 and H3 respectively focus on the significance of the influence of effort expectancy and social influence on teachers' behavioral intention of using AI tools for research. The results confirm both hypotheses: H2 ($t = 4.176$, $\beta = 0.210$, p-value < 0.001), H3 ($t = 1.890$, $\beta = 0.163$, p-value < 0.01).

The hypotheses H4 and H5 test the significance of the influence of facilitating conditions on teachers' behavioral intention to use AI tools, and their actual use of AI tools for research. The results provide support for the two hypotheses: H4 ($t = 4.208$, $\beta = 0.223$, p-value $<$ 0.001), H5 ($t = 5.474$, $\beta = 0.298$, p-value < 0.001). The hypotheses H6 and H7 regarding the significant influences of computer self-efficacy and personal innovativeness on teachers' behavioral intention to use AI tools are also accepted: H6 ($t = 3.381$, $\beta = 0.175$, p-value < 0.001), H7 ($t = 2.552$, $\beta = 0.157$, p-value $<$ 0.01).

Finally, the hypothesis concerning the significant influence of teachers' behavioral intention to use AI tools on the actual use of AI tools for research is also accepted ($t = 7.482$, $\beta = 0.388$, p-value < 0.01). The strengths of the proposed relationships were assessed

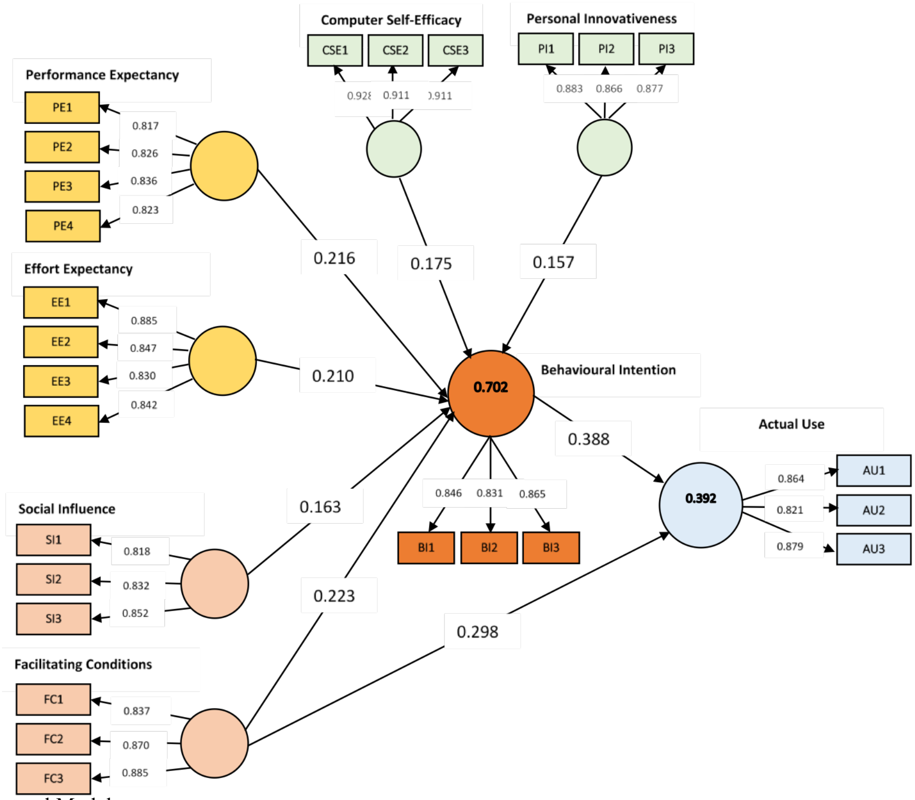

Figure 2 - Structural Model.

through their effect size (f^2) coefficients (Cohen, 1988). As suggested by Cohen (1988), $f^2 \geq 0.02$ indicates a small effect, $f^2 \geq 0.15$ signifies a medium effect and $f^2 \geq 0.35$ indicates a large effect. In the present study, the values of f^2 range between 0.01 to 0.13 (see Table 4), indicating small effects in the relationships of performance expectancy, social influence, computer self-efficacy and personal innovativeness with behavioral intention, and medium effects in the relationships between effort expectancy and behavioral intention; facilitating conditions and behavioral intention; facilitating conditions and actual use; and behavioral intention and actual use.

5. Discussion

The objective of the present study was to explore the factors influencing teachers' acceptance and use of AI tools for their research work, through the theoretical lens of UTAUT. Specifically, the study examined the influence of technological characteristics of AI tools, contextual factors, and teachers' individual characteristics on their behavior towards using these tools for research. The findings of the study are discussed below:

RQ1: How do technological characteristics of AI tools (i.e., performance expectancy and effort expectancy) influence teachers' behavior towards using these tools for research?

The study found that the technological characteristics of AI tools are the most critical predictors of teachers' intention to use AI tools for their research work. This aligns with the core tenets of the UTAUT framework, where performance expectancy and effort expectancy are crucial determinants of technology acceptance (Venkatesh et al., 2003).

Our findings suggest that the AI tools that offer utilitarian benefits to teachers by enhancing their research quality are more likely to be adopted. AI tools (such as Grammarly, Semantic scholar, ChatGPT) can significantly reduce the time required for various research-related tasks such as generating ideas, conducting literature reviews, and improving the clarity of academic writing (Sok & Heng, 2023; Aljuaid, 2024). If teachers believe that AI tools can improve their efficiency by faster completion of tasks, they are more inclined to adopt those tools for their research work. Our findings are in line with those of who Hu et al. (2020) found similar relationships in the context of teachers' acceptance of emerging technologies in higher education for classroom purposes.

Our findings further suggest that the ease of accessing and utilizing the AI tools (effort expectancy) also encourages their adoption.

Construct	Item	Item loading	CA	CR	AVE
PE	**PE1**	0.817***	0.844	0.846	0.681
	PE2	0.826***			
	PE3	0.836***			
	PE4	0.823***			
EE	**EE1**	0.885***	0.873	0.874	0.724
	EE2	0.847***			
	EE3	0.830***			
	EE4	0.842***			
SI	**SI1**	0.818***	0.785	0.804	0.696
	SI2	0.832***			
	SI3	0.852***			
FC	**FC1**	0.836***	0.830	0.833	0.747
	FC2	0.870***			
	FC3	0.885***			
PI	**PI1**	0.883***	0.847	0.849	0.766
	PI2	0.866***			
	PI3	0.877***			
CSE	**CSE1**	0.928***	0.905	0.914	0.840
	CSE2	0.911***			
	CSE3	0.911***			
BI	**BI1**	0.846***	0.804	0.804	0.718
	BI2	0.831***			
	BI3	0.865***			
AU	**AU1**	0.864***	0.815	0.817	0.731
	AU2	0.821***			
	AU3	0.879***			

Table 1 - Reliability and Convergent Validity.

Notes: *** p<0.001, CA=Cronbach's alpha, CR=Composite reliability, AVE=Average variance extracted

	AU	BI	CSE	EE	FC	PE	PI	SI
AU	0.855							
BI	0.586	0.847						
CSE	0.498	0.502	0.917					
EE	0.428	0.675	0.313	0.851				
FC	0.555	0.663	0.428	0.525	0.864			
PE	0.375	0.631	0.233	0.609	0.473	0.825		
PI	0.439	0.608	0.417	0.515	0.517	0.452	0.875	
SI	0.407	0.567	0.304	0.493	0.441	0.433	0.351	0.834

Table 2 - Discriminant Validity (Fornell and Larcker criterion).

Note: Diagonal values indicate the square roots of averange variance extracted

	AU	BI	CSE	EE	FC	PE	PI
AU							
BI	0.723						
CSE	0.576	0.584					
EE	0.508	0.805	0.350				
FC	0.674	0.810	0.490	0.617			
PE	0.450	0.763	0.261	0.708	0.561		
PI	0.528	0.734	0.474	0.596	0.612	0.532	
SI	0.501	0.699	0.351	0.593	0.541	0.529	0.419

Table 3 - Discriminant Validity (HTMT criterion).

Hypothesis	Path	β	t-value	p-value	f^2
H1	PE→BI	0.216	4.281	0.000***	0.146
H2	EE→BI	0.210	4.176	0.000***	0.154
H3	SI→BI	0.163	1.890	0.001**	0.057
H4	FC→BI	0.223	4.208	0.000***	0.154
H5	FC→AU	0.298	5.474	0.000***	0.163
H6	CSE→BI	0.175	3.381	0.000***	0.105
H7	PI→BI	0.157	2.552	0.007**	0.085
H8	BI→AU	0.388	7.482	0.000***	0.230

Table 4 – Summary of Hypotheses Testing.

Notes: $^{**}p<0.01$, $^{***}p<0.001$, β=standardized beta coefficient, f^2=effect size

This implies that AI tools that have user-friendly interfaces and put less cognitive load on teachers are more likely to be adopted by them. The ease of using the AI tools is particularly important for teachers who may not be very tech-savvy. However, our findings are in contrast with the prior studies (e.g., Sánchez-Prieto et al., 2019; Hu et al., 2020) which indicate that effort expectancy has no significant influence on teachers' adoption of mobile technologies for teaching purposes. One possible explanation of this contradictory finding could be that teaching involves repetitive and structured tasks, which require less effort to use technologies. In contrast, research is more dynamic and exploratory, where the effort expectancy of AI tools becomes more crucial.

Hence when teachers perceive AI tools as both beneficial and easy to use, they are more likely to incorporate them into their research workflows.

RQ2: How do contextual factors (i.e., social influence and facilitating conditions) influence teachers' behavior towards using AI tools for research?

Regarding contextual factors, our findings demonstrate that social influence significantly affects teachers' intention to use AI tools for their research work. This indicates that teachers are highly influenced by the opinions and behaviors of their colleagues in the academic community. When influential peers or academic leaders endorse the use of AI tools, other teachers are also encouraged to use them. This highlights the importance of social influence in academic environments where collaboration and peer review are integral to the research process. Our findings are in line with prior studies that indicate a positive influence of social influence on teachers' acceptance of technologies (El Alfy & Kehal, 2024; Buabeng-Andoh & Baah, 2020; Rodríguez-Gil, 2024).

Further, we observed significant influence of facilitating conditions on behavioral intention as well as actual use of AI tools. This suggests that the availability of resources and support not only shape teachers' intention to use AI tools, they are also essential for actual utilization. The institutional support and an enabling environment including access to high-speed internet, necessary technical infrastructure, and technical support makes it feasible for teachers to make sustained use AI tools in their research processes. This finding is in consistence with those prior studies (Teo, 2011; Strzelecki, 2023).

RQ3: How do teachers' individual characteristics (i.e., personal innovativeness and computer self-efficacy) influence their behavior towards using AI tools for research?

The results of our study indicate that teachers' individual characteristics i.e. personal innovativeness and computer self-efficacy also determine their behavioral intention to adopt AI tools for research. Teachers who are more innovative and confident in their technical skills are more likely to adopt AI tools. Personal innovativeness drives teachers to explore and experiment with AI tools to enhance their research productivity. Teachers with high innovativeness are proactive in not only adopting the AI tools but also in exploring their advanced functionalities to make their best possible utilization. Such teachers actively seek to understand the advanced capabilities of AI tools. This contributes to their intention to adopt AI tools for research work. Our finding is in line with prior studies that indicate significant influence of personal innovativeness on teachers' acceptance of e-learning (Loogma et al., 2012) and IoT technologies (Gökçearslan et al., 2022).

Similarly, computer self-efficacy instills confidence in teachers to effectively use these tools, overcoming potential barriers and technical challenges. Teachers who believe in their capability to use AI tools are more likely to integrate them into their research processes, thereby improving research outcomes. Teachers who are confident in their technological skills are more open to adopting and experimenting with new technologies (Teo, 2009). They are more likely to engage in exploratory behaviors such as seeking out training resources, and overcoming initial usage difficulties (Zhao & Zhao, 2021). Such behavior supports their adoption of AI tools for research work. Our finding is in line with that of Gupta and Bhaskar (2023), which indicates a strong influence of computer self-efficacy on teachers' intention to adopt virtual reality applications for teaching purposes.

5. Conclusion

This study empirically examined the factors influencing teachers' adoption of AI tools for research by using an extended UTAUT model. The findings of the study highlighted the importance of technological, contextual, and teachers' personal attributes in shaping their intentions and actual usage of AI tools in research work. The technological attributes included the performance expectancy and effort expectancy of AI tools; contextual factors included social influence and facilitating conditions; teachers' personal characteristics included personal innovativeness and computer self-efficacy.

The quantitative findings of the study provide various implications for the developers of AI tools as well as the HEIs. Firstly, the developers should focus on creating AI tools that are compatible with the existing systems used by teachers. This could reduce the effort required to switch between different platforms and enhance the overall usability of AI tools. Integration of AI tools such as Grammarly with commonly used word processors (e.g., Microsoft Word) can streamline the editing process, making it more convenient for teachers to use these tools. Moreover, the AI tools should have intuitive and user-friendly interfaces. Simplified navigation and clear instructions are particularly important for teachers with varying levels of technical expertise. Developers should offer step-by-step instructions and tutorials to teachers who may struggle with new technologies and require more assistance. Second, to encourage the use of AI tools, HEIs should ensure that necessary facilitating conditions are readily available to all teachers. HEIs should conduct training programs and provide technical assistance to their teachers so that they can become proficient in using AI tools. HEIs should also focus on enhancing the technical self-efficacy of their teachers, so that they can make effective utilization of the AI tools. Various learning opportunities can be provided to the teachers through online courses on platforms such as Coursera or edX that focus on specific AI tools for research, such as data analysis software or text editors.

The study has several limitations that must be addressed in future studies. First, the study is based on a convenience sample which may not fully represent the broader population of teachers in diverse educational contexts. This can limit the ability to make generalizations of our findings to a wider population of teachers. Hence, the results of the present study should be interpreted with caution in the context of other teachers with similar characteristics. Future research should include more diversified samples to enhance the generalizability of our findings. Second, the present study was based on a cross-sectional research design. Future studies should use longitudinal designs to understand the dynamic nature of teachers' adoption of AI tools over time. Further research could also employ other research methods, such as interviews and case studies to make the findings more convincing and gain deeper insights. Finally, future studies can investigate the perceptions of other stakeholders such as policymakers, and institutional leaders. Understanding their views can help identify systemic barriers and facilitators that influence the broader adoption and effective utilization of AI tools in academic research.

References

Agarwal, R., & Prasad, J. (1998). A conceptual and operational definition of personal innovativeness in the domain of information technology. *Information systems research, 9*(2), 204-215. https://doi.org/10.1287/isre.9.2.204

Alharbi, H., Ab Jalil, H., Omar, M. K., & Puad, M. H. M. (2022). The Roles of Mediators and Moderators in the Adoption of Madrasati (M) LMS among Teachers in Riyadh. *International Journal of Learning, Teaching and Educational Research, 21*(9), 95-119. https://doi.org/10.26803/ijlter.21.9.6

Aljuaid, H. (2024). The Impact of Artificial Intelligence Tools on Academic Writing Instruction in Higher Education: A Systematic Review. *Arab World English Journal (AWEJ)*

Special Issue on ChatGPT, https://ssrn.com/abstract=4814342

Al-Mughairi, H., & Bhaskar, P. (2024). Exploring the factors affecting the adoption AI techniques in higher education: insights from teachers' perspectives on ChatGPT. *Journal of Research in Innovative Teaching & Learning*. https://doi.org/10.1108/JRIT-09-2023-0129

Atiqah, S. N., Hanafiah, M. H., Ismail, H., & Balasubramaniam, K. (2024). Preparing instructors to transition to online distance learning: a pandemic panacea?. *Innoeduca*. International *Journal of Technology and Educational Innovation, 10*(1), 5-28. https://doi.org/10.24310/ijtei.101.2024.16820

Atkinson, C. F. (2024). Cheap, quick, and rigorous: Artificial intelligence and the systematic literature review. *Social Science Computer Review, 42*(2), 376-393. https://doi.org/10.1177/08944393231196281

Bornstein, M. H., Jager, J., & Putnick, D. L. (2013). Sampling in developmental science: Situations, shortcomings, solutions, and standards. *Developmental review, 33*(4), 357-370. https://doi.org/10.1016/j.dr.2013.08.003

Brunetti, F., Bonfanti, A., Chiarini, A., & Vannucci, V. (2023). Digitalization and academic research: knowing of and using digital services and software to develop scientific papers. *The TQM Journal, 35*(5), 1135-1155. https://doi.org/10.1108/TQM-02-2022-0050

Buabeng-Andoh, C., & Baah, C. (2020). Determinants of students' actual use of the learning management system (LMS): An empirical analysis of a research model. Advances in Science, Technology and *Engineering Systems Journal, 5*(2), 614-620. https://www.astesj.com/v05/i02/p77/

Budhathoki, T., Zirar, A., Njoya, E. T., & Timsina, A. (2024). ChatGPT adoption and anxiety: a cross-country analysis utilising the unified theory of acceptance and use of technology (UTAUT). *Studies in Higher Education*, 1-16. https://doi.org/10.1080/03075079.2024.2333937

Casal, J. E., & Kessler, M. (2023). Can linguists distinguish between ChatGPT/AI and human writing?: A study of research ethics and academic publishing. *Research Methods in Applied Linguistics, 2*(3), 100068. https://doi.org/10.1016/j.rmal.2023.100068

Chatterjee, S., & Bhattacharjee, K. K. (2020). Adoption of artificial intelligence in higher education: A quantitative analysis using structural equation modelling. *Education and Information Technologies*, 25, 3443-3463. https://doi.org/10.1007/s10639-020-10159-7

Clifford, P. L. R. (2024). AI in Higher Education: Faculty Perspective Towards Artificial Intelligence through UTAUT Approach. *Ho Chi Minh City Open University Journal of Science-Social Sciences, 14*(4). https://journalofscience.ou.edu.vn/index.php/soci-en/article/view/2851

Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS quarterly*, 189-211. https://doi.org/10.2307/249688

Edvardsen, Dag Fjeld, Finn R. Førsund, and Sverre AC Kittelsen (2017). Productivity development of Norwegian institutions of higher education 2004–2013. *Journal of the Operational Research Society 68*, 399-415. https://doi.org/10.1057/s41274-017-0183-x

El Alfy, S., & Kehal, M. (2024). Investigating the factors affecting educators' adoption of learning analytics using the UTAUT model. *The International Journal of Information and Learning Technology, 41*(3), 280-303. https://doi.org/10.1108/IJILT-06-2023-0102

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of marketing research, 18*(1), 39-50. https://doi.org/10.1177/002224378101800104

Gökçearslan, Ş., Yildiz Durak, H., & Atman Uslu, N. (2024). Acceptance of educational use of the Internet of Things (IoT) in the context of individual innovativeness and ICT competency of pre-service teachers. *Interactive Learning Environments, 32*(2), 557-571. https://doi.org/10.1080/10494820.2022.2091612

Greco, S., & Cinganotto, L. (2023). Re-thinking Education in the Age of AI. *Journal of e-Learning and Knowledge Society, 19*(3), I-IV. https://doi.org/10.20368/1971-8829/1135873

Guillén-Gámez, F. D., Ruiz-Palmero, J., & García, M. G. (2023). Digital competence of teachers in the use of ICT for research work: development of an instrument from a PLS-SEM approach. *Education and Information Technologies, 28*(12), 16509-16529. https://doi.org/10.1007/s10639-023-11895-2

Gupta, K. P., & Bhaskar, P. (2023). Teachers' intention to adopt virtual reality technology in management education. *International Journal of Learning and Change, 15*(1), 28-50. https://doi.org/10.1504/IJLC.2023.127719

Hair, Jr, J. F., Sarstedt, M., Matthews, L. M., & Ringle, C. M. (2016). Identifying and treating unobserved heterogeneity with FIMIX-PLS: part I–method. *European business review, 28*(1), 63-76. https://doi.org/10.1108/EBR-09-2015-0094

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the academy of marketing science, 43*, 115-135. https://doi.org/10.1007/s11747-014-0403-8

Hu, S., Laxman, K., & Lee, K. (2020). Exploring factors affecting academics' adoption of emerging mobile technologies-an extended UTAUT perspective. *Education and Information Technologies, 25*, 4615-4635. https://doi.org/10.1007/s10639-020-10171-x

Jakkaew, P., & Hemrungrote, S. (2017). The use of UTAUT2 model for understanding student perceptions using Google classroom: A case study of introduction to information technology course. In *2017 international conference on digital arts, media and technology (ICDAMT)* (pp. 205-209). IEEE. 10.1109/ICDAMT.2017.7904962

Joo, Y. J., Park, S., & Lim, E. (2018). Factors influencing preservice teachers' intention to use technology: TPACK, teacher self-efficacy, and technology acceptance model. *Journal of Educational Technology & Society, 21*(3), 48-59. https://www.jstor.org/stable/26458506

Kocaleva, M., Stojanovic, I., & Zdravev, Z. (2015). Model of e-learning acceptance and use for teaching staff in Higher Education Institutions. *International Journal of Modern Education and Computer Science (IJMECS), 7*(4), 23-31. https://eprints.ugd.edu.mk/id/eprint/11980

Lakhal, S., & Khechine, H. (2021). Technological factors of students' persistence in online courses in higher education: The moderating role of gender, age and prior online course experience. *Education and Information Technologies, 26*(3), 3347-3373. https://doi.org/10.1007/s10639-020-10407-w

Lin, H. C., Ho, C. F., & Yang, H. (2022). Understanding adoption of artificial intelligence-enabled language e-learning system: an empirical study of UTAUT model. *International Journal of Mobile Learning and Organisation, 16*(1), 74-94. https://doi.org/10.1504/IJMLO.2022.119966

Lin, H. C., Ho, C. F., & Yang, H. (2022). Understanding adoption of artificial intelligence-enabled language e-learning system: An empirical study of UTAUT model. *International Journal of Mobile Learning and Organisation, 16*(1), 74-94. 10.1504/IJMLO.2022.119966

Loogma, K., Kruusvall, J., & Ümarik, M. (2012). E-learning as innovation: Exploring innovativeness of the VET teachers' community in Estonia. *Computers & Education, 58*(2), 808-817. https://doi.org/10.1016/j.compedu.2011.10.005

Lopez, V., & Whitehead, D. (2013). Sampling data and data collection in qualitative research. *Nursing & midwifery research: Methods and appraisal for evidence-based practice, 123*, 140. https://researchnow.flinders.edu.au/en/publications/sampling-data-and-data-collection-in-qualitative-research

Lopez-Perez, V. A., Ramirez-Correa, P. E., & Grandon, E. E. (2019). Innovativeness and factors that affect the information technology adoption in the classroom by primary teachers in Chile. *Informatics in Education, 18*(1), 165-181. https://www.ceeol.com/search/article-detail?id=761646

Marsh, D. (2023). AI and the contemporary educational landscape: a personal view. *Journal of e-Learning and Knowledge Society, 19*(3), 1-5. https://doi.org/10.20368/1971-8829/1135874

Mazman Akar, S. G. (2019). Does it matter being innovative: Teachers' technology acceptance. *Education and Information Technologies, 24*(6), 3415-3432. https://doi.org/10.1007/s10639-019-09933-z

Nikolopoulou, K., Gialamas, V., & Lavidas, K. (2020). Acceptance of mobile phone by university students for their studies: An investigation applying UTAUT2 model. *Education and Information Technologies, 25*, 4139-4155. https://doi.org/10.1007/s10639-020-10157-9

Oguguo, B., Ezechukwu, R., Nannim, F., & Offor, K. (2023). Analysis of teachers in the use of digital resources in online teaching and assessment in COVID times. *Innoeduca. International Journal of Technology and Educational Innovation, 9*(1), 81-96. https://doi.org/10.24310/innoeduca.2023.v9i1.15419

Perkins, M., & Roe, J. (2024). Generative AI Tools in Academic Research: Applications and Implications for Qualitative and Quantitative Research Methodologies. *arXiv preprint arXiv:2408.06872*. https://www.arxiv.org/pdf/2408.06872

Raffaghelli, J. E., Rodríguez, M. E., Guerrero-Roldán, A. E., & Bañeres, D. (2022). Applying the UTAUT model to explain the students' acceptance of an early warning system in Higher Education. *Computers & Education, 182*, 104468. https://doi.org/10.1016/j.compedu.2022.104468

Raza, S. A., Qazi, W., Khan, K. A., & Salam, J. (2021). Social isolation and acceptance of the learning management system (LMS) in the time of COVID-19 pandemic: an expansion of the UTAUT model. *Journal of Educational Computing Research, 59*(2), 183-208. https://doi.org/10.1177/0735633120960421

Rodríguez-Gil, M. E. (2024). Factors Influencing 360-Degree Video Adoption in e-Learning: a UTAUT2 Case Study with Pre-service Primary Education Teachers in Spain. Journal of e-Learning and *Knowledge Society, 20*(1), 27-36. https://doi.org/10.20368/1971-8829/1135881

Sánchez-Prieto, J. C., Cruz-Benito, J., Therón Sánchez, R., & García-Peñalvo, F. J. (2020). Assessed by machines: Development of a TAM-based tool to measure AI-based assessment acceptance among students. *International Journal of Interactive Multimedia and Artificial Intelligence, 6*(4), 80. https://doi.org/10.9781/ijimai.2020.11.009

Saunders, M. N. (2012). Choosing research participants. Qualitative organizational research: *Core methods and current challenges*, 35-52. https://www.torrossa.com/en/resources/an/4913040#page=54

Shtykalo, O., & Yamnenko, I. (2024, February). ChatGPT and Other AI Tools for Academic Research and Education. In *IEEE lnternational Conference on Advanced Trends in Radioelectronics, Telecommunications and Computer Engineering* (pp. 605-630). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-61221-3_29

Siyam, N. (2019). Factors impacting special education teachers' acceptance and actual use of technology. *Education and Information Technologies, 24*(3), 2035-2057. https://doi.org/10.1007/s10639-018-09859-y

Sok, S., & Heng, K. (2023). ChatGPT for education and research: A review of benefits and risks. *Cambodian Journal of Educational Research*, *3*(1), 110-121.

Strzelecki, A. (2023). To use or not to use ChatGPT in higher education? A study of students' acceptance and use of technology. *Interactive Learning Environments*, 1-14. https://doi.org/10.1080/10494820.2023.2209881

Šumak, B., & Šorgo, A. (2016). The acceptance and use of interactive whiteboards among teachers: Differences in UTAUT determinants between pre- and post-adopters. *Computers in Human Behavior, 64*, 602-620. https://doi.org/10.1016/j.chb.2016.07.037

Sun, Y., & Jeyaraj, A. (2013). Information technology adoption and continuance: A longitudinal study of individuals' behavioral intentions. *Information & Management, 50*(7), 457-465. https://doi.org/10.1016/j.im.2013.07.005

Teo, T. (2009). Modelling technology acceptance in education: A study of pre-service teachers. *Computers & education, 52*(2), 302-312. https://doi.org/10.1016/j.compedu.2008.08.006

Teo, T. (2011). Factors influencing teachers' intention to use technology: Model development and test. *Computers & Education, 57*(4), 2432-2440. https://doi.org/10.1016/j.compedu.2011.06.008

Tian, W., Ge, J., Zhao, Y., & Zheng, X. (2024). AI Chatbots in Chinese higher education: adoption, perception, and influence among graduate students—an integrated analysis utilizing UTAUT and ECM models. *Frontiers in Psychology, 15*, 1268549. https://doi.org/10.3389/fpsyg.2024.1268549

Venkatesh, V., & Morris, M. G. (2000). Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior. *MIS quarterly*, 115-139. https://doi.org/10.2307/3250981

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478. https://doi.org/10.2307/30036540

Wang, C. S., Jeng, Y. L., & Huang, Y. M. (2017). What influences teachers to continue using cloud services? The role of facilitating conditions and social influence. *The Electronic Library, 35*(3), 520-533. https://doi.org/10.1108/EL-02-2016-0046

Wu, W., Zhang, B., Li, S., & Liu, H. (2022). Exploring factors of the willingness to accept AI-assisted learning environments: an empirical investigation based on the UTAUT model and perceived risk theory. *Frontiers in Psychology, 13*, 870777. https://doi.org/10.3389/fpsyg.2022.870777

Zhao, C., & Zhao, L. (2021). Digital nativity, computer self-efficacy, and technology adoption: a study among university faculties in China. *Frontiers in Psychology, 12*, 746292. https://doi.org/10.3389/fpsyg.2021.746292

Zhao, F., Ahmed, F., Iqbal, M. K., Mughal, M. F., Qin, Y. J., Faraz, N. A., & Hunt, V. J. (2020). Shaping behaviors through institutional support in British higher educational institutions: Focusing on employees for sustainable technological change. *Frontiers in Psychology, 11*, 584857. https://doi.org/10.3389/fpsyg.2020.584857

Annexure 1 - Measurement Items.

Performance Expectancy
PE1: I believe that AI tools are useful in my research work
PE2: Using AI tools increases my chances of achieving important things in my research work
PE3: Using AI tools helps me get tasks done faster in my research work
PE4: Using AI tools increases my productivity in research work

Effort Expectancy
EE1: Learning how to use AI tools is easy for me
EE2: My interaction with AI tools is clear and understandable
EE3: I find AI tools easy to use
EE4: It is easy for me to become skillful at using AI tools

Social Influence
SI1: People who are important to me think I should use AI tools
SI2: People who influence my behavior believe that I should use AI tools
SI3: People whose opinions I value prefer me to use AI tools

Facilitating conditions
FC1: I have the resources necessary to use AI tools
FC2: I have the knowledge necessary to use AI tools
FC3: Using AI tools fits into my work style

Computer Self Efficacy
CSE1: I know how to use computers, Internet and AI tools
CSE2: I am confident about using AI tools and related technologies for my research work
CSE3: I feel I am in control when I use AI tools for my research work

Personal Innovativeness
PI1: If I heard about a new information technology, I would look for ways to experiment with it.
PI2: Among my peers, I am usually the first to try out new information technologies.
PI3: In general, I like to experiment with new information technologies.

Behavioural Intention
BI1: I intend to continue using AI tools in the future
BI2: I will always try to use AI tools in my research work
BI3: I plan to continue to use AI tools frequently

Actual Use
AU1: I use the free version of AI tools
AU2: I use AI tools as AI powered writing assistant
AU3: I use AI tools to generate assessed work

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 20, No. 3 (2024), pp. 26-38

An ICT-integrated Modular Training Program Enhancing the Digital Research Skills of Research Scholars

Prakasha G S[a,1], Chanda R. Coblentz[b], Priyadarshini Muthukrishnan[c], Anthony Kenneth[a]

[a]*Christ University, School of Education – Bangalore (India)*

[b]*University of Mount Union, School of Education – Ohio (USA)*

[c]*INTI International University, Faculty of Education and Liberal arts – Negeri Sembilan (Malaysia)*

(submitted: 10/8/2024; accepted: 30/9/2024; published: 27/10/2024)

Abstract

The teaching profession in higher education demands strong research skills, and with rapid technological advancements, university teaching professionals must familiarize themselves with digital research skills. Thus, university teachers and PhD research scholars across the globe are eager to develop their digital research skills to enhance their work efficiency. Acquiring digital research skills on the job or during the PhD program has proven to be challenging. These skills assist higher education professionals in various ways, such as supervising doctoral students, conducting research, working on research projects, and publishing research articles.

Thus, the present study attempted to provide ICT-integrated modular training (MT) to facilitate the higher education teaching faculty and PhD scholars with digital research skills. The study employed a repeated cross-sectional research design and measured the effectiveness of the MT through a single group pre and post-test design. Researchers conducted three modular training sessions annually on digital research skills over five consecutive years. In total, 300 scholars attended the training and participated in the pre-test, post-test, and satisfaction survey. Findings from paired sample t-tests (t-value varied between 4.117 to 7.525, $p < 0.05$) revealed that modular training has been significantly effective with a large effect size ($d > 0.8$).

Furthermore, the satisfaction survey revealed a high degree of satisfaction among participants. Future research may explore ways to strengthen the technological and pedagogical content knowledge of modular training programs in developing digital research skills.

KEYWORDS: Digital-Research Skills, Digital Competence, Modular Training, Research Scholars.

DOI
https://doi.org/10.20368/1971-8829/1135998

CITE AS
Leave this space empty G S, P., Coblentz, C.R., Muthukrishnan, P., & Kenneth, A. (2024). An ICT-integrated Modular Training Program Enhancing the Digital Research Skills of Research Scholars. *Journal of e-Learning and Knowledge Society*, *20*(3), 26-38.
https://doi.org/10.20368/1971-8829/1135998

1. Introduction

The introduction of Information and Communication Technologies (ICT) in educational settings has revolutionized the landscape of higher education globally (Yadav et al., 2018). In India, this transformation is particularly significant, given the country's rapid expansion of the higher education sector and the increasing demand for advanced research capabilities (To & Yu, 2020). Currently, India's contribution to academic publications is nearing 8% (Dimitrije, 2023), making it a significant contributor to global research and development. The education sector views ICT as essential for educators (Kruskopf et al., 2024) and higher education institutions. Countries like Morocco have also recognized the need to integrate ICT into researcher training (El Hammoumi et al., 2022). Beyond the education sector, ICT has transformed the operations of individuals across various industries (Benos & Zotou, 2014; Jorgenson & Vu, 2016; Venturini, 2015). It has also been shown to positively impact the construction sector and contribute to project success (Moshood et al., 2020). ICT

[1] corresponding author - email: prakasha.gs@christuniversity.in – address: Hosur Road, 560029, Bangalore (India)

facilitates the integration of technological knowledge globally (Kano et al., 2021), which is why many ICT firms prefer to participate in global innovation networks (Chaminade et al., 2021).

Although ICT faces backlash due to excessive phone usage, time consumption, difficulties in adoption, and resistance to changes in work routines (Stein & Sim, 2020), Myovella et al. (2020) highlighted how education can positively influence ICT usage. ICT is crucial for fostering digital literacy and lifelong learning (Jiménez Sabino & Cabero Almenara, 2021). However, ICT skills are unevenly distributed and tend to be lower among certain demographics, such as the elderly, women, and immigrants (Ben Youssef et al., 2015; Castillo-Merino & Serradell-López, 2014; Fratto et al., 2016a; Vacek & Rybenska, 2015).

They recommend offering free courses tailored to the needs and interests of these groups to improve their ICT skills. Projects such as "ICT Go Girls!" (Fernandez-Morante et al., 2020) can help break down stereotype barriers that prevent women from engaging in ICT. Koutska (2023) advocates for the need for teachers to use ICT tools effectively for teaching and learning, and studies have also addressed the impact of ICT on students' academic performance (Mondal & Culp, 2017; Ramirez et al., 2018). Both Fratto et al. (2016b) and Magalhães et al. (2020) revealed that ICT usage positively impacts academic performance. The importance of its integration has already been emphasized (Abazi & Hajrizi, 2018; Ceker & Uzunboylu, 2016), along with the significance of professional education and certifications in ICT.

The implementation of ICT in the research process is influenced by factors such as access to digital resources, digital skills (Guillén-Gámez et al., 2023), and students' belief in the necessity of ICT for research. Students who consider ICT essential tend to value it more highly, leading to better ICT skills and increased usage (De Wit et al., 2014). According to Khasawneh (2023), ICT can yield beneficial outcomes for research though researchers must be aware of ethical practices. Researchers are more likely to use ICT to analyze research hotspots, innovations, and key authors, shaping the research landscape within the academic community (Zhu et al., 2023).

The current landscape of research skills among scholars in India is characterized by considerable variability (Sahoo et al., 2017). Some scholars exhibit a robust command of digital tools and methodologies, enabling them to conduct sophisticated analyses and effectively disseminate their findings. However, many scholars face challenges in utilizing these tools due to a lack of prior exposure and uneven access to technological resources (Anjaiah, 2016; Krishnamurthy & Shettappanavar, 2019). There is a correlation between ICT usage by professors and their students (Adetimirin, n.d.). Educators must commit to incorporating ICT into their teaching-learning environments through innovative pedagogies, ensuring active participation in the classroom (Durán Cuartero et al., 2016).

While some students and supervisors may view ICT as essential tools that encourage active thinking and support the planning and management of research, others may see ICT as challenging or unnecessary interruptions (Koşar, 2021). Currently, ICT has become an essential skill in educational research, enhancing ideas, improving effectiveness, and facilitating research processes (Stein & Sim, 2020). Estrada Villa et al. (2021) suggest that mobile devices can support digital research processes and improve research skills.

ICT competence varies among university faculties. Many university professors primarily use ICT for searching and accessing information, rather than engaging in more advanced tasks such as data analysis or citation management (Guillén-Gámez et al., 2023). However, conducting research actively promotes digital competence, as research activities encourage professors to enhance their digital skills. Interestingly, while gender does not significantly influence the use of ICT tools among lecturers (Oguguo et al., 2023), teaching experience appears to have a negative impact on overall digital competence. This suggests that more experienced professors may have lower levels of digital proficiency (Guillén-Gámez & Mayorga-Fernández, 2020). Professors with higher digital pedagogical competence tend to achieve better results in their research, and exposure to diverse research environments improves ICT utilization in research (Guillén-Gámez & Mayorga-Fernández, 2020). Therefore, the present study aims to introduce effective ICT-integrated modular training for researchers in higher education to enhance their digital research competence.

2. Theoretical Framework

The following theories guided the present study: Moore's theory of transactional distance, Knowles's adult learning theory, and the principles of modular instruction developed by Goldschmid and Goldschmid. Moore (1997), in his theory of transactional distance, proposes that transactional distance exists in distance education, influenced by instructional dialogue, communication, media, and program structure. The instructional dialogue must be constructive and purposeful, as it is a process in which the most meaningful construction occurs. This is also applicable to the online modular training introduced in the present study to develop digital research competence among researchers in higher education. Furthermore, it is noted that the dialogue is affected by the medium used by both the teacher and the student. Therefore, based on the medium, it is essential to design suitable programs, content, and lesson structures.

Knowles's (1978) adult learning theory outlines several assumptions about how adults learn. Adults possess an evolved concept of self and are intrinsically motivated to learn. They are ready to learn when they have a strong reason to build their knowledge, and the knowledge acquired should be applicable to their daily lives. A self-directed approach to learning is preferred over an instructor-led approach. In the present study, researchers are motivated to attend modular training to enhance their knowledge in research and publications, particularly under the guidance of experts in the field. Adults bring rich prior experiences that instructors must recognize and incorporate into their instruction. In their principles of modular instruction, Goldschmid and Goldschmid (1973) identified three major aspects: content, study time, and sequence. In modular learning, extensive content is divided into smaller modules and arranged sequentially, with each module building on the previous one. The objectives of each content module are clearly communicated to the learner, and study materials are accessible at any time.

An experimental study on improving the digital competence of special education teaching showed a significant increase in problem-solving, internet-browsing, and communication skills among the study participants (Compagno et al., 2016).

An eTwinning international training program with pre and post-webinar event for teachers showed improvement in their technology skills and reported enriching satisfaction with the conducted program (Cinganotto, 2017). An Italian study on E-learning 2.0 included web-2 technologies to supplement classroom learning and reported that online digital training could enhance learning, and participants are more satisfied with the training (Spadavecchia, 2009).

3. Context of the Study

In India, PhD aspirants can pursue their programs in two modes: full-time and part-time. However, coursework is mandatory for both part-time and full-time scholars, typically conducted at the beginning of the PhD program. Doctoral scholars from various disciplines encounter challenges at different stages of their doctoral journey. One of the most significant challenges is writing and publishing two research articles in international academic journals indexed in Scopus or Web of Science. To ensure success in research and publication, scholars require extensive research knowledge and proficient digital research skills. Currently, newer versions of data analysis software are being introduced, which both scholars and professors must master to advance their careers. In the near future, research software may incorporate even more complex artificial intelligence (AI) features, making their adoption inevitable.

However, in India, researchers often lack the digital skills needed for data analysis and scholarly writing. They encounter difficulties in organizing and systematically processing data, as well as performing appropriate statistical tests using research software. Although the doctoral coursework covers aspects of data analysis, the extensive content at that stage increases their cognitive load. Therefore, timely guidance on conducting analysis and editing manuscripts is necessary and can be highly beneficial. This study aimed to provide a unique modular training program for researchers in higher education, referred to as research scholars. The study's operational definition of research scholars includes university teaching staff, project research fellows, research associates, and full-time and part-time PhD scholars at various stages of their doctoral journey. The study sought to assess the effectiveness of its modular training program through a repeated cross-sectional research design. The online training focused on developing digital research skills for both PhD scholars and faculty members.

4. Objectives of the study

The primary objective of this study is to examine the impact of the ICT-integrated modular training (MT) program on enhancing the digital research skills of researchers in higher education. Researchers include doctoral students, university teachers, and project fellows. Therefore, the researchers have framed the following specific objectives:

- To measure the impact of an ICT-integrated modular training programme through single group pre-test and post-test design over a period of 5 consecutive years.
- To determine the participants' learning satisfaction level of digital research skills through the ICT-integrated modular training programme.

5. Method

5.1 Study design

The study employed a quasi-experimental design with a repeated measure cross-sectional data analysis. The quasi-experiment included a pre-test and post-test single-group design.

5.2 Sample of the Study

The study sample included researchers such as faculty members, doctoral students, and project associates from Universities across India who attended the ICT-integrated MT. The training has been conducted three times a year for five successive years. The researchers restricted the cohort size to 20 to 30 per session. The cohort size is restricted between 20 and 30 as this is training in data analysis, and the facilitator could engage them meaningfully and troubleshoot their technical hiccups quickly, which is otherwise difficult. Eventually, the researcher could collect data from 300 researchers who successfully participated. Further, the study conducted a satisfaction survey to understand the impact of the modular training program in developing digital research skills. Table 1 below presents the sample of the study.

Table 1- Showing the details of the study sample.

Total years of training	5
Training sessions/ year	3
N/ training session	20
Total Participants in 5 years	300
Participants age range in years	26-50
Participants Designation	Faculty members/ Doctoral students/ Project associates

The ICT-integrated modular training included modules on quantitative data analysis, qualitative data analysis, and research publications. That included ICT tools such as SPSS software, Dedoose, Open access sources for data collection, publication databases, and reference management software. Table 2 presents the details of the modules of modular training.

At each modular training session, the researcher administered a pre-test at the beginning, provided hands-on training, and administered a post-test. The pre-test or post-test had 50 questions in total. Each question was for three marks. Therefore, the minimum score can be 0, and the maximum is 150. A satisfaction survey was also conducted as and when modular trainings were completed. The nature of modular training is usually an expert demonstration followed by interactive in-class exercises to be practiced by participants on a computer device under the supervision of the expert teacher.

Each year, training on quantitative data analysis, qualitative data analysis, and research publication was conducted for five years. Each session had a new set of participants. Thus, pre-test, post-test, and learning-satisfaction-scale were administered at the end of each training session.

As the study followed a single-group pre-test and post-test quasi-experimental design, the researchers planned to conduct parametric or non-parametric differences in mean tests based on the normality test results. The difference in mean score would measure the impact of ICT-integrated modular training in developing digital research skills. Furthermore, the researchers planned to administer a learning satisfaction survey at the end of each training session to understand learner satisfaction.

Table 2 - Showing the training modules' details of modular training sessions.

Training modules on quantitative data analysis (Statistical Package for the Social Sciences-SPSS)
Data entry, Data cleaning, Data setting, basic working knowledge, normality testing, descriptive statistical analysis, parametric tests: Chi-square, t-tests, ANOVA, ANCOVA, MANOVA, Correlation, Regression, Graphs and charts, Cronbach alpha, Factor analysis.
Training modules on qualitative data analysis (Dedoose)
Organise qualitative research data: Text, audio, video, pictures, images. Data Coding, Word clouds, Data mining, Excerpting, Memos. Plots, tables, charts, graphs, Working with projects, Inter-rater reliability, Data filtering, exporting, Document searching
Training modules on research publication
Research search engines: CORE, Microsoft Academics, BASE, Semantic scholar, PubMed, Google Scholar. Research Data bases: Scopus, Web of science, Master journal list Clarivate analytics, DOAJ, Ebsco, JSTOR, Wiley, Our world in Data, Survey monkey, Redcap, Scimago, Resurchify. Reference mangers: Mendeley, Zotero, Grammarly, Journal templates, Journal guidelines, Submission sites and processes.

5.3 Validity of the Learning Satisfaction Survey Questionnaire

Researchers constructed a learning satisfaction survey questionnaire to assess the satisfaction levels of participants in the ICT-integrated modular training program. The survey initially included twelve components, but after removing overlapping ideas based on the expert panel's feedback, eight components were retained: efficiency, interaction, perceived usefulness, ICT integration, learning flexibility, personalization, practice opportunity, and delivery style. These components were included in the satisfaction survey based on the digital research tasks embedded in the intervention. Researchers established face validity and content validity through a panel of experts. Responses to the questionnaire were measured on a 5-point Likert scale ranging from strongly agree (SA) to strongly disagree (SD).

Furthermore, the reliability of the survey questionnaire was assessed using Cronbach's alpha internal consistency test. During pilot testing, the Cronbach's alpha coefficient was found to be 0.86, indicating that the questionnaire is highly reliable (Nunnally, 1978). Figure 1 in the results section presents the satisfaction ratings revealed by the training program participants.

5.4 Ethical Considerations

The study sought permission from the Institutional Review Board (IRB) to conduct the research. The researchers adhered to the ethical guidelines established by the IRB. They ensured participant confidentiality, obtained informed consent, and stored the data securely in a password-protected file accessible only to the researchers.

6. Results

The results of the study are presented in two sections. Section one presents the results of the experimental impact, and section two presents the satisfaction survey result. Table 3 presents the results of the Normality tests. Table 4 presents the descriptive statistical result, Table 5 presents the inferential statistical result of the experiment, and Table 6 presents the effect size of the paired sample t-test.

Table 3 indicates the Kolmogorov-Smirnov normality test results and the Shapiro-Wilk normality test. As the sample size is small (< 50), we shall utilize Shapiro-Wilk statistics to interpret the normality. Accordingly, the mean scores between the post-test and pre-test of all the years' training sessions are normal ($p > 0.05$). Thus, researchers decided to analyze the study data using a parametric t-test.

However, Table 4 presents the preliminary descriptive analysis before conducting the paired sample t-test statistics. The mean value of post-test scores is higher in all the training sessions conducted for five successive years. Post-test mean scores were highest in 2nd training session of year one and first training session of year 3. The average range value was found to be 135. That means the highest score minus the lowest score for each session. Overall, there has been a consistent increase in the mean post-test score in all five years and at each time of the modular training sessions held.

Table 5 presents the inferential statistical analysis result of paired sample t-test. Results in Table 5 indicate that the ICT-integrated modular training programme had enhanced the researchers' digital-research skills. A statistically significant difference existed in the mean scores of the pre-test and post-test of all the modular training sessions successively for all five years. In the first year, the first training session had a significant mean difference ($t = 4.122$, $p < 0.001$). The first year's second and third training sessions also had a significant mean difference ($t = 7.525$, $p < 0.001$) and ($t = 7.325$, $p < 0.001$), respectively. In the second year, the first training session had a significant mean difference ($t = 7.149$, $p < 0.001$). The second year's second and third training sessions also had a significant mean difference ($t = 6.948$, $p < 0.001$) and ($t = 7.024$, $p < 0.001$), respectively. In the third year, the first training session had a significant mean difference ($t = 4.185$, $p < 0.001$). The third year's second and third training sessions also had a significant mean difference ($t = 4.142$, $p < 0.001$) and ($t = 4.189$, $p < 0.001$), respectively. In the fourth year, the first training session had a significant mean difference ($t = 4.117$, $p < 0.001$). The fourth year's second and third training sessions also had a significant mean difference ($t = 4.127$, $p < 0.001$) and ($t = 4.117$, $p < 0.001$), respectively. In the fifth year, the first training session had a significant mean difference ($t = 4.189$, $p < 0.001$). The fifth year's second and third training sessions also had a significant mean difference ($t = 4.186$, $p < 0.001$) and ($t = 4.123$, $p < 0.001$), respectively.

Table 6 presents the effect size (d) of all the paired sample t-test results, indicating the strength of the significant difference. It presents Cohen's d effect size and effect size with Hedges' correction. The conventional interpretation of Cohen's effect size is if $d = 0.2$ small effect, if $d = 0.4$ medium effect, and if $d = 0.8$ large effect. Similarly, the conventional interpretation of Hedges correction (g) varies from $g = 0.15$ small effect, if $g = 0.40$ medium effect, and if $g = 0.75$ large effect (Cohen, 1988; Lakens, 2013). From Table 4, Cohen's (d) point estimate values ranged from 0.884 to 1.683 and are > 0.8, indicating a large effect size. Furthermore, Hedge's correction (g) values ranged from 0.884 to 1.615 and are > 0.75, indicating a large effect size. Thus, these results indicate the strength of the ICT-integrated modular training program.

The survey result yielded a high degree of satisfaction and is presented below. Figure 1 presents the satisfaction survey results the study participants responded to after completing each modular training session. It had eight items to respond to on a 5-point Likert scale varying from strongly agree (SA) to disagree strongly (SDA). Figure 1 below presents the average satisfaction survey scores for 15 sessions conducted in five consecutive years. Figure 1 shows that the participants are highly satisfied with the ICT-integrated modular training program they participated in. Most participants rated 4 (agree) and 5 (Strongly agree) to each program component, and very few or no participants rated the programme components as neutral (3), disagree (2), or strongly disagree (l). Thus, it indicates that the participants are satisfied with the modular training program and that it successfully developed their digital research skills. Further, from the modular training program's eight survey components (Efficiency, Interaction, Perceived usefulness, ICT integration, Learning flexibility, Personalisation, Practice opportunity, and Delivery style). Survey participant ratings were high for the components program's delivery style and perceived usefulness.

Table 3 - Shows the results of the Normality test.

Year wise training sessions conducted	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Year 1, Training I	.136	20	.200*	.942	20	.259
Year 1, Training II	.144	20	.200*	.943	20	.271
Year 1, Training III	.137	20	.200*	.940	20	.244
Year 2, Training I	.130	20	.200*	.948	20	.339
Year 2, Training II	.141	20	.200*	.933	20	.179
Year 2, Training III	.140	20	.200*	.934	20	.185
Year 3, Training I	.125	20	.200*	.942	20	.266
Year 3, Training II	.137	20	.200*	.941	20	.251
Year 3, Training III	.139	20	.200*	.940	20	.245
Year 4, Training I	.137	20	.200*	.940	20	.242
Year 4, Training II	.159	20	.198	.955	20	.447
Year 4, Training III	.136	20	.200*	.943	20	.270
Year 5, Training I	.139	20	.200*	.941	20	.246
Year 5, Training II	.126	20	.200*	.943	20	.268
Year 5, Training III	.136	20	.200*	.940	20	.243

Note: Where Y1, Y2, Y3, Y4, & Y5 stand for years one to four. I, II, & III are training session numbers in a particular year.
*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Table 4 - Showing the descriptive statistical result of Modular training sessions.

Year & Modular Training	(Pre-Post test)	Mean	N	Std. Deviation	Std. Error Mean
Year 1, Training I	Post-test	64.30	20	41.303	9.236
	Pre-test	51.30	20	40.467	9.049
Year 1, Training II	Post-test	69.65	20	41.803	9.347
	Pre-test	46.30	20	40.467	9.049
Year 1, Training III	Post-test	67.35	20	41.243	9.222
	Pre-test	44.30	20	40.467	9.049
Year 2, Training I	Post-test	68.35	20	41.242	9.222
	Pre-test	45.70	20	40.306	9.013
Year 2, Training II	Post-test	66.35	20	41.271	9.228
	Pre-test	43.85	20	40.737	9.109
Year 2, Training III	Post-test	65.35	20	41.230	9.219
	Pre-test	42.80	20	41.526	9.285
Year 3, Training I	Post-test	69.40	20	41.396	9.256
	Pre-test	56.25	20	40.286	9.008
Year 3, Training II	Post-test	67.30	20	41.319	9.239
	Pre-test	54.30	20	40.343	9.021
Year 3, Training III	Post-test	68.35	20	41.344	9.245
	Pre-test	55.20	20	40.297	9.011
Year 4, Training I	Post-test	66.30	20	41.303	9.236
	Pre-test	53.30	20	40.320	9.016
Year 4, Training II	Post-test	65.30	20	41.371	9.251
	Pre-test	52.30	20	40.290	9.009
Year 4, Training III	Post-test	67.30	20	41.331	9.242
	Pre-test	54.30	20	40.313	9.014
Year 5, Training I	Post-test	67.40	20	41.448	9.268
	Pre-test	54.20	20	40.344	9.021
Year 5, Training II	Post-test	68.30	20	41.360	9.248
	Pre-test	55.20	20	40.339	9.020
Year 5, Training III	Post-test	66.30	20	41.440	9.266
	Pre-test	53.30	20	40.342	9.021

Note: Where Y1, Y2, Y3, Y4, & Y5 stand for years one to four. I, II, & III are training session numbers in a particular year.

Table 5 - Showing the result of the Paired-sample t-test for the Modular training session.

Modular training		Paired Differences					*t*	*df*	Significance	
		Mean	SD	Std. Error Mean	95% Conf. Interval Lower	Upper			One-Sided *p*	Two-Sided *p*
Y1, I	Pre, Post test	13.000	14.105	3.154	6.399	19.601	4.122	19	<.001	<.001
Y1, II	Pre, Post test	23.350	13.876	3.103	16.856	29.844	7.525	19	<.001	<.001
Y1, III	Pre, Post test	23.050	14.073	3.147	16.464	29.636	7.325	19	<.001	<.001
Y2, I	Pre, Post test	22.650	14.169	3.168	16.019	29.281	7.149	19	<.001	<.001
Y2, II	Pre, Post test	22.500	14.482	3.238	15.722	29.278	6.948	19	<.001	<.001
Y2, III	Pre, Post test	22.550	14.358	3.211	15.830	29.270	7.024	19	<.001	<.001
Y3, I	Pre, Post test	13.150	14.054	3.142	6.573	19.727	4.185	19	<.001	<.001
Y3, II	Pre, Post test	13.000	14.038	3.139	6.430	19.570	4.142	19	<.001	<.001
Y3, III	Pre, Post test	13.150	14.039	3.139	6.580	19.720	4.189	19	<.001	<.001
Y4, I	Pre, Post test	13.000	14.053	3.142	6.423	19.577	4.137	19	<.001	<.001
Y4, II	Pre, Post test	13.000	14.086	3.150	6.407	19.593	4.127	19	<.001	<.001
Y4, III	Pre, Post test	13.000	14.120	3.157	6.392	19.608	4.117	19	<.001	<.001
Y5, III	Pre, Post test	13.200	14.092	3.151	6.605	19.795	4.189	19	<.001	<.001
Y5, III	Pre, Post test	13.100	13.996	3.130	6.550	19.650	4.186	19	<.001	<.001
Y5, III	Pre, Post test	13.000	14.101	3.153	6.400	19.600	4.123	19	<.001	<.001

Note: Where Y1, Y2, Y3, Y4, & Y5 stand for years one to four. I, II, & III are training session numbers in a particular year.

Table 6 - Shows the effect size for the Paired Sample *t*-test.

Effect sizes Cohen's d and Hedges' correction for all the training sessions			Standardizer[a]	Point Estimate	95% Confidence Interval Lower	Upper
Year 1, Training I	Post – Pre test	Cohen's d	14.105	.922	.387	1.439
		Hedges' correction	14.694	.885	.372	1.382
Year 1, Training II	Post – Pre test	Cohen's d	13.876	1.683	.985	2.362
		Hedges' correction	14.456	1.615	.946	2.267
Year 1, Training III	Post – Pre test	Cohen's d	14.073	1.638	.951	2.306
		Hedges' correction	14.661	1.572	.913	2.214
Year 2, Training I	Post – Pre test	Cohen's d	14.169	1.599	.921	2.258
		Hedges' correction	14.761	1.534	.884	2.167
Year 2, Training II	Post – Pre test	Cohen's d	14.482	1.554	.887	2.202
		Hedges' correction	15.087	1.491	.851	2.114
Year 2, Training III	Post – Pre test	Cohen's d	14.358	1.571	.900	2.223
		Hedges' correction	14.958	1.508	.864	2.134
Year 3, Training I	Post – Pre test	Cohen's d	14.054	.936	.399	1.456
		Hedges' correction	14.640	.898	.383	1.397
Year 3, Training II	Post – Pre test	Cohen's d	14.038	.926	.391	1.444
		Hedges' correction	14.624	.889	.375	1.387
Year 3, Training III	Post – Pre test	Cohen's d	14.039	.937	.400	1.457
		Hedges' correction	14.625	.899	.383	1.399
Year 4, Training I	Post – Pre test	Cohen's d	14.053	.925	.390	1.443
		Hedges' correction	14.639	.888	.374	1.385
Year 4, Training II	Post – Pre test	Cohen's d	14.086	.923	.388	1.441
		Hedges' correction	14.674	.886	.373	1.383
Year 4, Training III	Post – Pre test	Cohen's d	14.120	.921	.386	1.438
		Hedges' correction	14.709	.884	.371	1.381
Year 5, Training I	Post – Pre test	Cohen's d	14.092	.937	.399	1.457
		Hedges' correction	14.681	.899	.383	1.399
Year 5, Training II	Post – Pre test	Cohen's d	13.996	.936	.399	1.456
		Hedges' correction	14.580	.898	.383	1.398
Year 5, Training III	Post – Pre test	Cohen's d	14.101	.922	.387	1.440
		Hedges' correction	14.690	.885	.372	1.382

a. The denominator is used to estimate the effect sizes. Cohen's d uses the sample standard deviation of the mean difference. Hedges' correction uses the sample standard deviation of the mean difference plus a correction factor.

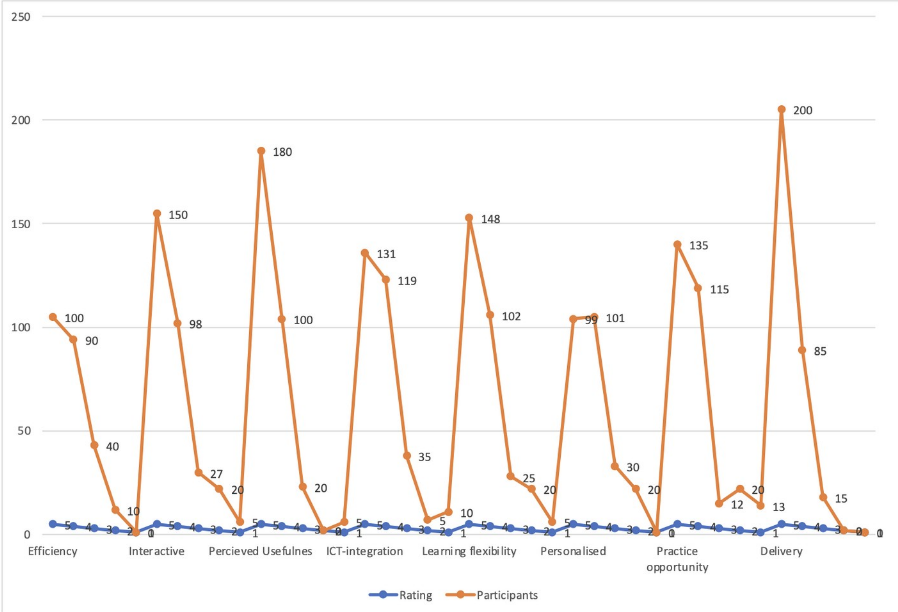

Figure 1 - Presents the results of the satisfaction survey.

7. Discussion

The present study aimed to examine whether the ICT-integrated modular training (MT) program enhances the digital research skills of researchers in higher education. The researchers involved include faculty members from universities or colleges, doctoral scholars, and research associates. The research confirmed that the program enhanced their digital research skills and that they were satisfied with the modular instruction.

Thus, the present study achieved its intended objectives by employing a quasi-experimental research design. The study measured the impact of ICT-integrated modular training through repeated measure cross-sectional design with the administration of single group pre and post-tests three times a year for a period of five consecutive years. The present study revealed that the modular training sessions on quantitative data analysis, qualitative data analysis, and research publication via digital software and various e-resources have successfully developed research scholars' digital research skills. Similar observations are found by (Cavite & Gonzaga, 2023). A recent study by Ambayon (2020) found that modular instruction improved achievement in literature. As ICT-integrated research data analysis and publication learning demands immense scholarly knowledge, learning them with ICT and software makes it even more complicated when taught in a non-modular approach. In the present study, modular instructions have enhanced learning productivity despite learning digital research skills via software and the more profound background domain knowledge.

All the pre-test and post-test scores showed a significant difference in the mean scores after each modular training session, and their effect size was also large. This articulates the lasting effect of modular learning or nano-learning and agrees with the recent work (Yousef et al., 2023).

The present study makes a unique contribution to existing training practices in higher education. Until recently, research scholars worldwide received data analysis and academic writing skills through lengthy workshops, semester-long coursework, or intensive faculty development programs. The impact of these methods was found to be weak, and participants in these learning modes tended to be passive.

With the advent of various new digital resources for conducting research and data analysis, along with artificial intelligence-enabled digital software, the traditional approach to training scholars in research skills is becoming less effective. Additionally, research has found that the attention spans of Generation Z and Generation Alpha learners are declining (Lamsal, 2022; Hermawati et al., 2018). Therefore, modular or nano-training significantly equips scholars with more sophisticated digital research skills (Hamilton et al., 2021). Modular training is effective as it caters to learners' short attention spans and engages their metacognitive processes, allowing them to learn small-sized content more effectively. This is supported by the present study and aligns with the findings of Vivekananth (2022).

The satisfaction survey administered to participants of the modular training program revealed a high level of satisfaction with their learning experiences through the modular approach, and they exhibited enhanced digital research skills compared to their capabilities before the training. A similar observation was noted by Mwangi (2023). Participants indicated that the ICT-integrated interactive modular training program incorporated effective time management, facilitated high levels of peer interaction, and imparted valuable research analysis skills in each module. They found the combination of software and online resources to be appropriate and appreciated the flexible approach to developing their digital research skills. A recent study reported analogous findings (Emara et al., 2023). Furthermore, the training sessions provided individualized attention to participants' learning and offered ample practice opportunities. Given that the information was presented in manageable chunks, participants were able to comprehend 100% of the material.

Earlier studies which are similarly in agreement with the present study are mostly at school level teaching; an experimental study on improving the digital competence of special education teaching showed a significant increase in problem-solving, internet-browsing, and communication skills among the study participants (Compagno et al., 2016). An eTwinning international training program with pre and post webinar event for teachers showed improvement in their technology skills and reported enriching satisfaction with the conducted programme (Cinganotto, 2017). An Italian study on E-learning 2.0 included web-2 technologies to supplement classroom learning and reported that online digital training could enhance learning, and participants are more satisfied with the training (Spadavecchia, 2009). The present study stands out as unique as higher education learners with the age range of 26 to 50 and especially on digital research data analysis skills with theoretical background knowledge had an improved research productivity. Research productivity is the most important contributor to the economic prosperity of the country and the world (Jorgenson & Vu, 2016).

8. Conclusion

Overall, the study on ICT-integrated modular training programs aimed at enhancing the digital research skills of research scholars has significantly contributed to the development of digital research skills among both scholars and faculty members. Their learning satisfaction also remained high. Given the technological advancements and the diminishing attention span during long lecture hours, educators are encouraged to adopt a more modular approach to their teaching and learning processes. Unlike traditional, lengthy training practices, modular training enhances students' learning and engagement. Students can maintain focus as the content is presented in smaller segments, which alleviates cognitive overload, provides ample practice time, reduces the duration of teaching, and minimizes learning anxiety and stress. However, the present study has its limitations regarding sampling. Specifically, participation was voluntary, data were collected over a five-year period, the data were not analyzed based on demographic differences, and all types of scholars were treated as researchers.

Since a different set of participants was involved in the study each time, the generalizability is limited despite the observed significant differences. Furthermore, the learning satisfaction questionnaire, along with the pre-test and post-test tools, was constructed by the researchers, and the lack of standardization limits the generalizability of the research. Future research could conduct modular training for each module with a larger sample to achieve better generalizability.

As modular training has gained popularity in recent years, particularly in the post-pandemic era and with the given context of technological advancements, future researchers must gather sufficient evidence of its effectiveness to understand the paradigm shift it is bringing to Generation Z and Generation Alpha learners Consequently, researchers highlight the necessity for both quantitative and qualitative research to gain a deeper understanding of the nuances of modular or nano training.

Conflict of interest

The authors of this study affirm that they have no competing interests. We extend our gratitude to all the participants for their cooperation throughout the study.

References

Abazi, B., & Hajrizi, E. (2018). Research on the importance of training and professional certification in the field of ICT Case Study in Kosovo. *IFAC-PapersOnLine*, 51(30), 336–339. https://doi.org/10.1016/j.ifacol.2018.11.327

Adetimirin, A. (n.d.). Female Lecturers’ Perception of ICT Integration for Teaching and Learning in University of Ibadan, Nigeria. In *Gender and Diversity* (pp. 1624–1636). IGI Global. https://doi.org/10.4018/978-1-5225-6912-1.ch084

Ambayon, C. M. (2020). Modular-Based Approach and Students’ Achievement in Literature. *International Journal of Education and Literacy Studies*, 8(3), 32–36. https://doi.org/10.7575/AIAC.IJELS.V.8N.3P.32

Anjaiah, D. M. (2016). Digital Information Literacy Among Research Scholars and Students Community At Dravidian University, Kuppam-Andra Pradesh (India): An Exploratory Study. *IOSR Journal of Humanities and Social Science*, 21(09), 01–08. https://doi.org/10.9790/0837-2109120108

Ben Youssef, A., Dahmani, M., & Omrani, N. (2015). Information technologies, students'e-skills and diversity of learning process. *Education and Information Technologies*, 20, 141–159.

https://doi.org/10.1007/s10639-013-9272-x

Benos, N., & Zotou, S. (2014). Education and Economic Growth: A Meta-Regression Analysis. *World Development*, 64, 669–689. https://doi.org/10.1016/j.worlddev.2014.06.034

Castillo-Merino, D., & Serradell-López, E. (2014). An analysis of the determinants of students' performance in e-learning. *Computers in Human Behavior*, 30, 476–484. https://doi.org/10.1016/j.chb.2013.06.020

Cavite, J. A. V., & Gonzaga, M. V. A. (2023). Pupils' Learning Styles and Academic Performance in Modular Learning. *International Journal of Multidisciplinary Educational Research and Innovation*,1(3),72-88. https://philpapers.org/archive/CAVPLS-2.pdf

Ceker, E., & Uzunboylu, H. (2016). Comparing ICT Oriented Phd Research in Turkey with Recent ICT Research Trends. *Procedia Computer Science*, 102, 90–97. https://doi.org/10.1016/j.procs.2016.09.374

Chaminade, C., Martin, R., & McKeever, J. (2021). When regional meets global: exploring the nature of global innovation networks in the video game industry in Southern Sweden. *Entrepreneurship & Regional Development*, 33(1–2), 131–146. https://doi.org/10.1080/08985626.2020.1736184

Cinganotto, L. (2017). Experiential Learning for teacher training: a case example on language, content and technologies in a Learning Event by eTwinning. *Journal of E-Learning and Knowledge Society*, 13(1). https://doi.org/10.20368/1971-8829/156

Cohen J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. New York, NY: Routledge Academic

Compagno, G., Cappuccio, G., & Pedone, F. (2016). Digital Competence for the improvement of Special Education Teaching. *Journal of E-Learning and Knowledge Society*, 12(4). https://doi.org/10.20368/1971-8829/1134

De Wit, K., Heerwegh, D., & Verhoeven, J. C. (2014). Can openness to ICT and scientific research predict the ICT skills and ICT use of bachelor's students? *Computers & Education*, 78, 397–413. https://doi.org/10.1016/j.compedu.2014.07.003

Dimitrije, C. (2023). Number of Academic Papers Published Per Year. Wordsrated. https://wordsrated.com/number-of-academic-papers-published-per-year/

Durán Cuartero, M., Gutiérrez Porlán, I., & Prendes Espinosa, M. P. (2016). Análisis Conceptual de Modelos de Competencia Digital del Profesorado Universitario / Conceptual analysis of digital competence models of university teacher. *Revista Latinoamericana de Tecnología Educativa - RELATEC*, 15(1), 97-114. https://doi.org/10.17398/1695-288X.15.1.97

El Hammoumi, S., Zerhane, R., & Janati Idrissi, R. (2022). The impact of using interactive animation in biology education at Moroccan Universities and students' attitudes towards animation and ICT in general. *Social Sciences & Humanities Open*, 6(1), 100293. https://doi.org/10.1016/j.ssaho.2022.100293

Emara, H. T., Elkhawaga, G. O., Abdelsalam, S. A., & Niazy, N. A. (2023). Readiness for and satisfaction with blended learning among integrated modular-based medical students, Mansoura University, Egypt. *The Egyptian Journal of Community Medicine*, 41(2), 127-134.

https://doi.org/10.21608/ejcm.2023.180526.1242

Estrada Villa, E. J., Marín, V. I., & Salinas, J. (2021). Research Skills for Information Management: Uses of Mobile Devices in Research Training. *Education Sciences*, 11(11), 749. https://doi.org/10.3390/educsci11110749

Fernandez-Morante, C., Cebreiro López, B., & Casal Otero, L. (2020). Capacitar y motivar a las niñas para su participación futura en el sector TIC. Propuesta de cinco países. *Innoeduca. International Journal of Technology and Educational Innovation*, 6(2), 115–127. https://doi.org/10.24310/innoeduca.2020.v6i2.6256

Fratto, V., Sava, M. G., & Krivacek, G. J. (2016a). The impact of an online homework management system on student performance and course satisfaction in introductory financial accounting. *International Journal of Information and Communication Technology Education (IJICTE)*, 12(3), 76–87. https://doi.org/10.4018/IJICTE.2016070107

Fratto, V., Sava, M. G., & Krivacek, G. J. (2016b). The Impact of an Online Homework Management System on Student Performance and Course

Satisfaction in Introductory Financial Accounting. *International Journal of Information and Communication Technology Education*, 12(3), 76–87. https://doi.org/10.4018/IJICTE.2016070107

Guillén-Gámez, F. D., & Mayorga-Fernández, M. J. (2020). Prediction of Factors That Affect the Knowledge and Use Higher Education Professors from Spain Make of ICT Resources to Teach, Evaluate and Research: A Study with Research Methods in Educational Technology. *Education Sciences*, 10(10), 276. https://doi.org/10.3390/educsci10100276

Guillén-Gámez, F. D., Ruiz-Palmero, J., & García, M. G. (2023). Digital competence of teachers in the use of ICT for research work: development of an instrument from a PLS-SEM approach. *Education and Information Technologies*, 28(12), 16509–16529. https://doi.org/10.1007/s10639-023-11895-2

Hamilton, J., Hall, D., & Hamilton, T. (2021). Microlearning in the workplace of the future. In microlearning in the digital age (pp. 240-263). Routledge. https://doi.org/10.4324/9780367821623

Hermawati, D., Rahmadi, F. A., Sumekar, T. A., & Winarni, T. I. (2018). Early electronic screen exposure and autistic-like symptoms. *Intractable & rare diseases research*, 7(1), 69-71. https://doi.org/10.5582/irdr.2018.01007

Jiménez Sabino, M. J., & Cabero Almenara, J. (2021). Los conocimientos tecnológicos, pedagógicos y de contenidos del profesorado universitario andaluz sobre las TIC. Análisis desde el modelo TPACK. *Innoeduca. International Journal of Technology and Educational Innovation*, 7(1), 4–18. https://doi.org/10.24310/innoeduca.2021.v7i1.11940

Jorgenson, D. W., & Vu, K. M. (2016). The ICT revolution, world economic growth, and policy issues. *Telecommunications Policy*, 40(5), 383–397. https://doi.org/10.1016/j.telpol.2016.01.002

Kano, L., Ciravegna, L., & Rattalino, F. (2021). The family as a platform for FSA development: Enriching new internalization theory with insights from family firm research. *Journal of International Business Studies*, 52(1), 148–160. https://doi.org/10.1057/s41267-020-00308-y

Khasawneh, A. J. (2023). Unveiling the role of ICT in social science research: An examination of ICT applications in the Saudi Arabian and Joranian context. *Journal of Southwest Jiaotong University*, 58(5). https://doi.org/10.35741/issn.0258-2724.58.5.36

Koşar, G. (2021). Distance teaching practicum: Its impact on pre-service EFL teachers' preparedness for teaching. *IAFOR Journal of Education*, 9(2), 111–126. https://doi.org/10.22492/ije.9.2.07

Koutska, I. (2023). Educational Technology 'Introduced' by the COVID-19 Pandemic. *Innoeduca. International Journal of Technology and Educational Innovation*, 9(2), 115-133. https://doi.org/https://doi.org/10.24310/innoeduca.2023.v9i2.154811548124310

Krishnamurthy, C., & Shettappanavar, L. (2019). Digital literacy among female postgraduate students of Karnatak University, Dharwad, Karnataka, India: A study. Library Philosophy and Practice, 2019 (September 2019). https://digitalcommons.unl.edu/libphilprac/2934

Kruskopf, M., Abdulhamed, R., Ranta, M., Lammassaari, H., & Lonka, K. (2024). Future teachers' self-efficacy in teaching practical and algorithmic ICT competencies – Does background matter? *Teaching and Teacher Education*, 144, 104574. https://doi.org/10.1016/j.tate.2024.104574

Lakens D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *Frontiers in psychology*, 4, 863. https://doi.org/10.3389/fpsyg.2013.00863

Lamsal, B. (2022). Exploring Issues Surrounding a Safe and Conducive Digital Learning Space in Nepal: A Preparation for Online Education in the Post-Pandemic Era. In M. Garcia (Ed.), *Socioeconomic Inclusion During an Era of Online Education* (pp. 246-263). IGI Global. https://doi.org/10.4018/978-1-6684-4364-4.ch012

Magalhães, P., Ferreira, D., Cunha, J., & Rosário, P. (2020). Online vs traditional homework: A systematic review on the benefits to students' performance. *Computers & Education*, 152, 103869. https://doi.org/10.1016/j.compedu.2020.103869

Mwangi, E. G. (2023). Influence of Modular Object-oriented Dynamic Learning Environment Features on Student's Satisfaction in Learning Common Units in Public Universities in Kenya. University of Nairobi. http://erepository.uonbi.ac.ke/handle/11295/164295

Mondal, S., & Culp, D. (2017). Academic performance in online versus blended classes in principles of economics and statistics courses. *Journal of Applied Business and Economics*, 19(3), 117-135. https://articlegateway.com/index.php/JABE/article/view/710

Moshood, T., Nawanir, G., Sorooshian, S., Mahmud, F., & Adeleke, A. (2020). Barriers and Benefits of ICT Adoption in the Nigerian Construction Industry. A Comprehensive Literature Review.

Applied System Innovation, 3(4), 46. https://doi.org/10.3390/asi3040046

Myovella, G., Karacuka, M., & Haucap, J. (2020). Digitalization and economic growth: A comparative analysis of Sub-Saharan Africa and OECD economies. *Telecommunications Policy*, 44(2), 101856. https://doi.org/10.1016/j.telpol.2019.101856

Nunnally, J. C. (1978). *Psychometric Theory* (2nd ed.). New York: McGraw-Hill.

Oguguo, B., Ezechukwu, R., Nannim, F., & Offor, K. (2023). Analysis of teachers in the use of digital resources in online teaching and assessment in COVID times. *Innoeduca. International Journal of Technology and Educational Innovation*, 9(1), 81-96. https://doi.org/10.24310/innoeduca.2023.v9i1.15419

Ramirez, G. M., Collazos, C. A., & Moreira, F. (2018). All-Learning: The state of the art of the models and the methodologies educational with ICT. *Telematics and Informatics*, 35(4), 944–953. https://doi.org/10.1016/j.tele.2017.10.004

Sahoo, B. K., Singh, R., Mishra, B., & Sankaran, K. (2017). Research productivity in management schools of India during 1968-2015: A directional benefit-of-doubt model analysis. *Omega*, 66, 118–139. https://doi.org/10.1016/j.omega.2016.02.004

Spadavecchia, E. (2009). E-learning 2.0 for supplementary teaching. *Journal of E-Learning and Knowledge Society,* 4(3). https://doi.org/10.20368/1971-8829/287

Stein, S. J., & Sim, K. N. (2020). Enhancing the roles of information and communication technologies in doctoral research processes. *International Journal of Educational Technology in Higher Education*, 17(1), 34. https://doi.org/10.1186/s41239-020-00212-3

To, W. M., & Yu, B. T. W. (2020). Rise in higher education researchers and academic publications. *Emerald Open Research*, 2, 3. https://doi.org/10.35241/emeraldopenres.13437.1

Vacek, P., & Rybenska, K. (2015). Research of Interest in ICT Education among Seniors. *Procedia - Social and Behavioral Sciences*, 171, 1038–1045. https://doi.org/10.1016/j.sbspro.2015.01.276

Venturini, F. (2015). The modern drivers of productivity. *Research Policy*, 44(2), 357–369. https://doi.org/10.1016/j.respol.2014.10.011

Vivekananth, P. (2022). Nanolearning: A new paradigm shift in teaching and learning. *International Journal Of Engineering And Management Research*,12(1), 112-114. https://doi.org/10.31033/ijemr.12.1.14

Yadav, N., Gupta, K., & Khetrapal, V. (2018). Next Education: Technology Transforming Education. *South Asian Journal of Business and Management Cases*, 7(1), 68–77. https://doi.org/10.1177/2277977918754443

Yousef, A.M.F., Huang, R., Tlili, A., Garcia, M.B., Mahmoud, A.G., Metwally, A.H.S. (2023). Small Bites, Big Impact: The Power of Nanolearning. In: Anutariya, C., Liu, D., Kinshuk, Tlili, A., Yang, J., Chang, M. (eds) Smart Learning for A Sustainable Society. ICSLE 2023. Lecture Notes in Educational Technology. Springer, Singapore. https://doi.org/10.1007/978-981-99-59617-12

Appendix - Satisfaction survey

Items of the satisfaction survey	Strongly Dis-agree (1)	Dis-agree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
I found the ICT-integrated modular training workshop efficient					
I found the ICT-integrated modular training workshop interactive					
I found the ICT-integrated modular training workshop useful					
I found the ICT-integrated modular training workshop had sufficient ICT-tools integration					
I found the ICT-integrated modular training workshop had learning flexibility					
I found the ICT-integrated modular training workshop personalised					
I found the ICT-integrated modular training workshop had enough opportunity for practice					
I found the ICT-integrated modular training workshop had appropriate style of content delivery					

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 20, No. 3 (2024), pp. 39-55

Enhancing Students' Research Skills Through AI Tools and Teacher Competencies: A Mixed-Methods Study

Najmeh Behnamnia[a,1], Siavash Hayati[b], Amirrudin Kamsin[a], Ali Ahmadi[c], Zahra Alizadeh[c]

[a]Faculty of Computer Science & Information Technology, Universiti Malaya – Kuala Lumpur (Malaysia)

[b]Faculty of Electrical Engineering, Tarbiat Modares University – Tehran (Iran)

[c]Faculty of Computer Science & Information Technology, Islamic Azad University – Tehran (Iran)

(submitted: 8/6/2024; accepted: 29/9/2024; published: 27/10/2024)

Abstract

This mixed-methods study examines the relationship between the integration of the AI-driven educational platform BrainPOP, teacher digital competencies, and the development of students' research skills in elementary and secondary education in Tehran, Iran. The study focuses on four primary objectives: (1) identifying strategies for integrating BrainPOP in teaching and learning, (2) assessing the influence of teacher digital competencies on successful BrainPOP integration, (3) analyzing the impact of BrainPOP on students' research skills, and (4) exploring the interconnected roles of BrainPOP, teacher digital competencies, and students' research skills development. Participants include 100 elementary and secondary school teachers and 200 students from Tehran, Iran. Data is collected using surveys, interviews, and classroom observations, and analyzed through descriptive statistics, regression, and thematic coding. Key findings for each objective include: 1. Diverse strategies for integrating BrainPOP in the classroom, 2. A positive correlation between teacher digital competencies and successful BrainPOP adoption, 3. Enhanced student research skills linked to the use of BrainPOP, and 4. The significance of a supportive learning environment that fosters collaboration, critical thinking, and adaptability among students, teachers, and AI tools in Iran. This study highlights the need for different ways to use BrainPOP, improving teachers' digital skills, and creating a supportive learning environment to help students improve their research skills in elementary and secondary schools. The results provide essential information for education practices and policies in Iran and other places, highlighting that AI tools like BrainPOP can significantly enhance how students learn and develop their research abilities.

KEYWORDS: AI in Education, AI Competency, Teacher Competency, Teaching Competency, Technological Pedagogical Content Knowledge (TPACK).

DOI
https://doi.org/10.20368/1971-8829/1135960

CITE AS
Behnamnia, N., Hayati, S., Kamsin, A., Ahmadi, A., & Alizadeh, Z. (2024). Enhancing Students' Research Skills Through AI Tools and Teacher Competencies: A Mixed-Methods Study. *Journal of e-Learning and Knowledge Society*, *20*(3), 39-55. https://doi.org/10.20368/1971-8829/1135960

1. Introduction

The integration of artificial intelligence (AI) tools has substantially transformed educational environments, impacting how students engage with and process information (Holmes et al., 2023; Zhu et al., 2016). A crucial aspect of this transformation is the digital competencies that teachers and future teachers possess in research work and their utilization of digital tools within this context. It is essential to examine the interconnected relationship between AI tool integration, teacher digital competencies in research tasks, and students' research skills development (Luckin et al., 2022; Mikalef et al., 2021).

As the demand for proficient information seeking, evaluation, and utilization increases in our knowledge-driven world, research skills have become essential for students to succeed (Kirschner & Selinger, 2003). Teachers, with their digital competencies, are instrumental in fostering these abilities, guiding students through the complex information landscape (Ilomäki et al., 2016; Suelves et al., 2019). With AI

[1] corresponding author - email: n.behnamnia@gmail.com – address: Faculty of Computer Science and Information Technology, University of Malaya (UM), Kuala Lumpur, Malaysia

tools progressively integrating into educational settings, it is vital to examine their impact on teacher digital competencies and the consequent influence on students' research abilities (Behnamnia et al., 2018; Hayati et al., 2023; Najmeh, 2021).

The role of AI-driven educational platforms like BrainPOP as essential tools for teachers and future teachers in elementary education is highlighted (Rosen et al., 2022). BrainPOP is an online educational platform offering engaging animated videos, interactive activities, and games that facilitate learning across various subjects, such as science, math, history, and language arts. Specifically designed for elementary students, BrainPOP caters to their learning needs by presenting information in a visual, engaging, and age-appropriate manner (Rosen et al., 2022).

The integration of BrainPOP in the classroom provides several advantages (Barak et al., 2011):

- Content engagement: BrainPOP's animated videos and interactive activities make learning enjoyable and engaging for elementary students, fostering their interest in various subjects and improving knowledge retention.
- Differentiated instruction: With a wide range of resources, BrainPOP caters to diverse learning needs and preferences, enabling teachers to differentiate instruction and create personalized learning experiences.
- Skill development: The platform's quizzes and activities allow students to practice and develop critical thinking, problem-solving, and research skills, supporting their overall academic growth.

Hence, this comprehensive study underlines the importance of digital competencies among teachers and future teachers, as well as the benefits of integrating AI tools like BrainPOP in elementary education. It emphasizes the role of AI in enhancing teacher digital competencies and fostering students' research skills development within a supportive learning environment. This study focuses on addressing the following research questions:

1. What strategies do educators employ to integrate AI tools into their teaching practices, and how do these strategies support the development of students' research skills?
2. How do teacher digital competencies impact the selection, implementation, and effectiveness of AI tools in teaching practices, particularly in the context of enhancing students' research skills?
3. To what extent do AI tools and teacher digital competencies influence students' development of research skills, such as information literacy, critical thinking, and problem-solving abilities?

2. Background

As AI continues to permeate various industries, its impact on education is becoming increasingly evident, with innovative solutions emerging to enhance teaching and learning practices (Fernández et al., 2023; Holmes et al., 2023). AI tools, such as intelligent tutoring systems, adaptive learning platforms, and virtual assistants, are progressively integrated into classroom settings to facilitate personalized learning and support teachers' work (Giménez & Porlán, 2017; Luckin et al., 2022; Mikalef et al., 2021). In this context, digital competencies specifically related to research work have become crucial for educators to effectively navigate and harness the full potential of AI tools in education (Lawless et al., 2007; Redecker, 2017).

As AI-driven platforms become more prevalent, educators must possess strong digital competencies in research work to successfully integrate these tools into their teaching practices. This includes the ability to identify, evaluate, and select appropriate AI tools for their students, as well as design and implement research-based instructional strategies that leverage the unique capabilities of AI technologies (Fernández et al., 2023; Holmes et al., 2023). By focusing on digital competencies in research work, educators can better support students' research skills development and ensure they are well-equipped to navigate the increasingly digital landscape of education.

In this digital age, students' research skills have become vital for their academic success and future careers (Fernández-Batanero et al., 2022; Kirschner et al., 2003). As AI tools continue to shape the information landscape, students must be equipped with the necessary skills to locate, evaluate, and utilize information from various sources effectively (Celik et al., 2022). Research has shown that teachers' digital competencies significantly influence students' research skills, emphasizing the importance of understanding how AI tools affect both educators and learners (Ilomäki et al., 2016).

Despite the growing interest in AI tools specifically designed for research work, such as the BrainPOP platform, and teacher digital competencies, there remains a lack of research on their impact on students' research skills (Liu et al., 2022). Existing studies have primarily focused on the effects of AI tools like BrainPOP on student learning outcomes (Chalkiadaki, 2018; Zhao et al., 2021); or teacher practices practices (Chen et al., 2020; Gong, 2021). However, the specific relationship between AI tools such as BrainPOP, teacher digital competencies in research, and students' development of research skills has received little attention.

In addition, the rapid evolution of AI technologies presents ongoing challenges for teachers to keep up with the latest developments and incorporate them effectively into their practice (Luckin et al., 2022;

Oguguo et al., 2023). Further research is required to examine the barriers and facilitators to AI adoption in education, as well as the implications for teacher professional development and support (Mikalef et al., 2021; Şimşek et al., 2022).

To address this gap in the literature, it is crucial to investigate how research-focused AI tools like BrainPOP can be effectively integrated into educational settings, and how teacher digital competencies in research can support this process. By gaining a deeper understanding of the interplay between AI tools such as BrainPOP, teacher digital competencies, and students' research skills, educators can better equip students with the necessary skills to thrive in the digital age.

2.1 Overview of BrainPOP as an AI-driven Educational Platform

While there are studies investigating AI-driven platforms in education, research focusing specifically on the relationship between platforms like BrainPOP, teacher digital competencies in research tasks, and students' research skills development remains limited (Celik, 2023; Esteve-Mon et al., 2020). This study aims to contribute to the existing literature by examining BrainPOP, an AI-driven educational platform founded by Dr. Avraham Kadar in 1999, initially designed to help young patients grasp complex concepts (Rosen et al., 2022). Over time, the platform has transformed into a comprehensive online resource catering to students in grades K-8 (ages 5 to 14), with the goal of making learning engaging, accessible, and effective through animated videos, interactive activities, quizzes, and games, while simultaneously fostering teachers' digital competencies in research (Rosen et al., 2022).

BrainPOP covers diverse subjects, including science, social studies, English, math, engineering and technology, health, arts, and music (Rosen et al., 2022). The platform employs AI algorithms to analyze users' performance and preferences, enabling it to customize content and offer personalized learning experiences (Luckin et al., 2022; Mikalef et al., 2021). Consequently, students receive targeted support in areas requiring improvement, optimizing their learning outcomes and promoting digital competencies in research tasks (Barak et al., 2011).

Apart from its core content, BrainPOP provides various features and tools that support teachers' digital competencies in research and bolster students' research skills (Rosen et al., 2022):

- My BrainPOP: This feature enables teachers to create custom assignments, track student progress, and generate detailed reports on individual and class performance, promoting data-driven instruction and supporting digital competencies in research.
- GameUp: A compilation of educational games designed to reinforce learning and promote critical thinking, problem-solving, and collaboration among students, nurturing vital research skills.
- Make-a-Map: A concept mapping tool that helps students visualize connections between key ideas, concepts, and events, strengthening their research and organizational skills within the context of digital competencies.

BrainPOP's extensive range of features and tools make it an ideal AI-driven platform for investigating the connection between teacher digital competencies in research, students' research skills, and AI integration in education (Rosen et al., 2022). By exploring BrainPOP's role in elementary and middle school settings, researchers can gather valuable insights into the potential benefits and challenges of AI-driven platforms, informing best practices for educational practice and policy in promoting digital competencies for research tasks (Celik, 2023; Esteve-Mon et al., 2020).

2.2 Digital Competencies of Teachers in Research Work: Review of Relevant Studies

Teachers' digital competencies in research tasks are crucial for successfully integrating AI-driven platforms and developing students' research skills Several studies emphasize the importance of these competencies and the need for educators to adapt to evolving technology (Guillén-Gámez et al. 2023).

Guillén-Gámez et al. (2023) developed an instrument to assess teachers' digital competence in using ICT for research work. Their findings highlighted the significance of effectively leveraging digital tools to support research endeavors, including AI tools like BrainPOP (Guillén-Gámez et al. 2023). However, the study did not explicitly focus on AI tool integration in elementary and middle school settings.

Guillén-Gámez et al. (2023) identified creativity and entrepreneurship as essential for teacher training in digital competencies for research. They asserted the importance of cultivating these skills to enhance innovative and effective use of technology in research tasks, especially in elementary and middle school education.

Guillén-Gámez et al. (2024) examined predictors impacting digital competence in research work among higher education teachers based on university type and gender (Guillén-Gámez et al., 2023). This study highlighted the need for tailored strategies to address varying digital competencies among educators and their distinct teaching contexts. While contributing to understanding teacher digital skills, the research did not specifically address AI tool integration in elementary and middle school settings.

The authors have included these studies to emphasize the importance of teachers' digital competencies in research tasks and the potential benefits of effectively leveraging AI-driven platforms like BrainPOP for students' research skills development (Heinz, 2016). However, further research is needed to explore the relationship between AI tools, teacher digital competencies in research work, and students' research skills development in elementary and middle school education. The primary objective of this study is to bridge this research gap, offering novel insights to the existing body of literature and furnishing practical implications for educators and policymakers alike. These implications will aid in better supporting teachers as they integrate AI tools into their research practices and teaching methods.

2.3 Research Gap and Critical Analysis of Existing Literature

Existing studies have analyzed the digital competencies of teachers in research work, providing a solid foundation for further investigation (Guillén-Gámez et al., 2023). However, these studies primarily focus on digital competencies in general, without delving into the specific competencies required for the integration of AI-driven platforms in research tasks (Heinz, 2016). Furthermore, the literature often overlooks the potential impact of AI tools on students' research skills development and the correlation between teacher digital competencies in research tasks and students' research abilities (Beardsley et al., 2021; Canal et al., 2024; Haşlaman et al., 2024).

Moreover, the majority of research on AI in education has employed quantitative methods, with fewer mixed-methods investigations exploring the nuanced perspectives and experiences of teachers regarding digital competencies in research work (Dunn & Kennedy, 2019; Liaw et al., 2013; Pettersson, 2018). This highlights the need for a more holistic understanding of the interplay between AI tools, teacher digital competencies in research tasks, and students' research skills (Napal Fraile et al., 2018).

2.4 Addressing the Research Gap and Positioning the Study

The existing literature on AI tools in education, teacher digital competencies in research tasks, and students' research skills development has several knowledge gaps that this study aims to address. These gaps include:

1. Limited focus on elementary and middle school education: Current research primarily examines AI tool integration in higher education or general educational settings. There is a need to investigate the specific implications for elementary and middle school students, as their learning needs and abilities differ from older students (Giménez et al., 2017; Luckin et al., 2022; Mikalef et al., 2021).
2. Scarcity of research on teacher digital competencies in the context of AI tool integration for research tasks: While teacher digital competencies in research work have been studied extensively, there is limited research on how these skills influence the selection and implementation of AI tools in teaching practices, particularly in relation to students' research skills development (Lawless et al., 2007; Redecker, 2017).
3. Lack of attention to the interplay between AI tools, teacher digital competencies in research tasks, and students' research skills development: Existing studies often examine these factors separately, neglecting the complex interconnections between them (Fernández-Batanero et al., 2022; Kirschner et al., 2003).

By focusing on the strategies employed by educators, the influence of teacher competencies on AI tool integration for research tasks, and the impact on students' research skills, this study contributes new insights to the existing literature.

Moreover, the inclusion of BrainPOP as a case study provides a unique perspective on the role of AI-driven educational platforms in promoting teacher digital competencies in research tasks and fostering students' research skills. This context-specific focus adds depth to the research, enabling a more comprehensive understanding of the complex interplay between AI tools, teacher competencies in research work, and student learning outcomes.

3. Objectives of the Study

This study aims to achieve the following objectives:

1. Identify and analyze the strategies employed by educators to integrate AI tools into their teaching practices and their impact on students' research skills development.
2. Investigate the influence of teacher digital competencies on the selection, implementation, and effectiveness of AI tools in teaching practices, with a focus on enhancing students' research skills.
3. Assess the extent to which AI tools and teacher digital competencies affect students' development of research skills, including information literacy, critical thinking, and problem-solving abilities.

4. Methodology

This study employed a mixed-methods approach, combining quantitative and qualitative methods to gain a comprehensive understanding of the relationship between AI tools, teacher digital competencies, and students' research skills (Creswell et al., 2017). The study's design and methods were guided by the following frameworks and theories: Technological Pedagogical Content Knowledge (TPACK) Framework (Mishra et al., 2006), Digital Competence Framework for Educators (DigCompEdu) (Conrads et al., 2017), Information Literacy Model (Kuhlthau, 2004), and Social Constructivism (Vygotsky et al., 1978).

The instruments used in this study were carefully selected and adapted to measure the digital competencies of teachers in research work and the impact of AI tools like BrainPOP on students' research skills development. These instruments include:

1. A questionnaire based on the DigCompEdu framework, assessing teachers' digital competencies in various areas, such as information and data literacy, communication and collaboration, and digital content creation.
2. A rubric adapted from the Information Literacy Model to evaluate students' research skills, focusing on their ability to locate, evaluate, and synthesize information effectively.
3. Interview protocols grounded in Social Constructivism, exploring teachers' and students' perceptions of AI tools and their influence on teaching practices and learning experiences.

By employing these instruments and drawing upon the relevant frameworks, the study aims to provide a nuanced understanding of the interplay between AI tools, teacher digital competencies, and students' research skills development.

4.1 Research Design

A sequential explanatory mixed-methods design was used, involving two phases (Creswell et al., 2003):

1. Quantitative Phase: A survey was administered to collect data on teacher digital competencies, AI tool usage (e.g., BrainPOP), and students' research skills. This phase involved statistical analyses to identify trends and correlations (Pallant, 2020).
2. Qualitative Phase: Semi-structured interviews and classroom observations were conducted to gather in-depth insights into teachers' and students' experiences with AI tools. This phase aimed to explain and elaborate on the quantitative findings (Creswell & et al., 2017).

By using a mixed-methods approach, the study aimed to capture a broad range of perspectives and experiences with AI tools in education, investigating the relationship between AI tools, teacher digital competencies, and students' research skills in the context of elementary and middle school education.

4.2 Participants and Sampling

This mixed-methods study involved two groups: teachers and students. Participants were selected to ensure a diverse and representative sample for the study.

Teachers: The population consisted of elementary and secondary school teachers using AI tools (e.g., BrainPOP) in their teaching practices. A sample of 100 teachers was selected through stratified random sampling, ensuring representation from different school levels (elementary and secondary) and varying years of teaching experience.

The stratified random sampling procedure and demographic characteristics of the teachers are presented in Table 1 and Table 2, respectively.

Students: The student population comprised elementary and secondary school students who had been exposed to AI tools (e.g., BrainPOP) in their learning. A sample of 200 students was recruited through convenience sampling from the classrooms of participating teachers.

The demographic characteristics of the student participants are outlined in Table 3.

These tables summarize the stratified random sampling procedure for selecting teacher participants and the demographic characteristics of both teacher and student participants. Although convenience sampling facilitated the recruitment of relevant student participants, it is important to note that the findings may not be entirely representative of the broader population due to the convenience sampling approach.

Table 1 - Stratified Random Sampling Procedure for Teachers.

Stratum	Category	Sample
School Level	Elementary	48%
	Secondary	52%
Years of Teaching Experience	< 5 years	25%
	5-10 years	35%
	11-15 years	20%
	> 15 years	20%

Table 2 - Demographic Characteristics of Teachers.

Characteristic	Category	Percentage
Gender	Female	60%
	Male	40%
Age	25-34 years	32%
	35-44 years	42%
	45-54 years	18%
	55+ years	8%

Table 3 - Demographic Characteristics of Students.

Characteristic	Category	Percentage
Gender	Female	52%
	Male	48%
Age	10-12 years	35%
	13-15 years	40%
	16-18 years	25%
School Level	Elementary	45%
	Secondary	55%

4.3 Measuring Instruments

This study utilized three adapted instruments to assess the integration of AI tools in teaching and research tasks, and their impact on students' research skills. The adaptations and measured constructs were informed by relevant frameworks and theories, including the Technological Pedagogical Content Knowledge (TPACK) Framework, Digital Competence Framework for Educators (DigCompEdu), Information Literacy Model, and Social Constructivism.

1. *Technology Integration Self-Assessment (TISA) Survey (Bersin, 2004)*: Adapted with a focus on AI tools integration, such as BrainPOP. The TPACK Framework and DigCompEdu informed the adaptation of items, emphasizing the interplay between technology, pedagogy, and content knowledge in the context of AI tools. Examples of items include:

- *"I can effectively integrate AI tools, such as BrainPOP, into my lesson plans".*
- *"I am confident in using AI tools to differentiate instruction for students with diverse needs".*

2. *Teacher Digital Competence (TDC) Scale (Rodríguez et al., 2021)*: Adjusted to focus on teachers' knowledge and skills in using AI platforms for research tasks. The adaptation was guided by the DigCompEdu and Social Constructivism, highlighting the importance of digital competencies and the role of social interactions in facilitating learning. Examples of items include:

- *"I am proficient in leveraging AI tools to guide students in developing well-structured research questions".*
- *"I am capable of guiding students in evaluating the credibility of sources found through AI tools".*

3. Student Research Skills Survey (SRSS) (Tzafilkou et al., 2022): Adapted to measure students' abilities in research skills when using AI tools. The adaptation was informed by the Information Literacy Model and Social Constructivism, emphasizing the essential research skills and the social aspects of learning. Examples of items are:

- *"I can develop focused research questions using AI tools like BrainPOP".*
- *"I can check if sources from AI platforms are trustworthy".*

Likert Scale Interpretation

All three measuring instruments employed in this study use a 5-point Likert scale. The scale ranges from 'Strongly Disagree' (1) to 'Strongly Agree' (5), with 'Disagree' (2), 'Neither Agree Nor Disagree' (3), and 'Agree' (4) as intermediate options. This scale is used to assess participants' level of agreement with the statements related to the use of AI tools in teaching and learning, research tasks, and students' research skills. Higher scores indicate a stronger agreement with the statements and, consequently, greater confidence, competence, or proficiency in the respective areas.

The complete list of items for each instrument can be found in Appendixes A, B, and C, which provide further insights into the specific statements and questions used in the study.

4.4 Assessment of Psychometric Properties

The original measurement instruments (TISA, TDC, and SRSS) have demonstrated satisfactory reliability and validity in previous research. In adapting these instruments for the study, the researchers carefully considered the content and structure of each instrument to maintain their strong foundations while addressing the context of AI tools in teaching and learning.

Reliability: To ensure internal consistency in the adapted instruments, the researchers reviewed and modified the items to align with the study's objectives and the target population of teachers and students. Cronbach's alpha coefficients were calculated to measure the internal consistency of each instrument. The alpha coefficients were 0.82 for TISA, 0.85 for TDC, and 0.88 for SRSS, indicating good to excellent reliability for each instrument.

Validity: The researchers evaluated the content validity of the adapted instruments by reviewing the relevance and representativeness of the items, as well as consulting with experts in the field. An exploratory factor analysis (EFA) was conducted to evaluate the underlying factor structure of the adapted instruments. The EFA results supported a three-factor structure for TISA, a two-factor structure for TDC, and a four-factor structure for SRSS. The factors accounted for 60% of the variance in the TISA data, 55% of the variance in the TDC data, and 65% of the variance in the SRSS data. Factor loadings ranged from 0.50 to 0.85 for TISA, 0.55 to 0.80 for TDC, and 0.60 to 0.90 for SRSS, further confirming the instruments' construct validity.

By carefully considering the content and structure of each instrument, calculating Cronbach's alpha coefficients, and conducting EFA, the researchers ensured the reliability and validity of the adapted TISA, TDC, and SRSS instruments for their study.

4.5 Data Collection and Classroom Observations

This study utilizes various data collection methods to gather information from both teachers and students, addressing the research objectives through a comprehensive approach. The methods and instruments used for each participant group are as follows.

Teachers

- *Surveys*: An adapted version of the DigCompEdu framework survey (Redecker, 2017) assesses six key areas of digital competence.
- *Interviews*: Semi-structured interview questions (Johnson et al., 2007) provide in-depth insights into AI tool usage, teacher-student interactions, and classroom implementation.

Students

- *Surveys*: A student research skills survey based on the Information Literacy Model (Kuhlthau, 2004) evaluates students' abilities in identifying, locating, evaluating, and using information.
- *Classroom Observations*: A classroom observation protocol (Raywid, 1995)focuses on AI tool usage, teacher-student interactions, and the development of students' research skills. This observational data provides valuable insights into the integration of AI tools and their impact on classroom dynamics.

To summarize the data collection methods and instruments used in this study, please refer to Table 4 (see Table 4). This holistic approach ensures a diverse and robust dataset, enabling a thorough examination of the relationship between AI tool usage, teacher digital competencies, and students' research skills development.

Table 4 - Data Collection Methods and Instruments.

Participant Group	Data Collection Method	Instrument
Teachers	Surveys	Adapted DigCompEdu framework survey (Redecker, 2017)
Teachers	Interviews	Semi-structured interview questions (Johnson et al., 2007)
Students	Surveys	Student research skills survey based on the Information Literacy Model (Kuhlthau, 2004)
Students	Classroom Observations	Classroom observation protocol (Raywid, 1995)

This table provides an overview of the various methods and instruments used to gather data from teachers and students, enabling a comprehensive analysis of AI tool usage, teacher digital competencies, and students' research skills development.

4.6 Data Analysis and Regression Results

Quantitative data was analyzed using descriptive and inferential statistics (Pallant, 2020). The authors conducted two regression analyses to investigate predictive relationships.

Model 1: *Reading Comprehension* - This regression analysis examined the effects of AI tool usage and teacher digital competencies on students' reading comprehension skills using data collected from teachers.

Model 2: *Research Skills* - Another regression analysis was performed to study the impact of AI tool usage and teacher digital competencies on students' research skills. Information literacy was used as a proxy for research skills and served as the dependent variable. This model used data collected from students.

Prior to both regression analyses, the following assumptions were assessed:

1. Normality: the Shapiro-Wilk test examined the normality of the dependent variable and residuals (Pallant, 2020).
2. Multicollinearity: tolerance values and the Variance Inflation Factor (VIF) evaluated multicollinearity among predictor variables (Tabachnick et al., 2019).
3. Autocorrelation: the Durbin-Watson test checked for autocorrelation in the residuals (Pallant, 2020).

Results from these assumption checks ensured that the data met the requirements for conducting regression analyses (Tabachnick et al., 2019).

For Model 2, the independent variables, AI tool usage and teacher digital competencies, demonstrated positive trends across the sample. The authors linked students' results with their teachers' profiles using unique teacher identifiers, allowing them to account for potential teacher influences on student research skills. The model's goodness of fit was evaluated using R-squared (R^2), adjusted R-squared (Adjusted R^2), and Akaike's Information Criterion (AIC). The model achieved an R^2 of 0.65 and an Adjusted R^2 of 0.62, indicating that the independent variables explained approximately 62% of the variance in students' research skills. The AIC value of 450.20 suggests that the model provides a relatively good fit to the data (Kline, 2023).

4.7 Ethical Considerations

In the conduct of this study, the principles of research ethics were adhered to, including the acquisition of informed consent from participants, maintenance of confidentiality and anonymity, and compliance with data protection regulations (Mertens et al., 2009). Prior to initiating data collection, the research design was reviewed and approved by the relevant institutional review board.

5. Results

The results section outlined the findings of the study, addressing the research questions concerning the relationship between AI tools, teacher digital competencies, and students' research skills. The data was presented in tables to enhance clarity and facilitate interpretation.

5.1 Research Question 1: What strategies do educators employ to integrate AI tools into their teaching practices, and how do these strategies support the development of students' research skills?

Research Question 1 inquired into the strategies teachers employ when incorporating AI tools into their teaching practices to bolster students' research skills. Table 5 served as the basis for the discussion of results and implications pertinent to this question.

Overview of results: Table 5 shows the frequency, mean, and standard deviation of various AI tool integration strategies in teaching practices. Teachers rated the extent to which they utilized each strategy on a 5-point Likert scale (1 = never, 5 = always). Most teachers reported encouraging independent use (M = 3.80, SD = 0.40), providing guided practice (M = 3.65, SD = 0.50), modeling AI tool use (M = 3.20, SD = 0.40), and facilitating collaboration (M = 3.10, SD = 0.35) to support students' research skills development.

Most commonly used strategies: Encouraging independent use and providing guided practice were the most frequently reported strategies, with means above the scale midpoint (M = 3). This suggests that teachers value hands-on experience and scaffolded support for students when learning to use AI tools for research purposes.

Implications for teaching practices: These findings highlight the importance of employing various integration strategies to accommodate diverse student needs and learning styles. By promoting independent use, guided practice, and collaboration, educators can create engaging and effective learning experiences that foster students' research skills development.

Relationship with Research Question 2: The response options provided for teachers to rate the AI tool integration strategies influenced the correlation coefficients calculated for Research Question 2 (Table 6). The Likert scale responses allowed teachers to indicate the frequency of using each strategy, capturing variability in their teaching practices and contributing to the observed relationships between AI tool integration strategies and teacher digital competencies.

Table 5 - AI Tool Integration Strategies in Teaching Practices.

Strategy	Frequency (%)	Mean	SD
Modeling AI tool use	65%	3.20	0.40
Providing guided practice	78%	3.65	0.50
Encouraging independent use	85%	3.80	0.40
Facilitating collaboration	60%	3.10	0.35

Table 6 - Correlation between Teacher Digital Competencies and AI Tool Integration.

Strategy	Professional Engagement	Teaching and Learning
Modeling AI tool use	0.56**	0.43*
Providing guided practice	0.61**	0.47*
Encouraging independent use	0.53**	0.39*
Facilitating collaboration	0.49**	0.36*

**p < 0.01, *p < 0.05

5.2 Research Question 2: How do teacher digital competencies influence the use of AI tools in teaching practices?

Research Question 2 probed the connection between teacher digital competencies and their utilization of AI tools within teaching practices. The discussion of results and implications for this question was based on Table 6.

Overview of results: Table 6 presents correlation coefficients between teacher digital competencies and AI tool integration strategies. The significant positive correlations indicate that various aspects of digital competencies, such as professional engagement and teaching/learning skills, are associated with the adoption of different AI tool integration strategies.

Strongest associations: The highest correlation coefficients are observed between the digital competency components (professional engagement and teaching/learning) and the AI tool integration strategies (providing guided practice and encouraging independent use). This suggests that teachers with strong digital competencies are more likely to employ strategies that provide hands-on experience and support for students in using AI tools.

Implications for teaching practices: These findings emphasize the importance of fostering digital competencies among teachers to promote the effective integration of AI tools in teaching practices. Teachers who are proficient in digital skills are better equipped to model AI tool use, provide guided practice, encourage independent use, and facilitate collaboration among students.

5.3 Research Question 3: To what extent do AI tools and teacher digital competencies influence students' development of research skills, such as information literacy, critical thinking, and problem-solving abilities?

Research Question 3 focused on the impact of AI tool usage and teacher digital competencies on the development of students' research skills. The discussion of results and implications pertaining to this question relied on the examination of two regression models presented in Table 7.

Model 1: Reading Comprehension - Although not directly related to research skills, Model 1 provides context by examining the effects of AI tool usage and teacher digital competencies on students' reading comprehension skills. This model helps understand the relationship between these factors and student outcomes in a broader context.

Model 2: Research Skills - This model specifically examines the impact of AI tool usage and teacher digital competencies on students' research skills, using data collected from students.

Overview of results: Table 7 displays the regression coefficients for both models. In Model 2, AI tool usage and teacher digital competencies are significant predictors of students' research skills, with positive relationships.

Table 7 - Regression Coefficients for Predictive Models.

Predictor	Model 1: Reading Comprehension	Model 2: Research Skills
AI tool usage	0.25 (SE = 0.07, β = 0.40*)	0.35 (SE = 0.09, β = 0.45\\)
Teacher digital competencies	0.20 (SE = 0.06, β = 0.30*)	0.28 (SE = 0.08, β = 0.35\\)

\p < 0.05, *p < 0.01

Strength and significance of relationships: The beta coefficients (β) in Model 2 indicate that AI tool usage ($\beta = 0.45$, $p < 0.01$) and teacher digital competencies ($\beta = 0.35$, $p < 0.01$) have moderate to strong positive relationships with students' research skills.

Implications for teaching practices: Findings from Model 2 suggest that the effective integration of AI tools in teaching practices and the development of teachers' digital competencies can positively influence students' research skills. Teachers who are more proficient in using AI tools and possess strong digital competencies are better equipped to support students in developing research skills.

5.4 Qualitative Findings

The qualitative findings from interviews and classroom observations provide a deeper understanding of the experiences and challenges associated with AI tool integration. Thematic analysis of this data uncovers common themes, such as the importance of professional development, technological infrastructure, and pedagogical support for effective AI tool integration in teaching practices. These themes may inform recommendations for educational practice and further research. Here are some sample quotes from interviews that reflect the experiences and perspectives of teachers regarding AI tool integration in teaching practices:

> Teacher 1: *"AI tools have become an essential part of my teaching practice, especially when it comes to enhancing students' research skills. I've seen significant improvements in their ability to locate and evaluate information"*.

> Teacher 2: *"Integrating AI tools can be challenging, especially if you're not familiar with the technology. I had to invest a lot of time in professional development to feel confident in using these tools effectively"*.

> Teacher 3: "*Collaboration among students has improved since we started using AI tools in the classroom. They're more engaged in the research process and are constantly learning from each other."*

> Teacher 4: *"While AI tools have numerous benefits, they can sometimes distract students from focusing on the content. It's crucial to strike a balance between technology use and traditional teaching methods"*.

> Teacher 5: "*My digital competencies have played a significant role in successfully integrating AI tools into my teaching practice. Understanding how to effectively use technology has made a real difference in my students' learning outcomes"*.

> Teacher 6: *"It's important to remember that AI tools are not a one-size-fits-all solution. We need to tailor our approach to meet the specific needs of our students and the subject matter we're teaching"*.

These quotes provide valuable insights into the experiences, challenges, and perspectives of teachers as they navigate the integration of AI tools in their teaching practices to support students' research skills development.

Here's a brief analysis and discussion of the main themes identified:

1. Perceived benefits of AI tool integration: The interviews reveal that teachers perceive improvements in students' research skills, collaboration, and engagement when AI tools are integrated into teaching practices. This supports the quantitative findings and highlights the potential advantages of AI tools for enhancing students' learning experiences.
2. Importance of professional development: Teachers emphasize the need for professional development to gain confidence and competence in using AI tools effectively. This underscores the significance of providing targeted training and support for educators to ensure successful AI tool integration.
3. Balancing technology use with traditional teaching methods: Teachers acknowledge that while AI tools can enhance teaching practices, they must be balanced with conventional approaches to minimize potential distractions and maintain focus on content. This highlights the importance of thoughtful and purposeful integration of AI tools in the classroom.
4. Tailoring AI tool integration: Teachers recognize the need to adapt AI tool integration strategies to meet the specific needs of students and subject matter. This suggests that educators must be flexible and responsive in their approach to AI tool integration.

The qualitative findings complement the quantitative results by offering a more nuanced understanding of the factors that influence AI tool integration in teaching practices. By considering both the quantitative and qualitative data, educational stakeholders can make informed decisions regarding professional development, technology integration, and pedagogical support to optimize the use of AI tools in enhancing students' research skills.

6. Discussion

6.1 Interpretating of Results and Implications

This study examined the connection between AI tools, teacher digital competencies, and students' research skills development, addressing three primary research questions. In the following discussion, each research question was addressed, emphasizing the study's contributions to the existing literature and tackling research gaps recognized in the literature review.

Research Question 1: What strategies do educators employ to integrate AI tools into their teaching practices, and how do these strategies support the development of students' research skills?

Our findings revealed that teachers employ diverse strategies for AI tool integration, including modeling AI tool use, providing guided practice, encouraging independent use, and facilitating collaboration. These strategies align with the recommendations of previous studies emphasizing the importance of diverse instructional strategies in leveraging AI tools to enhance students' research skills (Chiu et al., 2023).

This study revealed that the most commonly adopted strategies—encouraging independent use and providing guided practice—indicate the teachers' understanding of the importance of hands-on experience and structured support for students utilizing AI tools for research purposes. These findings contribute empirical evidence to the existing literature, enhancing the understanding of effective AI tool integration in teaching practices and mirroring previous research focused on nurturing students' research skills development (Chiu et al., 2023).

Research Question 2: How do teacher digital competencies impact the selection, implementation, and effectiveness of AI tools in teaching practices, particularly in the context of enhancing students' research skills?

The positive correlations between teacher digital competencies and AI tool integration strategies underscore the crucial role that teacher competencies play in the successful implementation of AI tools in classrooms. This finding corroborates the existing literature emphasizing the importance of teacher professional development in digital competencies (Adnan et al., 2024; Castañeda et al., 2022). This study extends this research by providing further evidence of the relationship between teacher digital competencies and AI tool integration, highlighting the need for continued investment in teacher professional development.

Research Question 3: To what extent do AI tools and teacher digital competencies influence students' development of research skills, such as information literacy, critical thinking, and problem-solving abilities?

The predictive model revealed that both AI tool usage and teacher digital competencies have moderate to strong positive relationships with students' research skills. These findings suggest that the effective integration of AI tools in teaching practices, combined with the development of teachers' digital competencies, can positively influence students' information literacy and research abilities.

The beta coefficients in the author's study indicated that AI tool usage ($\beta = 0.45$, $p < 0.01$) and teacher digital competencies ($\beta = 0.35$, $p < 0.01$) are significant predictors of students' research skills, emphasizing the importance of addressing both factors simultaneously to optimize student outcomes. This finding aligns with previous research highlighting the potential benefits of

AI tools in education (Bahroun et al., 2023) and the role of teacher digital competencies in promoting student learning outcomes (Wu et al. 2024).

This research extends previous studies by examining the combined effects of AI tools and teacher digital competencies on students' research skills. The implications of these findings for teaching practices emphasize the need for teachers to develop proficiency in using AI tools and possess strong digital competencies to better support students in developing their research skills. By addressing both factors, educators can create effective learning experiences that foster students' information literacy and research abilities in the digital age.

6.2 Limitations

While this study contributes valuable insights into the relationship between AI tools, teacher digital competencies, and students' research skills development, it has some limitations that should be acknowledged.

Limitation 1: The convenience sampling of students may limit the generalizability of the findings. The sample was drawn from a specific educational context, and the results may not be representative of broader student populations or other contexts.

Limitation 2: The study relied on self-reported measures of teacher digital competencies and AI tool integration strategies.

Limitation 3: The cross-sectional design of the study does not allow for causal inferences to be drawn regarding the relationships between teacher digital competencies, AI tool integration strategies, and students' research skills development.

Limitation 4: The study did not account for potential moderating factors, such as school contextual factors or individual student characteristics, which may influence the relationship between AI tools, teacher digital competencies, and students' research skills.

6.3 Future Research

The limitations of this study present opportunities for future research to further explore the relationship between AI tools, teacher digital competencies, and students' research skills development.

Future Research 1: To address the issue of convenience sampling, future studies should strive to employ more rigorous sampling techniques, such as stratified or random sampling, to enhance the representativeness of the sample and improve generalizability.

Future Research 2: To overcome the reliance on self-reported measures, future research could incorporate additional methods of assessment, such as direct observation or performance-based measures, to triangulate findings and gain a more comprehensive understanding of teacher digital competencies and AI tool integration strategies.

Future Research 3: To establish causal links between teacher digital competencies, AI tool integration strategies, and students' research skills development, future research should consider using longitudinal or experimental studies.

Future Research 4: To account for potential moderating factors, future studies should examine the influence of school contextual factors and individual student characteristics on the relationship between AI tools, teacher competencies, and student outcomes, thereby providing a more nuanced understanding of the interplay between these factors.

By pursuing these research directions and addressing the limitations of the current study, scholars can further advance our understanding of how to effectively leverage AI tools and teacher digital competencies to support students' research skills development and promote academic success in the digital age.

7. Conclusion

This mixed-methods study explored the relationship between AI tools, teacher digital competencies, and students' research skills development. Through a combination of quantitative and qualitative analyses, the study found that teachers employ diverse AI tool integration strategies and that teacher digital competencies play a crucial role in the effective use of AI tools in teaching practices. Moreover, the findings revealed that both AI tool usage and teacher digital competencies positively impact students' research skills development.

The study's findings contribute to the existing literature by providing a more comprehensive understanding of the interconnected roles of AI tools, teacher digital competencies, and students' research skills development. This research emphasizes the importance of diverse AI tool integration strategies, continued teacher professional development in digital competencies, and a systemic approach to leveraging AI tools and teacher competencies to enhance students' research skills.

Educational practitioners and policymakers can draw valuable insights from this study to inform their efforts in promoting effective AI tool integration and fostering digital competencies among teachers. By addressing the identified factors and implementing targeted interventions, educators can create learning environments that optimize the potential of AI tools to support students' research skills development and contribute to their overall academic success.

In conclusion, this study highlights the significance of understanding and addressing the interplay between AI tools, teacher digital competencies, and students' research skills development in contemporary educational settings. Future research should continue to build upon these findings by exploring additional factors, conducting longitudinal studies, and investigating potential differences across educational contexts to further advance our understanding of how to effectively integrate AI tools in teaching practices and promote students' digital literacy and research skills.

Acknowledgments

The researchers would like to express their gratitude to the participants who generously contributed their time and insights to this study. Without their cooperation, this research would not have been possible.

We also extend our appreciation to the research assistants who diligently supported data collection and analysis efforts. Their contributions have been invaluable in ensuring the success of this project.

This research has been supported by the Ministry of Higher Education through the Fundamental Research Grant Scheme (FRGS/1/2022/SSI07/UM/02/21), with Grant ID Number FP051-2022.

Conflict of Interest

The authors declare no conflicts of interest with respect to the authorship or the publication of this study. No financial or personal relationships with other individuals or organizations have influenced the conduct, analysis, or interpretation of the research findings. All efforts were made to ensure the objectivity and integrity of the research process. The authors declare that the research was conducted with objectivity and impartiality, and they remain committed to upholding the highest standards of ethical conduct in their scholarly work.

References

Adnan, M., Tondeur, J., Scherer, R., & Siddiq, F. (2024). Profiling teacher educators: ready to prepare the next generation for educational technology use? *Technology, Pedagogy and Education*, 1-18. https://doi.org/10.1080/1475939x.2024.2322481

Bahroun, Z., Anane, C., Ahmed, V., & Zacca, A. (2023). Transforming education: A comprehensive review of generative artificial intelligence in educational settings through bibliometric and content analysis. *Sustainability*, 15(17), 12983. https://doi.org/10.3390/su151712983

Barak, M., Ashkar, T., & Dori, Y. J. (2011). Learning science via animated movies: Its effect on students' thinking and motivation. *Computers & education*, 56(3), 839-846. https://doi.org/10.1016/j.compedu.2010.10.025

Barak, M., & Dori, Y. J. (2011). Science education in primary schools: is an animation worth a thousand pictures? *Journal of Science Education and Technology*, 20, 608-620. https://doi.org/10.1007/s10956-011-9315-2

Beardsley, M., Albó, L., Aragón, P., & Hernández□ Leo, D. (2021). Emergency education effects on teacher abilities and motivation to use digital technologies. *British Journal of Educational Technology*, 52(4), 1455-1477. https://doi.org/10.1111/bjet.13101

Behnamnia, N., Kamsin, A., Ismail, M. A. B., & Hayati, A. (2018). The main components of creativity in educational game: A case study. Emerging Technologies in Computing: First International Conference, iCETiC 2018, London, UK, August 23–24, 2018, Proceedings 1, https://doi.org/10.1007/978-3-319-95450-9_25

Bersin, J. (2004). The blended learning book: Best practices, proven methodologies, and lessons learned. San Francisco: Pfeiffer. https://doi.org/10.2514/6.2020-4136.vid

Canal, M. N., de las Mercedes de Obesso, M., & Rivera, C. A. P. (2024). Does educators' digital competence improve entrepreneurial students' learning outcomes? *International Entrepreneurship and Management Journal*, 1-24. https://doi.org/10.1007/s11365-023-00921-x

Castañeda, L., Esteve-Mon, F. M., Adell, J., & Prestridge, S. (2022). International insights about a holistic model of teaching competence for a digital era: the digital teacher framework reviewed. *European Journal of Teacher Education*, 45(4), 493-512. https://doi.org/10.1080/02619768.2021.1991304

Celik, I. (2023). Towards Intelligent-TPACK: An empirical study on teachers' professional knowledge to ethically integrate artificial intelligence (AI)-based tools into education. *Computers in human behavior*, 138, 107468. https://doi.org/10.1016/j.chb.2022.107468

Celik, I., Dindar, M., Muukkonen, H., & Järvelä, S. (2022). The promises and challenges of artificial intelligence for teachers: A systematic review of research. *TechTrends*, 66(4), 616-630. https://doi.org/10.1007/s11528-022-00715-y

Chalkiadaki, A. (2018). A systematic literature review of 21st century skills and competencies in primary education. *International Journal of Instruction*, 11(3), 1-16. https://doi.org/10.12973/iji.2018.1131a

Chen, C.-H., Shih, C.-C., & Law, V. (2020). The effects of competition in digital game-based learning (DGBL): a meta-analysis. Educational *Technology Research and Development*, 68(4), 1855-1873. https://doi.org/10.1007/s11423-020-09794-1

Chiu, T. K., Xia, Q., Zhou, X., Chai, C. S., & Cheng, M. (2023). Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, 4, 100118. https://doi.org/10.1016/j.caeai.2022.100118

Conrads, J., Rasmussen, M., Winters, N., Geniet, A., Langer, L., Redecker, C., Kampylis, P., Bacigalupo, M., & Punie, Y. (2017). Digital education policies in Europe and beyond. *JRC Science for policy report*. https://doi.org/10.21125/iceri.2016.1150

Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications. https://doi.org/10.7748/nr.12.1.82.s2

Dunn, T. J., & Kennedy, M. (2019). Technology Enhanced Learning in higher education; motivations, engagement and academic achievement. *Computers & education*, 137, 104-113. https://doi.org/10.1016/j.compedu.2019.04.004

Esteve-Mon, F., Llopis, M., & Adell-Segura, J. (2020). Digital competence and computational thinking of student teachers. *International Journal of Emerging Technologies in Learning (iJET)*, 15(2), 29-41. https://doi.org/10.3991/ijet.v15i02.11588

Fernández-Batanero, J. M., Montenegro-Rueda, M., Fernández-Cerero, J., & García-Martínez, I. (2022). Digital competences for teacher professional development. Systematic review. *European Journal of Teacher Education*, 45(4), 513-531. https://doi.org/10.1080/02619768.2020.1827389

Fernández, R. G., & Garrido, D. C. (2023). Challenges of social media in education: review and bibliometric analysis of scientific production to map trends and perspectives. *Innoeduca: international journal of technology and educational innovation*, 9(2), 51-67. https://doi.org/10.24310/innoeduca.2023.v9i2.16340

Galindo-Domínguez, H., & Bezanilla, M.-J. (2019). A systematic review of flipped classroom methodology at university level in Spain. Innoeduca. *International journal of technology and educational innovation*, 5(1), 81-90. https://doi.org/10.24310/innoeduca.2019.v5i1.4470

Giménez, F. J. P., & Porlán, I. G. (2017). Implementación y análisis de una experiencia de flipped classroom en Educación Musical. Innoeduca. *International journal of technology and educational innovation*, 3(1), 4-14. https://doi.org/10.24310/innoeduca.2017.v3i1.1964

Gong, Y. (2021). Application of virtual reality teaching method and artificial intelligence technology in digital media art creation. *Ecological Informatics*, 63, 101304. https://doi.org/10.1016/j.ecoinf.2021.101304

Guillén-Gámez, F. D., Ruiz-Palmero, J., & García, M. G. (2023). Digital competence of teachers in the use of ICT for research work: development of an instrument from a PLS-SEM approach. *Education and Information Technologies*, 28(12), 16509-16529. https://doi.org/10.1007/s10639-023-11895-2

Guillén-Gámez, F. D., Ruiz-Palmero, J., & Gómez-García, M. (2023). Digital competences in research: creativity and entrepreneurship as essential predictors for teacher training. *Journal of Computers in Education*, 1-20. https://doi.org/10.1007/s40692-023-00299-3

Guillén-Gámez, F. D., Gómez-García, M., & Ruiz-Palmero, J. (2024). Digital competence in research work: predictors that have an impact on it according to the type of university and gender of the Higher Education teacher:[Digital competence in research work: predictors that have an impact on it according to the type of university and gender of the Higher Education teacher]. Pixel-Bit. *Revista de Medios y Educación*, 69, 7-34. https://doi.org/10.12795/pixelbit.99992

Haşlaman, T., Atman Uslu, N., & Mumcu, F. (2024). Development and in-depth investigation of pre-service teachers' digital competencies based on DigCompEdu: a case study. *Quality & Quantity*, 58(1), 961-986. https://doi.org/10.1007/s11135-023-01674-z

Hayati, S., & Behnamnia, N. (2023). Exploring Game Behavior, Scaffolding, and Learning Mathematics in Digital Game-based Learning Apps on Children. *J Mod Educ Res*, 2(5). https://doi.org/10.53964/jmer.2023005

Heinz, J. (2016). Digital skills and the influence of students' socio-economic background. An exploratory study in German elementary schools. *Italian Journal of Sociology of Education*, 8, 186-212. https://doi.org/10.2307/2112747

Holmes, W., Bialik, M., & Fadel, C. (2023). Artificial intelligence in education. In Globethics Publications. https://doi.org/10.58863/20.500.12424/4276068

Ilomäki, L., Paavola, S., Lakkala, M., & Kantosalo, A. (2016). Digital competence–an emergent boundary concept for policy and educational research. *Education and Information Technologies*, 21, 655-679. https://doi.org/10.1007/s11135-023-01674-z

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of mixed methods research*, 1(2), 112-133. https://doi.org/10.1177/1558689806298224

Kirschner, P., & Selinger, M. (2003). The state of affairs of teacher education with respect to information and communications technology. *Technology, pedagogy and education*, 12(1), 5-17. https://doi.org/10.1080/14759390300200143

Kline, R. B. (2023). Principles and practice of structural equation modeling. Guilford publications. https://doi.org/10.1080/10705511.2012.687667

Kuhlthau, C. C. (2004). Seeking meaning: A process approach to library and information services (Vol. 2). Libraries Unlimited Westport, CT. https://doi.org/10.2307/40323160

Lai, J. W., & Cheong, K. H. (2022). Educational opportunities and challenges in augmented reality: *Featuring implementations in physics education*. IEEE Access, 10, 43143-43158. https://doi.org/10.1109/access.2022.3166478

Lawless, K. A., & Pellegrino, J. W. (2007). Professional development in integrating technology into teaching and learning: Knowns, unknowns, and ways to pursue better questions and answers. *Review of educational research*, 77(4), 575-614. https://doi.org/10.3102/0034654307309921

Liaw, S.-S., & Huang, H.-M. (2013). Perceived satisfaction, perceived usefulness and interactive learning environments as predictors to self-regulation in e-learning environments. *Computers & education*, 60(1), 14-24. https://doi.org/10.1016/j.compedu.2012.07.015

Liu, Y., Chen, L., & Yao, Z. (2022). The application of artificial intelligence assistant to deep learning in teachers' teaching and students' learning processes. *Frontiers in Psychology*, 13, 929175. https://doi.org/10.3389/fpsyg.2022.929175

Luckin, R., Cukurova, M., Kent, C., & du Boulay, B. (2022). Empowering educators to be AI-ready. *Computers and Education: Artificial Intelligence*, 3, 100076. https://doi.org/10.1016/j.caeai.2022.100076

Martínez, A. M. (2019). Aprendizaje móvil en Educación Física. Una propuesta de innovación en ESO. *Innoeduca. International journal of technology and educational innovation*, 5(2), 167-177. https://doi.org/10.24310/innoeduca.2019.v5i2.5082

Mertens, D. M., & Ginsberg, P. E. (2009). The handbook of social research ethics. Sage. https://doi.org/10.4135/9781483348971

Mikalef, P., & Gupta, M. (2021). Artificial intelligence capability: Conceptualization, measurement calibration, and empirical study on its impact on organizational creativity and firm performance. *Information & Management*, 58(3), 103434. https://doi.org/10.1016/j.im.2021.103434

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers college record*, 108(6), 1017-1054. https://doi.org/10.1177/016146810610800610

Najmeh, B. (2021). A STEM game based learning apps model to enhance creativity among preschoolers/Najmeh Behnamnia Universiti Malaya].

Napal Fraile, M., Peñalva-Vélez, A., & Mendióroz Lacambra, A. M. (2018). Development of digital competence in secondary education teachers' training. *Education Sciences*, 8(3), 104. https://doi.org/10.3390/educsci8030104

Ng, D. T. K., Leung, J. K. L., Su, J., Ng, R. C. W., & Chu, S. K. W. (2023). Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. *Educational Technology Research and Development*, 71(1), 137-161. https://doi.org/10.1007/s11423-023-10203-6

Oguguo, B., Ezechukwu, R., Nannim, F., & Offor, K. (2023). Analysis of teachers in the use of digital resources in online teaching and assessment in COVID times. *Innoeduca. International journal of technology and educational innovation*, 9(1), 81-96. https://doi.org/10.24310/innoeduca.2023.v9i1.15419

Pallant, J. (2020). SPSS survival manual: A step by step guide to data analysis using IBM SPSS. Routledge. https://doi.org/10.4324/9781003117407

Pettersson, F. (2018). On the issues of digital competence in educational contexts–a review of literature. *Education and Information Technologies*, 23(3), 1005-1021. https://doi.org/10.1007/s10639-017-9649-3

Raywid, M. A. (1995). Alternative schools: The state of the art. *Educational leadership*, 52(1), 26-31.

Redecker, C. (2017). European framework for the digital competence of educators: DigCompEdu. https://doi.org/10.46403/akulturavaltashatasaegyeni.2020.74

Rodríguez, M. U., Cantabrana, J. L. L., & Cervera, M. G. (2021). Validation of a tool for self-evaluating teacher digital competence. *Educación XXI*, 24(1), 353-373. https://doi.org/10.5944/educxx1.27080

Rosen, Y., Rushkin, I., Hubert, B., Hogan, M., & Dawood, M. (2022). Efficacy Research Report: The Effects of BrainPOP and BrainPOP Jr. on Learning Outcomes in Literacy, Math and Science.

Şimşek, A. S., & Ateş, H. (2022). The extended technology acceptance model for Web 2.0 technologies in teaching. *Innoeduca. International journal of technology and educational innovation*, 8(2), 165-183. https://doi.org/10.24310/innoeduca.2022.v8i2.15413

Suelves, D. M., Esteve, M. I. V., Chacón, J. P., & Alonso, Á. S. M. (2019). Competencia digital transversal en la formación del profesorado, análisis de una experiencia. *Innoeduca. International journal of technology and educational innovation*, 5(1), 4-12. https://doi.org/10.24310/innoeduca.2019.v5i1.4890

Tabachnick, B., & Fidell, L. (2019). Using multivariate statistics (7th Ed.). In: Boston: Allyn & Bacon/Pearson Education. https://doi.org/10.1207/s15328007sem0904_9

Tan, S. (2023). Harnessing Artificial Intelligence for innovation in education. In Learning intelligence: Innovative and digital transformative learning strategies: Cultural and social engineering perspectives (pp. 335-363). Springer. https://doi.org/10.1007/978-981-19-9201-8_8

Tzafilkou, K., Perifanou, M., & Economides, A. A. (2022). Development and validation of students' digital competence scale (SDiCoS). *International Journal of Educational Technology in Higher Education*, 19(1), 30. https://doi.org/10.1186/s41239-022-00330-0

Vygotsky, L. S., & Cole, M. (1978). Mind in society: Development of higher psychological processes. Harvard university press. https://doi.org/10.2307/j.ctvjf9vz4

Wu, R., & Yu, Z. (2024). Do AI chatbots improve students learning outcomes? Evidence from a meta-analysis. *British Journal of Educational Technology*, 55(1), 10-33. https://doi.org/10.1111/bjet.13334

Zhao, Y., Llorente, A. M. P., & Gómez, M. C. S. (2021). Digital competence in higher education research: A systematic literature review. *Computers & education*, 168, 104212. https://doi.org/10.1016/j.compedu.2021.104212

Zhu, Z.-T., Yu, M.-H., & Riezebos, P. (2016). A research framework of smart education. *Smart Learning Environments*, 3, 1-17. https://doi.org/10.1186/s40561-016-0026-2

Appendix A: Adapted Technology Integration Self-Assessment (TISA) Survey

Instructions: Please rate your level of agreement with each statement using the following scale:

1 - Strongly Disagree

2 - Disagree

3 - Neutral

4 - Agree

5 - Strongly Agree

Items:

1. I can effectively integrate AI tools, such as BrainPOP, into my lesson plans.
2. I am confident in using AI tools to differentiate instruction for students with diverse needs.
3. I support students in using AI tools to enhance their research skills.
4. I am competent in using AI tools to engage students in critical thinking activities.
5. I am aware of the potential benefits and challenges of using AI tools in the classroom.
6. I collaborate with colleagues to share best practices in using AI tools for teaching and learning.
7. I participate in professional development opportunities to improve my skills in using AI tools.
8. I encourage students to use AI tools to take ownership of their learning.
9. I can evaluate the effectiveness of AI tools in promoting student learning.
10. I am aware of ethical considerations when using AI tools in the classroom.
11. I can troubleshoot basic technical issues when using AI tools.
12. I provide guidance to students on responsible use of AI tools.
13. I adapt my teaching strategies to incorporate AI tools effectively.
14. I am familiar with a variety of AI tools relevant to my subject area.
15. I incorporate AI tools into assessment practices to provide timely feedback.
16. I model effective use of AI tools for students.
17. I foster a positive attitude towards using AI tools among my students.
18. I evaluate and select appropriate AI tools to support learning objectives.
19. I encourage students to provide feedback on their experiences using AI tools.
20. I am committed to continuous improvement in my use of AI tools for teaching and learning.

This adapted version of the Technology Integration Self-Assessment (TISA) survey was used in the study to assess teachers' self-perceived competencies in utilizing AI tools, such as BrainPOP, for teaching and learning.

Appendix B: Adapted Teacher Digital Competence (TDC) Scale

Instructions: Please rate your level of agreement with each statement using the following scale:

1 - Strongly Disagree

2 - Disagree

3 - Neutral

4 - Agree

5 - Strongly Agree

Items:

1. I can effectively use AI tools to support students in formulating research questions.
2. I am capable of guiding students in evaluating the credibility of sources found through AI tools.
3. I am proficient in using AI tools to promote critical thinking in research tasks.
4. I support students in effectively searching for information using AI tools.
5. I am knowledgeable about the features and capabilities of various AI tools for research.
6. I collaborate with colleagues to share strategies for using AI tools in research tasks.
7. I participate in professional development opportunities focused on using AI tools for research.
8. I encourage students to use AI tools to compare and contrast different sources of information.
9. I am skilled in using AI tools to analyze and interpret research data.
10. I model responsible use of AI tools for research purposes.
11. I provide guidance to students on managing digital information obtained through AI tools.
12. I adapt my teaching strategies to incorporate AI tools into research tasks.
13. I can troubleshoot basic technical issues when using AI tools for research.
14. I encourage students to use AI tools to synthesize information from multiple sources.
15. I am aware of ethical considerations when using AI tools for research purposes.

This adapted version of the Teacher Digital Competence (TDC) scale was used in the study to evaluate teachers' knowledge and skills in utilizing AI platforms, such as BrainPOP, for research tasks.

Appendix C: Adapted Student Research Skills Survey (SRSS)

Instructions: Please rate your level of agreement with each statement using the following scale:

1 - Strongly Disagree

2 - Disagree

3 - Neutral

4 - Agree

5 - Strongly Agree

Items:

1. I can develop focused research questions using AI tools like BrainPOP.
2. I can effectively evaluate the credibility of sources provided by AI platforms.
3. I can synthesize information from multiple sources found through AI tools.
4. I am competent in using AI tools to locate relevant sources for research tasks.
5. I am aware of the benefits and limitations of using AI tools for research.
6. I can organize information obtained from AI tools effectively.
7. I collaborate with peers to share research strategies using AI tools.
8. I participate in learning activities focused on developing research skills with AI tools.
9. I can analyze and interpret data obtained through AI tools.
10. I take responsibility for the ethical use of AI tools in research.
11. I can adapt my research strategies to incorporate AI tools efficiently.
12. I am familiar with various AI tools relevant to my research topics.
13. I can effectively use AI tools to support my understanding of complex concepts.
14. I seek guidance from teachers or peers when encountering challenges with AI tools.
15. I am committed to continuous improvement in my use of AI tools for research.
16. I evaluate and select appropriate AI tools to support my research objectives.
17. I can compare and contrast different sources of information obtained through AI tools.
18. I provide feedback on my experiences using AI tools for research purposes.
19. I can manage digital information obtained through AI tools efficiently.
20. I am aware of the importance of citing sources found through AI tools.

This adapted version of the Student Research Skills Survey (SRSS) was used in the study to assess students' abilities in various research skills when using AI tools, such as BrainPOP.

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 20, No. 3 (2024), pp. 56-70

Integration of digital resources in research work by Indian Higher Education teachers: PLS-SEM analysis

Sukhjit Singh, Pooja Singh[1], Vismaad Kaur, Parul Sood, Sangeeta Pant

Department of Education, Chitkara University, Punjab (India)

(submitted: 31/8/2024; accepted: 13/10/2024; published: 30/10/2024)

Abstract

The present study attempted to investigate the integration of digital resources in research work by Indian higher education teachers. The success of the digital resources in research can be affected by several factors, such as digital skills, digital flow, anxiety in the use of ICT, digital ethics, quality of digital resources and the behavioral intention to integrate ICT and the relationship between the factors. An online survey originally constructed by Guillén-Gámez et al. (2023) was used to collect data, and the final sample used for this study was 347 teachers of Universities in Punjab, India. Data analysis and hypotheses testing were done using partial least squares structural equations modeling (PLS-SEM). All the hypotheses are supported except hypothesis 10 implying that the quality of technological resources did not influence integration. The total of the factors corresponded to 65.6% of the variance in the integration of ICT in the research process. The results confirm that the model proposed by Guillén-Gámez et al. (2023) in the Spanish context, is effective in the Indian higher Education context in explaining the technological integration of teachers to use ICT in research work. The findings of this study open the possibilities for researchers in India to find out the reasons for the above results by conducting qualitative or mixed-method research in the context of the use of ICT in the Indian higher education landscape.

KEYWORDS: Digital Skills, Technology, Research Process, Higher Education, NEP 2020.

DOI
https://doi.org/10.20368/1971-8829/1136035

CITE AS
Singh, S.,Singh, P., Kaur, V., Sood, P., & Pant, S. (2024). Integration of Digital Resources in Research Work by Indian Higher Education Teachers: PLS-SEM Analysis. *Journal of e-Learning and Knowledge Society*, *20*(3), 56-70. https://doi.org/10.20368/1971-8829/1136035

1. Introduction

Digital competence is one of the main competencies that is much needed in the teachers of higher education institutes. This competency will contribute to a major shift toward the knowledge society that is envisioned by National Education Policy 2020. Digital competence refers to the knowledge, skills, and attitudes that a teacher must possess to maximize the use of technology. Ferrari (2013) defines digital competence as a collection of skills that enables one to use technology to assist us in our daily lives. It may be understood as the confident, critical, and responsible use of technology for work, entertainment, and education (European Commission, 2018; Kaur et al., 2022). To achieve SDGs (SDG-4, SDG-8, and SDG-9) in 2030, digital competence will be a driver in the context of higher education. Quality education along with decent work for economic growth is an aim that every higher education institution aims for. In this century, digital competence is a new kind of resource in the hands of teachers whether at the primary, secondary, or tertiary level.

Many studies have been conducted to map the digital competency of school teachers, but not much work has been done to identify the digital competency of teachers in higher education which is much needed at this level as well. Teachers need digital competency for integrating enhanced teaching methods and it also helps in enhancing the learner's experience. It further helps them to provide an enriched curriculum to the students in the form of academic papers, e- books.

A recent study conducted by Dong et al. (2024) highlighted the importance of digital competence of college lecturers on professional engagement, digital

[1] corresponding author – email: pooja.singh@chitkara.edu.in

resources, teaching and learning, assessment, empowering learners, and facilitating learners' digital competence to enhance student learning value.

Buils et al. (2024) concluded that for digital competence education, the most frequently identified areas are professional engagement, digital resources and teaching and learning. This study also highlighted the importance of digital training programs in Higher education institutes.

Based on the findings, the researchers advised instructors to receive technology and pedagogy training and institutions to fund infrastructure development.

The enhanced digital competency amongst higher education teachers opens many avenues for them to access online databases, conduct research, and collaborate globally through digital platforms. Canal et al. (2022) reported that the digital skills of professors have an impact on the learning of the students. The enhanced digital competency of the professors could also lead to changes in pedagogy and university management.

The idea of digital competency has drawn more attention within the past ten years. Technology is advancing so quickly that it has unavoidably impacted every industry, including education and research. In the present era, the internet and other digital technology have had a huge impact on us. Not only have technological trends transformed how we live, but they have also affected how we acquire knowledge (Zhao et al, 2021, Chitkara et al., 2020). Any university's primary missions are teaching and research, which is why they invest a lot of financial resources in hiring and developing the finest faculty members. In order to do this, university lecturers use the internet to obtain data for use in their research, teaching, and knowledge-production activities (Kanyengo & Smith, 2022). Academic staff members must be digitally competent in order to carry out their teaching and research duties effectively and efficiently.

Ferrari (2012) defined digital competence as

> *"the set of knowledge, skills, attitudes, abilities, strategies and awareness that are required when using ICT information and communication technologies and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning and socializing".*

The focus on digital competence continues to grow in higher education in the 21st century (Iansiti & Richards, 2020). Furthermore, the incorporation of these applications into the teaching-learning process would be highly advantageous for today's prospective educators, who are digital natives accustomed to using technology in daily life (Guillén-Gámez, Mayorga-Fernández, and Álvarez-García, 2018). To meet the recently enhanced teaching criteria, teachers also need to acquire associated skills and make adjustments to fit the new learning environment.

Guillén-Gámez et al (2021) examined and contrasted the usage of ICT resources to analyze and compare the digital proficiency of teaching staff in higher education when conducting research. Overall, the findings indicated that there were no appreciable variations in the teaching staff members' levels of digital competency between males and females. Significant variations were discovered in the following domains- ICT anxiety, digital skills, digital ethics, quality of ICT resources, and intention to use ICT. The aforementioned results underscore the necessity for academic institutions to put forth training programs aimed at enhancing the digital competencies of their faculty and research personnel in the areas where deficiencies have been identified.

Gámez, Palmero and García (2023) showed that although instructors had appropriate digital research skills, this could vary depending on transversal skills such as creativity and entrepreneurship, with significant disparities when these skills were at the basic level. Furthermore, whether teachers have research expertise in technology, cryptocurrencies, face identification systems, wearables, or robots, among other topics, this has a substantial impact on their level of digital competence in research.

Aliyu, Adamu & Umar (2024) investigated the influence of digital competence in teaching and research of the academic staff of Modibbo Adama University, Yola, Nigeria. The results of the study revealed, among other things, that the academic staff of Modibbo Adama University, Yola, Nigeria had a high level of digital competence, which highly influenced their teaching and research activities.

As a result of the existence of technology in the field of research, there is an urgent need for faculty at the higher education level to possess conceptual, procedural, and attitudinal abilities in order to initiate research (Guzman & Nussbaum, 2009). At the same time, they must have the digital expertise needed to integrate digital resources, search for and understand information more efficiently, and compile and share scientific knowledge (Guillén-Gámez et al., 2020).

The digital skills of professors in universities have been researched a lot over the last several decades (Oguguo et al., 2023; Şimşek & Ateş, 2022), with a skill level ranging from basic to intermediate (Cabero-Almenara et al., 2021; Santos et al., 2021). However, while studies on research skills have been published, yielding average results (Abykenova et al., 2016; Rubio et al., 2018), most studies have focused on Masters students and very less on university teachers.

Furthermore, the scientific literature that focuses on the interconnections between digital capabilities and research activities is less, where ICT is rarely employed to increase research skills, demonstrating basic levels (Robelo et al., 2018; Sánchez & Bucheli, 2020). Therefore, the present study bridges the gap by providing the results of the linkage of digital integration and research in the context of Indian higher education.

2. Theoretical Framework

The present study has used the theoretical framework proposed by Guillén-Gámez et al. (2023). The following section explores the factors that influence teachers' digital competence and how all of these factors interact with one another.

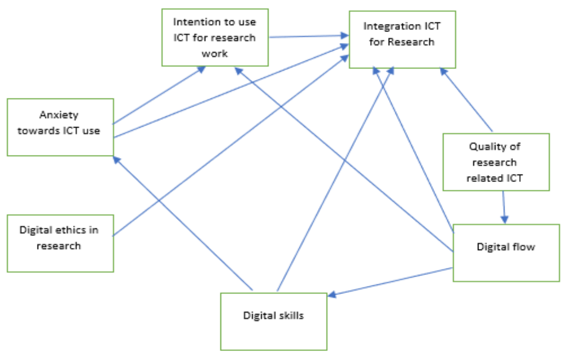

Figure 1 - Theoretical Framework by Guillén-Gámez et al. (2023).

Integration of ICT in Research

Pandey and Pandey (2020) observed that the use of ICT in developing countries like India is on the lesser side as compared to developed countries. According to Mittal (2010), there are disparities in the levels of ICT readiness and use, and this could further cause disparities in the level of productivity which would influence a country's rate of economic growth. Studies have highlighted the role of intentions in predicting ICT integration behaviors (Anderson & Maninger, 2007; Venkatesh et al., 2003; Shiue, 2007). For example, research with 242 Taiwanese science teachers showed that the intention to use ICT strongly predicts its actual use (Shiue, 2007). While intention does not always result in behavior, it is a reliable predictor (Banas & York, 2014). In Czerniak et al. (1999), teachers' intentions explained 18-24% of the variance in actual ICT use. The likelihood of ICT integration increases with stronger intentions (Olugbara & Letseka, 2020). However, teachers are hesitant to use technology if it is subpar (Shiue, 2007), highlighting the need for quality digital resources.

Intention to use ICT for research

Higher education institutions all over the world have increasingly adopted ICT not just for teaching and learning, but also for curriculum development and research. To use technology effectively, teachers must be willing to accept and use it. Sharma and Srivastava (2020) carried out a study in the management institutions in Bengaluru, Pune, Indore, and Delhi to measure the teachers' intention to use technology. The results of the study confirm a significant positive impact of value beliefs, social influence, and perceived ease of use on the behavioral intention to use technology by teachers.

Quality of ICT Resources

Various external factors can significantly affect the integration of ICT in teaching, such as access to the Internet (Lin et al., 2012), available software and hardware (Gil-Flores et al., 2017), and the availability of technical and training support (Lawrence & Tar, 2018). The quality of the resources available in the universities and colleges in India and their easy accessibility to the teachers can help them utilize them for research purposes.

Digital Flow in Research Work

The concept of the flow state was introduced by Csikszentmihalyi in 1975, and it is characterized by a combination of enjoyment and intrinsic interest, with enhanced focus on the task (Davis & Csikszentmihalyi,1977) People experiencing flow are so immersed in a task that they enjoy it completely. If someone gets into the flow state while using ICT, they can start enjoying it and utilizing it effectively. Hoffman and Novak (1996) say that the more individuals experience a flow state, the more likely they are to have higher intentions to use ICT in the future, leading to increased technology use (Ahmad & Abdulkarim, 2019; Kim & Jang, 2015). There has been some research on the concept of flow while using ICT (Sharafi et al, 2006; Rodriguez-Sanchez et al, 2008).

Digital Skills for Research Work

According to DPsouza (2022), India's National Education Policy (NEP) 2020 has proposed many changes in the mainstream education system. Therefore, it is necessary to help the HEI teachers through various initiatives to enhance their technological-pedagogical-content knowledge and help them become more competent in using innovative methods such as inquiry- and problem-based learning effectively, in online, offline, and blended modes. Technological and digital skills include finding, managing, analyzing information, and communicating results. Research skills are defined as the ability to use the scientific method to address and solve problems

(Pérez & López, 1999), utilizing ICT in the process (Hassani, 2015; Murnane & Levy, 1996). Effective use of ICT enables individuals to search for information, manage data, and communicate effectively (García et al., 2018). Proficiency in ICT is crucial for its integration, potentially reducing negative emotions (anxiety) towards its use (Revilla et al., 2017). The European Commission (2006) proposed digital competence as one of the key competencies for lifelong learning and it considers it as one of the key competencies for life (Zvereva, 2023).

Digital ethics in research process

Ethics involves the principles that govern behavior within a community (Dewey, 2008). The rise of digital culture presents ethical challenges for the scientific community (Luke, 2018). Researchers must be knowledgeable about ethical principles (Sanjuanelo et al., 2007) and practice good ICT use (Dominighini & Cataldi, 2017; Stahl et al., 2014). Ethical awareness can promote innovative ICT practices (Stahl et al., 2017). Zvereva (2023) discusses how, in the current scenario, it is important that the relevance of the development of the digital educational environment, the issue of developing ethical regulatory mechanisms in the digital space, revising traditional ethical approaches to assessing the situation and forming new digital educational ethics, be studied.

Anxiety in using ICT for research

Various researchers have categorized attitudes towards ICT into anxiety or stress (Loyd & Gressard, 1984; Yildirim, 2000; Téllez et al., 2022), and it has been defined as a person's reluctance or negative feelings when required to incorporate ICT into their professional activities (Simonson et al., 1987). According to a literature review conducted by Fernández-Batanero et al. (2021), it was found that teachers experience a lot of stress and anxiety related to educational technology, and this stress has only increased over time. A study conducted on 200 university teachers by Mehra and Far (2015) studied their attitudes towards ICT use at different levels of computer anxiety. The study found that teachers with low, moderate, and high computer anxiety exhibited differences in their attitudes toward Information and Communication Technology use. Teachers with low computer anxiety exhibited better attitudes towards Information and Communication Technology use as compared to those with moderate and high levels of computer anxiety.

3. Methodology

3.1 Design and Participants

A non-experimental quantitative survey-type methodology was used. A non-probabilistic purposive sampling was used, collecting a total of 390 responses from Higher Education Teachers of Punjab, India. Out of 390, only 347 responses were selected for further analysis. The sample consisted of 347 Higher education teachers, where 53.6% (n = 186) were female while 46.40% (n = 161) were male teachers. In terms of experience, 19% (n = 66) teachers have 0-5 years of experience, 25.6% (n = 89) teachers have 5-10 years of experience and 55.3% (n = 192) teachers have more than 10 years of experience. In terms of Faculty/Area of Knowledge, 21% (n = 73) teachers belong to Humanities, 36.6% (n = 127) teachers belong to Sciences/Engineering/Medical, 42.4% (n = 147) teachers belong to Social Sciences. Before the teachers filled in the online questionnaire, they have been informed about the purpose of the study. The data collection was carried out anonymously through a form without recording any personal details of Teachers to ensure the confidentiality of teachers.

3.2 Instrument

In this study an instrument developed by Guillén-Gámez et al. (2023) was used to collect data related to use of ICT in research among teachers of Higher Education Institutions. The original instrument composed of 40 questions on 7-point Likert scale. Table 1 shows the items of each dimension together with their corresponding code.

3.3 Data analysis and procedures

This study used PLS-SEM (Partial Least Square – Structural Equation model) for the analysis of the data collected under the purposed model by using Smart PLS software. As this study had two purposes in consideration i.e. testing of theoretical model constructed by Guillén-Gámez et al. (2023) and predicting the model in Indian Higher education context, the use of non-probabilistic purposive sampling with a complex structural model makes a good case for using PLS-SEM for data analysis (Hair et al., 2019).

Following steps were followed during analysis.

For Measurement Model: As per the guidelines given by Hair et al. (2019) for measurement model, Internal consistency (Cronbach alpha value >0.7), Convergent Validity (AVE value greater that 0.50). Discriminant validity (criteria of Fornell-Larcker, Heterotrait-Monotrait correlations (HTMT) and cross-loadings need to be part of reporting.

For Structural Model: Bootstrapping procedure was followed with 10000 samples. Reporting of R square (for explaining the variance in the endogenous variable explained by exogenous variable as per purposed model), t value along p values was done for hypotheses testing. Reporting of effect size (f square) was done with hypotheses testing. Q square values were reported to check the predictive relevance of model (Hair et al., 2019).

Table 1 - Instrument Information Dimension wise and Item Description (adapted from Guillén-Gámez et al. (2023).

Instrument Information Dimension wise and Item Description (adapted from Guillén-Gámez et al. (2023) original paper "Digital competence of teachers in the use of ICT for research work: development of an instrument from a PLS- SEM approach")

DIM.	Code	Scale information	Description
DIM. 1. Digital skills to search for information, manage it, analyze it and communicate results	D1_1	value 1 (I am notable to) to value 7 (I am able to)	I know how to use software for the analysis of qualitative data (Atlas.ti, Nvivo, Ethnograph, Hyperresearch, Maxqda, QDA MINER, NUD*IST)
	D1_2		I know how to use audio and video editors to create and edit collected information through interviews, focal groups, etc. (Adobe Premiere, iMovie, Windows Movie Maker, Audacity)
	D1_3		I have abilities necessary for analysing quantitative data (SPSS, EXCEL, JAMOVI, AMOS, R, Minitab)
	D1_4		I know how to search in scientific data bases (ScienceDirect, ProQuest, PsycINFO, Redalyc.org, Scielo, Academia.edu…)
	D1_5		I know how to use Boolean operators (AND, NOT, OR, XOR) to refine my searches for scientific articles
	D1_6		I have the skills to use bibliographical managers (Mendeley Zotero Endnote, Refworks) those which allow me to store bibliographic references and use such references in my studies following different citation rules
	D1_7		I have abilities in managing my scientific social media, add my published studies and/or consult their reading statistics
	D1_8		I usually use scientific social media to interact with other investigators.
DIM. 2. Digital ethics in digital research	D2_9	value 1 (I never do it) to value 7 (I do it frequently)	I apply the rules of copyright when I share the results of my studies through scientific social media
	D2_10		Before sending a study for its' publication, I digitally check it and apply the publication rules employed in every editorial/journal (APA v.7; Chicago, Harvard…)
	D2_11		I check the original source, and the results of a study referenced by other authors in their original publications.
	D2_12		I check that the bibliography selected for my study comes from journals with a certain grade of scientific prestige (for example, that they use paired revision "double look")
	D2_13		I check that in my studies there is no self-plagiarism or plagiarism of other studies
DIM. 3. Digital flow in research work	D3_26	value 1 (Totally disagree) to value 7 (Totally agree)	I find it gratifying to use ICT resources in my investigation works
	D3_27		I find it enjoyable to use software for the analysis of data both quantitative (SPSS, JAMOVI, R…) and qualitative, Atlas.ti, Nvivo…) to complete my research
	D3_28		I am motivated by the thought that by using digital software for data design and analysis I can more easily publish my scientific achievements in high-impact journals
	D3_29		I like to learn new digital resources that are going to allow me to analyse data and/or communicate the results in some software afterwards
DIM. 4. Anxiety towards the use of ICT resources for research	D4_30	value 1 (Totally disagree) to value 7 (Totally agree)	*It overwhelms me to think that I have to learn to use digital resources to collect data and analyse it with some software afterwards
	D4_31		*It makes me anxious to have to be constantly checking the impact indexes of the journals for if the quartile has increased or decreased
	D4_32		* I get tired of having to constantly use ICTs to position and share my scientific publications and improve my digital reputation through the h-index and/ or the i-index10
	D4_33		* I get nervous when I have to teach a colleague and/or student some ICT resource related to research (Mendeley, SPSS, AMOS, Google form, Atlas. ti…)
	D4_35		*In general, I would prefer not to have to learn or use ICT resources for my research

(continue...)

Instrument Information Dimension wise and Item Description (adapted from Guillén-Gámez et al. (2023) original paper "Digital competence of teachers in the use of ICT for research work: development of an instrument from a PLS- SEM approach")

DIM.	Code	Scale information	Description
DIM. 5. Quality of research-related ICT resources	D5_22	value 1 (It is poor) to value 7 (It is excellent)	My place of work had a good internet connection
	D5_23		My department or my investigation group buys ICT resource licenses that require an additional page
	D5_24		Mi department or my investigation group provides me with all the ICT resources I require for my investigations
	D5_25		My department or investigation group has strong devices (pc/laptops) available so that the technological resources function smoothly and quickly
DIM. 6. Intention to use ICTs for research work	D6_35	value 1 (Totally disagree) to value 7 (Totally agree)	Assuming my educational institution provides me with ICT resources for research work, I intend to use them at some point in time
	D6_36		If the institution to which I belong does not provide me with a certain ICT resource that I require for my research, I am responsible for obtaining it
	D6_37		In the near future, I plan to continue learning how to use ICT resources to expand my research work
	D6_38		I intend to further develop my training in the use of online scientific data- bases for my research
	D6_39		I intend to continue to use and/or use bibliographic managers for my future studies
	D6_40		I want to improve my use of social networks to transfer my research and interact with other researchers
DIM. 7. Inte-gration ICT resources for research	D7_14	value 1 (I never do it) to value 7 (I do it frequently)	I use anti-plagiarism programs (Plagium, Viper, Article checker, Turnitin, Compilatio, etc.)
	D7_15		I use bibliographic managers
	D7_16		I use social media to circulate my scientific publications
	D7_17		I use scientific databases for access to read other studies
	D7_18		I use web search engines to consult bibliographies (Google academic / Google scholar)
	D7_19		I use video conference systems to have meetings with my investigation group
	D7_20		I use Google + collaboratives to host my research data
	D7_21		I use data analysis programs (be it quantitative and/or qualitative)
Note: Items with * in their name have an inverse score			

4. Results

4.1 Measurement model

D1-5, D6-36, D7-14, D7-18 items were deleted on the basis of outer loadings with value less than 0.7 (Vinzi et al., 2010). D6-37, D6-38, D2-12, item were deleted based on VIF >5.

Convergent Validity

Table 2 illustrates the Average Variance Extracted (AVE) coefficients for the instrument's factors, demonstrating convergent validity. The AVE values for each factor exceed 0.50, indicating that over 50% of the variance in the teachers' scores can be attributed to their respective indicators. Consequently, the AVE coefficients for the model factors, ranging from 0.60 to 0.79, confirm an adequate level of convergent validity along with respective Cronbach alpha values greater than 0.7 (Wasko and Faraj, 2005).

Discriminant Validity

The discriminant validity was assessed using the Fornell-Larcker (Fornell & Larcker,1981) criteria, which measures the extent to which one construct differs from other constructs in the model along with HTMT ratio. As per the values given in the Table 3, all values are below than 0.90 for HTMT (Henseler et al., 2015), the Table 4 shows that the square root of AVE (diagonal values in italics), for the construct was greater than the inter-construct correlation. Hence, discriminant validity is established.

4.2 Structural model and Hypotheses testing

Following the assessment of the measurement model, the next step was taken for evaluation of structural path for the evaluation of path coefficients (relationships amongst study constructs) and their statistical significance (Table 5).

Table 2 - Loadings, Reliability, Convergent Validity.

DIMENSIONS	ITEMS	Outer loadings	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
D1 - SKILLS	D1-1 <- D1	0.741	0.892	0.896	0.609
	D1-2 <- D1	0.788			
	D1-3 <- D1	0.741			
	D1-4 <- D1	0.705			
	D1-6 <- D1	0.811			
	D1-7 <- D1	0.802			
	D1-8 <- D1	0.865			
D2 – ETHICS	D2-10 <- D2	0.906	0.895	0.905	0.76
	D2-11 <- D2	0.913			
	D2-13 <- D2	0.845			
	D2-9 <- D2	0.819			
D3- FLOW	D3-26 <- D3	0.887	0.879	0.884	0.738
	D3-27 <- D3	0.747			
	D3-28 <- D3	0.923			
	D3-29 <- D3	0.867			
D4- ANXIETY	D4-30 <- D4	0.701	0.837	0.853	0.606
	D4-31 <- D4	0.856			
	D4-32 <- D4	0.749			
	D4-33 <- D4	0.824			
	D4-34 <- D4	0.752			
D5- QUALITY	D5-22 <- D5	0.814	0.913	0.916	0.794
	D5-23 <- D5	0.911			
	D5-24 <- D5	0.899			
	D5-25 <- D5	0.936			
D6- INTENTION	D6-35 <- D6	0.83	0.815	0.819	0.729
	D6-39 <- D6	0.869			
	D6-40 <- D6	0.861			
D7- INTEGRATION	D7-15 <- D7	0.733	0.902	0.904	0.672
	D7-16 <- D7	0.829			
	D7-17 <- D7	0.865			
	D7-19 <- D7	0.862			
	D7-20 <- D7	0.817			
	D7-21 <- D7	0.806			

Table 3 - HTMT (Heterotrait-monotrait Ratio of Correlations) ratio.

	D1	D2	D3	D4	D5	D6	D7
D1 - SKILLS							
D2 – ETHICS	0.551						
D3- FLOW	0.592	0.716					
D4- ANXIETY	0.254	0.499	0.467				
D5- QUALITY	0.512	0.638	0.638	0.401			
D6- INTENTION	0.468	0.724	0.814	0.542	0.429		
D7- INTEGRATION	0.824	0.685	0.685	0.4	0.555	0.538	

Table 4 - Fornell-Larcker Criteria.

	D1	D2	D3	D4	D5	D6	D7
D1 - SKILLS	*0.781*						
D2 - ETHICS	0.503	*0.872*					
D3- FLOW	0.526	0.641	*0.859*				
D4- ANXIETY	0.216	0.43	0.416	*0.778*			
D5- QUALITY	0.464	0.577	0.576	0.35	*0.891*		
D6- INTENTION	0.407	0.622	0.744	0.466	0.382	*0.854*	
D7- INTEGRATION	0.742	0.625	0.61	0.358	0.504	0.464	*0.82*

Table 5 - Hypotheses Results.

Hypotheses		Beta values	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Result	5.00%	95.00%	f-square
H1	**SKILLS -> ANXIETY**	0.216	0.218	0.057	3.805	0	Supported	0.118	0.305	**0.049**
H2	**SKILLS -> INTEGRATION**	0.529	0.531	0.046	11.459	0	Supported	0.446	0.6	**0.542**
H3	**ETHICS -> INTEGRATION**	0.248	0.248	0.05	4.934	0	Supported	0.168	0.335	**0.081**
H4	**FLOW -> SKILLS**	0.526	0.528	0.036	14.592	0	Supported	0.462	0.581	**0.383**
H5	**FLOW -> INTENTION**	0.665	0.664	0.045	14.816	0	Supported	0.589	0.736	**0.877**
H6	**FLOW -> INTEGRATION**	0.212	0.211	0.06	3.528	0	Supported	0.114	0.311	**0.043**
H7	**ANXIETY -> INTENTION**	0.189	0.191	0.055	3.438	0	Supported	0.098	0.28	**0.071**
H8	**ANXIETY -> INTEGRATION**	0.099	0.104	0.038	2.612	0.005	Supported	0.037	0.161	**0.021**
H9	**QUALITY -> FLOW**	0.576	0.578	0.032	18.124	0	Supported	0.521	0.624	**0.495**
H10	**QUALITY -> INTEGRATION**	0	0	0.037	0	0.5	Not Supported	-0.061	0.059	**0**
H11	**INTENTION -> INTEGRATION**	-0.11	-0.114	0.055	1.975	0.024	Supported	-0.199	-0.02	**0.013**

The results of the structural model using PLS-SEM indicate the following.

H1 (SKILLS -> ANXIETY) evaluates whether researcher's digital skills in the use of specific digital resources specific to the research area have a significantly and positively relationship with the level of anxiety that they can feel when using them. The path coefficient (Beta value) is 0.216, with a t-statistic of 3.805 ($p < 0.001$), indicating strong and positive relationship, with a small effect size ($f^2 = 0.049$).

H2 (SKILLS -> INTEGRATION): H2 evaluates whether the researcher's digital skills and their subsequent integration of ICT into research process. The path coefficient is 0.529, with a t-statistic of 11.459 ($p < 0.001$), indicating strong support. This implies that enhanced digital skills significantly contribute to integration of ICT in research process, with a large effect size ($f^2 = 0.542$).

H3 (ETHICS -> INTEGRATION) evaluates whether digital ethical standards had a significant effect on the integration of ICT resources in the research process. The path coefficient is 0.248, with a t-statistic of 4.934 ($p < 0.001$), indicating strong support. Ethics positively affect integration, with a moderate effect size ($f^2 = 0.081$).

H4 (FLOW -> SKILLS): evaluates whether Digital flow in research work significantly affects the digital skills. The path coefficient is 0.526, with a t-statistic of 14.592 ($p < 0.001$), indicating strong support. Flow significantly enhances Digital skills to search for information, manage it, analyze it and communicate results, with a large effect size ($f^2 = 0.383$).

H5 (FLOW -> INTENTION) evaluates whether the researcher's flow state on using digital resources in research tasks has a significant relationship with intention of using these resources in the research process. The path coefficient is 0.665, with a t-statistic of 14.816 ($p < 0.001$), indicating strong support. Flow greatly influences intention, with a very large effect size ($f^2 = 0.877$).

H6 (FLOW -> INTEGRATION) evaluates whether the researcher's flow state on using digital resources in research tasks has a significant relationship with, integration into this process. The path coefficient is 0.212, with a t-statistic of 3.528 ($p < 0.001$), indicating strong support. Flow positively affects integration, with a small effect size ($f^2 = 0.043$).

H7 (ANXIETY -> INTENTION) evaluates whether the researcher's state of anxiety about the use of specific digital resources used in the research process has an impact on the behavioral intention to use these resources. The path coefficient is 0.189, with a t-statistic of 3.438 ($p < 0.001$), indicating strong support. Anxiety significantly influences intention but with a small effect size ($f^2 = 0.071$).

H8 (ANXIETY -> INTEGRATION) evaluates whether the researcher's state of anxiety about the use of specific digital resources used in the research process has an impact on the integration itself in the research process. The path coefficient is 0.099, with a t-statistic of 2.612 ($p = 0.005$), indicating support. Anxiety has a positive, albeit very small, effect on integration ($f^2 = 0.021$).

H9 (QUALITY -> FLOW) evaluates whether the significant relationships between the quality of the techno- logical resources and the state of flow of the researcher exists. The path coefficient is 0.576, with a t-statistic of 18.124 ($p < 0.001$), indicating strong support. Quality significantly enhances flow, with a large effect size ($f^2 = 0.495$).

H10 (QUALITY -> INTEGRATION): the significant relationships between the quality of the techno- logical resources and the integration. The path coefficient is 0.000, with a t-statistic of 0.000 ($p = 0.500$), indicating no support. Quality does not influence integration ($f^2 = 0.000$).

H11 (INTENTION -> INTEGRATION): This hypothesis determines whether the behavioral intention of the researcher regarding the use of ICT in the research process significantly affects the subsequent integration in the research process. The path coefficient is -0.110, with a t-statistic of 1.975 ($p = 0.024$), indicating support but Intention has a negative effect on integration, though the effect size is small ($f^2 = 0.013$).

These results suggest that the constructs of skills, ethics, flow, and anxiety significantly influence integration and intention, with varying degrees of effect sizes. Quality notably impacts flow, but not integration. Intention has a negative influence on integration.

Figure 2 observes that the underlying factors included in the model explain 65.60% of the integration variable variance; the 58% of the intention factor variance is explained by factors anxiety and flow; the quality factor explains 32.9 % of the flow factor variance; the 27.5% of the digital skills factor variance is explained by the flow factor; and finally, the 4.4% of the anxiety variable variance is explained by the digital skills factor.

As the Q^2 value is >0 for each construct, the given model has a predictive relevance. According to Hair et al. (2014), if Q is 0.02 (weak predictive relevance), .15 (moderate predictive relevance), .35 (strong predictive relevance), hence predictive relevance was established.

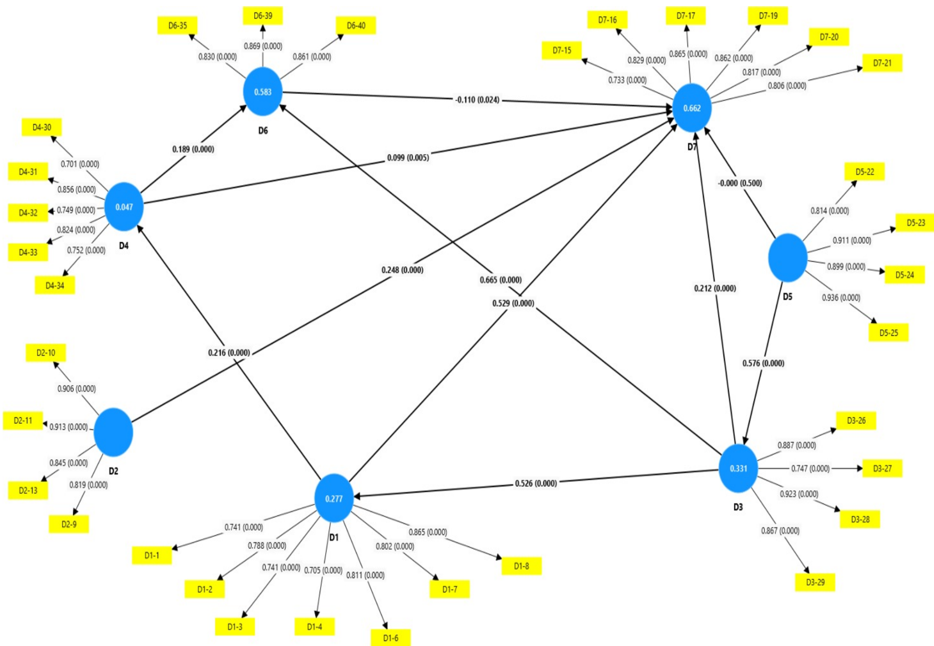

Figure 2 - Structural Model for Hypotheses Results.

Table 6 - Q²predict values.

Endogenous constructs	Q²predict	Degree of Predictive relevance
D1 - SKILLS	0.186	Moderate
D3- FLOW	0.325	Strong
D4- ANXIETY	0.04	Weak
D6- INTENTION	0.143	Moderate
D7-INTEGRATION	0.361	Strong

5. Discussion

The main purpose of this study was to investigate the impact of the integration of digital resources by Higher Education teachers in the research process. For this, an instrument prepared by Guillén-Gámez et al. (2023) was used to collect the data. The rapidly changing world today requires the integration of ICT resources in higher education. It is very important that higher education teachers use ICT to enhance their research capabilities. If they have good knowledge of ICT resources, it will be easy for them to use various digital tools to help them in academic inquiry. ICT helps them use data analysis software, to share findings, to connect on projects across the globe, use tools for plagiarism checking, for reference management, etc.

If we discuss H1, the present study supports it. However, the results stand in contrast to those reported by Guillén-Gámez et al. (2023). Also, it also contrasts with research conducted by Revilla et al. (2017) who assert that the continuous application of digital skills by educators is a critical factor in reducing negative attitudes related to using ICT; greater the skill and ease of using ICT, less the stress and anxiety related to ICT usage. These findings suggest that further investigation of the results is required to find the cause behind this. The probable causes for the significant positive relationship between digital skills and anxiety in Indian Higher Education Institutes might include inadequate digital infrastructure, insufficient training, resistance to technological change, constant pressure by academic institutes to publish research papers (Kmetz,2019), and the pressure to adapt quickly to digital tools. These factors can elevate anxiety levels despite possessing digital skills in the Indian context.

The subsequent hypothesis (H2) was validated, establishing a correlation between digital skills and the integration of digital resources in the research process. The digital skills of educators in utilizing technological resources within research processes exhibit the third-largest impact relative to other factors in the causal model. This finding supports earlier research by Alazam et al. (2013) and Teo (2009). This result further emphasizes the significance of teacher training in the practical application of technological resources in scientific processes (Guillén-Gámez et al., 2023; El Hassani, 2015). If the teachers have good digital skills, they would be more likely to integrate digital tools into their research activities.

Regarding hypothesis H3, there is an observable correlation between digital ethical standards and the integration of these resources within the research process (H3). This factor significantly influences the use of digital resources. These findings are open to further investigation. As highlighted by Guillén-Gámez et al. (2023) and Mbunge et al. (2021), there is a necessity for an ethical and digital framework to further optimize the use of technology under optimal conditions. Ethical usage will lead to better and more efficient use of digital tools.

The study also found out a correlation between the teachers' digital flow and their digital competencies in the research process, thereby confirming hypothesis H4. Specifically, a strong state of digital flow in the researcher is associated with better digital skills. When teachers experience complete engagement in using digital tools, and are immersed in the process, it is said that they are experiencing "flow". The results are supported by work by Guillén-Gámez et al. (2023). If teachers are interested in using digital resources in research, it will add to their engagement while using these digital tools for research.

The fifth and sixth hypotheses (H5 and H6) of the proposed model demonstrated results similar to those reported by Guillén-Gámez et al. (2023). They identified a link between digital flow and both the intention to use technology and the integration of digital resources in the research process. The findings revealed that a researchers' digital flow significantly impacts their intention to use technology, subsequently influencing the actual integration of digital resources in the research process. These outcomes go with the findings of Kim and Jang (2015), Calvo-Porral et al. (2017), and Rodriguez-Sanchez et al. (2008). Digital flow can positively impact the teachers' intention to use digital tools as it reduces the levels of frustration and annoyance. This would definitely then lead to a higher likelihood of integrating digital resources into research activities.

The findings also support hypotheses H7 and H8, indicating a positive relationship between technology-related anxiety and the intention to utilize digital resources for research. This result is noteworthy as it contrasts with previous studies (Babie et al., 2016; Guillén-Gámez et al., 2023; Joo et al., 2018; Knezek & Christensen, 2016; Paraskeva et al., 2008; Ünal et al., 2019). Higher technology anxiety can make teachers feel overwhelmed and they may end up avoiding digital tools usage. This can be a barrier to the adoption of new technology in research. This can be countered by ensuring a supportive environment for technology adoption. This could lead to lower anxiety and encourage the integration of digital resources in research.

H9 was supported by findings from Guillén-Gámez et al. (2023), which established a link between the quality of technological resources and digital flow—defined as the enjoyment and motivation of educators in their research activities. The experience of enjoyment in scientific processes is more likely to be enhanced with adequate access to technology (Lin et al., 2012; Gil-Flores et al., 2017). As noted by Guillén-Gámez et al. (2023), referencing Gil-Flores et al. (2017), the access, availability, and quality of digital resources can influence their integration into the educational process. However, it is important that we acknowledge that "teachers are reluctant to use technology as a teaching tool if the tool is not adequate".

The study did not support the hypothesis (H10) regarding the relationship between the quality of technological resources and their integration. A plausible explanation for this finding is that the research was conducted in a developing country where, despite substantial investment and subsidies aimed at advancing technological innovation in universities, progress is slower than anticipated. This outcome hints at the need to further investigate this relationship within the context of Indian higher education. This result can also be analyzed along with the situation that still teachers in higher education use less technology inside the classroom for learning and assessment due to the quality of these resources (Oguguo et al., 2023).

Regarding hypothesis (H11), even though the hypothesis is supported, a negative correlation was found between the teachers' intention to use ICT and the integration of these digital resources into the research process. This finding contrasts with the positive relationships reported by Guillén-Gámez et al. (2023), Kovalik et al. (2013), and Ndlovu et al. (2020). This result supports Banas and York's (2014) assertion that intention does not necessarily predict future behavior. Additionally, Shiue (2007) suggests that the quality of available tools might explain this negative relationship. Talking in terms of the Indian context, the negative correlation between intention and integration may be due to inadequate infrastructure, limited training, or insufficient support. These factors could negatively impact effective utilization.

6. Future Suggestions and Limitations

The findings of this study have important implications for the integration of ICT resources in higher education in India. Higher education institutions need to prioritize the development of digital skills in their faculty members. Ensuring that teachers are comfortable with using technology, such as data analysis software, plagiarism detection tools, and reference management systems, is crucial. Institutions should provide sufficient technical support to make digital learning more accessible and less of a burden for faculty members.

Encouraging the use of technology as a positive and engaging tool, rather than a task, will contribute to a more innovative academic environment. Faculty members should use ICT resources with enthusiasm, fostering a culture of continuous learning and growth. This aligns with the goals of the National Education Policy (NEP) 2020, which emphasizes the need for greater investment in research and innovation in higher education institutions.

As far as the limitations of the present study are concerned, further exploration can be made to build more understanding of ICT integration in higher education. First, the study relied on quantitative data and did not delve into qualitative methods such as interviews, open-ended questions, and focused group discussions, which could have provided deeper insights into faculty members' perceptions, challenges, and experiences with ICT adoption. These methods would have allowed for a more detailed understanding of the barriers and motivations behind the use of technology in academic settings.

Additionally, other variables such as the age of faculty members, their qualifications, the type of institution (public vs. private), and regional differences could have been examined in greater detail. These factors may significantly influence the willingness of faculty members to adopt ICT in their teaching and research practices. For example, older faculty members or those with fewer qualifications in technology may face more difficulties than their younger or more tech-savvy counterparts. Moreover, differences in funding, institutional support, and access to resources between urban and rural institutions or between government and private universities could have an effect on the successful integration of ICT.

The study was limited to the northern region of India. Given India's vast and diverse landscape, expanding the research to include other regions could offer a broader understanding of how ICT adoption varies across different educational and socio-cultural contexts. For instance, regions with better technological infrastructure and higher educational investments may display different results compared to those with limited resources.

In light of these limitations, future research should aim to replicate this study in various regions across India, incorporating qualitative and quantitative methods to provide a more holistic understanding of ICT integration in higher education. This would further contribute to the development of a comprehensive framework that could guide universities in providing tailored support to their faculty members, helping them to effectively adopt and implement ICT tools in their teaching and research. Such a framework could inform policy recommendations, especially in the context of the National Education Policy (NEP) 2020, by identifying the specific needs and challenges faced by faculty across different regions and institutional types.

Moreover, future studies should investigate the long-term effects of ICT integration on student learning outcomes, as well as the professional development of faculty members. Research could also focus on exploring collaborative efforts between institutions to share resources and best practices, enhancing the overall adoption of technology in higher education.

References

Abykenova, D. B., & Assainova, A. Z. (2017). Forming master's degree students' ICT competencies as future researchers and educators: A Kazakhstan case study. *Novosibirsk State Pedagogical University Bulletin*, 7(1), 34-48. https://doi.org/10.15293/2226-3365.1701.03

Ahmad, N., & Abdulkarim, H. (2018). The impact of flow experience and personality type on the intention to use virtual world. *International Journal of Human-Computer Interaction*, 35(12), 1074-1085. https://doi.org/10.1080/10447318.2018.1509500

Alazam, A. O., Bakar, A. R., Hamzah, R., & Asmiran, S. (2013). Teachers' ICT skills and ICT integration in the classroom: The case of vocational and technical teachers in Malaysia. *Creative Education*, 3(08), 70.

Aliyu, m., Adamu, A. L. G., & Umar, B. B. (2024). Influence of Digital Competence on Teaching and Research: A Survey of Academic Staff of Modibbo Adama University, Yola, Nigeria. International *Journal of Research in Library Science (IJRLS)*, 10(3), 10–26. https://doi.org/10.26761/IJRLS.10.3.2024.1766

Anderson, S. E., Groulx, J. G., & Maninger, R. M. (2011). Relationships among Preservice teachers' technology-related abilities, beliefs, and intentions to use technology in their future classrooms. *Journal of Educational Computing Research*, 45(3), 321-338. https://doi.org/10.2190/ec.45.3.d

Atiqah, S. N., Hanafiah, M. H., Ismail, H., & Balasubramaniam, K. (2024). Preparing instructors to transition to online distance learning: A pandemic Panacea? *Innoeduca. International Journal of Technology and Educational Innovation*, 10(1), 5-28. https://doi.org/10.24310/ijtei.101.2024.16820

Banas, J. R., & York, C. S. (2014). Authentic learning exercises as a means to influence preservice teachers' technology integration self-efficacy and intentions to integrate technology. *Australasian Journal of Educational Technology*, 30(6). https://doi.org/10.14742/ajet.362

Buils, S., Viñoles-Cosentino, V., Esteve-Mon, F. M., & Sánchez-Tarazaga, L. (2024). Digital training in university teaching induction programmes in Spain: a comparative analysis based on DigComp and DigCompEdu. *Educación XX1*, 27(2), 37-64.

Cabero-Almenara, J., Guillén-Gámez, F. D., Ruiz-Palmero, J., & Palacios-Rodríguez, A. (2021). Digital competence of higher education professor according to DigCompEdu. Statistical research methods with ANOVA between fields of knowledge in different age ranges. *Education and Information Technologies*, 26(4), 4691-4708. https://doi.org/10.1007/s10639-021-10476-5

Chitkara, M., Kanwar, V. S., & Dutta, H. (2020). Redefining Indian Universities: An Insight of Education Sector towards Evolution of Industry 4.0 and 5.0. *University News*, 58, 33.

Dang, T. D., Phan, T. T., Vu, T. N., La, T. D., & Pham, V. K. (2024). Digital competence of lecturers and its impact on student learning value in higher education. *Heliyon*, 10(17), e37318. https://doi.org/10.1016/j.heliyon.2024.e37318

Davis, M. S., & Csikszentmihalyi, M. (1977). Beyond boredom and anxiety: The experience of play in work and games. *Contemporary Sociology*, 6(2), 197. https://doi.org/10.2307/2065805

Dewey, J. (2008). The later works of John Dewey, volume 13, 1925 - 1953: 1938-1939, experience and education, freedom and culture, theory of valuation, and essays. SIU Press.

Dominighini, C., & Cataldi, Z. (2017). Ética en la investigación en TICS: Formación en buenas prácticas en ciencia y tecnología. *Revista de Informática Educativa y Medios Audiovisuales*, 14(22), 20–25.

DPsouza, R., Auti, A., & Diwekar-Joshi, M. A. N. A. W. A. (2022). Enhancing Digital Pedagogy Skills of Higher Education Teachers in the Context of Indian

National Education Policy 2020. *Bridging Educational Emergency to Digital Pedagogies*, 47.

El Hassani, A. (2015). The role of information literacy in higher education: An initiative at al Akhawayn University in Morocco. *Nordic Journal of Information Literacy in Higher Education*, 7(1), 32-37. https://doi.org/10.15845/noril.v7i1.229

Fernández-Batanero, J., Román-Graván, P., Reyes-Rebollo, M., & Montenegro-Rueda, M. (2021). Impact of educational technology on teacher stress and anxiety: A literature review. *International Journal of Environmental Research and Public Health*, 18(2), 548. https://doi.org/10.3390/ijerph18020548

Fernández-Batanero, J., Román-Graván, P., Reyes-Rebollo, M., & Montenegro-Rueda, M. (2021). Impact of educational technology on teacher stress and anxiety: A literature review. *International Journal of Environmental Research and Public Health*, 18(2), 548. https://doi.org/10.3390/ijerph18020548

Ferrari, A. (2012). *Digital competence in practice: An analysis of frameworks*. JRC Technical Reports. Institute for Prospective Technological Studies, European Union.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39. https://doi.org/10.2307/31513

García Robelo, O., & Veytia Bucheli, M. G. (2018). Comparative analysis of research skills and ICT: A case study in higher education. *International Journal of Educational Excellence*, 4(1), 15-27. https://doi.org/10.18562/ijee.031

Gil-Flores, J., Rodríguez-Santero, J., & Torres-Gordillo, J. (2017). Factors that explain the use of ICT in secondary-education classrooms: The role of teacher characteristics and school infrastructure. *Computers in Human Behavior*, 68, 441-449. https://doi.org/10.1016/j.chb.2016.11.057

Guillén-Gámez, F. D., Ruiz-Palmero, J., & Gómez-García, M. (2023). Digital competencies in research: creativity and entrepreneurship as essential predictors for teacher training. *Journal of Computers in Education*. https://doi.org/10.1007/s40692-023-00299-3

Guillén-Gámez, F. D., Ruiz-Palmero, J., & García, M. G. (2023). Digital competence of teachers in the use of ICT for research work: Development of an instrument from a PLS-SEM approach. *Education and Information Technologies*, 28(12), 16509-16529. https://doi.org/10.1007/s10639-023-11895-2

Guzman, A., & Nussbaum, M. (2009). Teaching competencies for technology integration in the classroom. *Journal of Computer Assisted Learning*, 25(5), 453-469. https://doi.org/10.1111/j.1365-2729.2009.00322.x

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2014). A primer on partial least squares structural equation modeling (PLS-SEM). Thousand Oaks: SAGE.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, 31(1), 2-24. https://doi.org/10.1108/ebr-11-2018-0203

Hoffman, D. L., & Novak, T. P. (1996). Marketing in hypermedia computer-mediated environments: Conceptual foundations. *Journal of Marketing*, 60(3), 50-68. https://doi.org/10.2307/1251841

Joo, Y. J., Park, S., & Lim, E. (2018). Factors Influencing Preservice Teachers' Intention to Use Technology: TPACK, Teacher Self-efficacy, and Technology Acceptance Model. *Journal of Educational Technology & Society*, 21(3), 48–59. http://www.jstor.org/stable/26458506

Kanyengo, C. W., & Smith, G. J. (2022). Digital Skills among Lecturers at the University of Zambia, School of Medicine. *Zambia Journal of Library & Information Science (ZAJLIS)*, ISSN: 2708-2695, 6(1), 19-29.

Kaur, D. P., Kumar, A., Dutta, R., & Malhotra, S. (2022). The role of interactive and immersive technologies in higher education: A survey. *Journal of Engineering Education Transformations*, 36(2), 79-86.

Kim, H. J., & Jang, H. Y. (2015). Motivating pre-service teachers in technology integration of web 2.0 for teaching internships. *International Education Studies*, 8(8), 21–32. https://doi.org/10.5539/ies. V8n8p21.

Kmetz, J. L. (2019). Correcting corrupt research: Recommendations for the profession to stop misuse of p -values. *The American Statistician*, 73(sup1), 36- 45. https://doi.org/10.1080/00031305.2018.1518271

Knezek, G., & Christensen, R. (2016). Extending the will, skill, tool model of technology integration: Adding pedagogy as a new model construct. *Journal of Computing in Higher Education*, 28(3), 307–325. https://doi.org/10.1007/s12528-016-9120-2.

Kovalik, C., Kuo, C.L. & Karpinski, A. (2013). Assessing Preservice Teachers' Information and Communication Technologies Knowledge. *Journal of Technology and Teacher Education*, 21(2), 179-202. Waynesville, NC USA: Society for

Information Technology & Teacher Education. Retrieved September 18, 2024 from https://www.learntechlib.org/primary/p/40634/.

Lawrence, J. E., & Tar, U. A. (2018). Factors that influence teachers' adoption and integration of ICT in teaching/le*arning process.* Educational Media International, 55(1), 79-105. https://doi.org/10.1080/09523987.2018.1439712

Lin, J. M. C., Wang, P. Y., & Lin, I. C. (2012). Pedagogy* technology: A two-dimensional model for teachers' ICT integration. *British Journal of Educational Technology*, 43(1), 97–108. https://doi.org/10.1111/j.1467-8535.2010.01159.x.

Loyd, B. H., & Gressard, C. (1984). Reliability and factorial validity of computer attitude scales. *Educational and Psychological Measurement*, 44(2), 501-505. https://doi.org/10.1177/0013164484442033

Luke, A. (2018). Digital ethics now. *Language and Literacy*, 20(3), 185-198 .

Mbunge, E., Fashoto, S. G., Akinnuwesi, B., Metfula, A., Simelane, S., & Ndumiso, N. (2021). Ethics for integrating emerging technologies to contain COVID-19 in Zimbabwe. *Human Behavior and Emerging Technologies*, 3(5), 876-890. https://doi.org/10.1002/hbe2.277.

Mehra, V., & Far, Z. N. (2015). Attitude towards Information and Communication Technology use among University Teachers of different faculties in relation to Computer Anxiety. *Indian Educational*, 53(1).

Mittal, K. (2010). ICT Integration in Teacher Education India Report. New Delhi: NCERT. Retrieved from gauge. ugakugei. ac. jp/apeid/apeid07/CoutryReport/India. pdf on, 3, 2010.

Murnane, R. J., & Levy, F. (1996). Teaching the New Basic Skills. Principles for Educating Children To Thrive in a Changing Economy. Free Press, 1230 Avenue of the Americas, New York, NY 10020.

Ndlovu, M., Ramdhany, V., Spangenberg, E. D., & Govender, R. (2020). Preservice teachers' beliefs and intentions about integrating mathematics teaching and learning ICTs in their classrooms. *ZDM*, 52(7), 1365–1380. https://doi.org/10.1007/s11858-020-01186-2.

Núñez-Canal, M., De Obesso, M. D., & Pérez-Rivero, C. A. (2022). New challenges in higher education: A study of the digital competence of educators in Covid times. *Technological Forecasting and Social Change*, 174, 121270. https://doi.org/10.1016/j.techfore.2021.121270

Oguguo, B., Ezechukwu, R., Nannim, F., & Offor, K. (2023). Analysis of teachers in the use of digital resources in online teaching and assessment in COVID times. *Innoeduca. International Journal of Technology and Educational Innovation*, 9(1), 81-96. https://doi.org/10.24310/innoeduca.2023.v9i1.15419

Olugbara, C. T., & Letseka, M. (2020). Factors predicting integration of E Learning by Preservice science teachers: Structural model development and testing. *Electronic Journal of e-Learning*, 18(5). https://doi.org/10.34190/jel.18.5.005

Pandey, A., & Pandey, A. K. (2020). ICT in teaching and learning: An Indian scene. *Journal of Critical reviews*, 7(9), 861-865.https://doi.org/10.31838/jcr.07.09.161

Paraskeva, F., Bouta, H., & Papagianni, A. (2008). Individual characteristics and computer self-efficacy in secondary education teachers to integrate technology in educational practice. *Computers & Education*, 50(3), 1084-1091. https://doi.org/10.1016/j.compedu.2006.10.006.

Pérez, C., & López, L. (1999). Las habilidades e invariantes investigativas en la formación del profesorado. Una propuesta metodológica para su estudio. *Pedagogía universitaria*, 4(2), 5-14 .

Revilla Munoz, O., Alpiste Penalba, F., Fernandez Sanchez, J., & Santos, O. C. (2017). Reducing techno-anxiety in high school teachers by improving their ICT problem-solving skills. *Behaviour & Information Technology*, 36(3), 255-268. https://doi.org/10.1080/0144929X.2016.1221462.

Rodriguez-Sanchez, A. M., Schaufeli, W. B., Salanova, M., & Cifre, E. (2008). Flow experience among information and communication technology users. *Psychological Reports*, 102(1), 29-39. https://doi.org/10.2466/pr0.102.1.29-39.

Rubio, M. J., Torrado, M., Quiros, C., & Valls, R. (2018). Self-perception of investigative competences in final-year students of Pedagogy of the University of Barcelona to develop the Final Grade Work. *Revista Complutense De Educacion*, 29(2), 335-354.

Sánchez, A. G. A., & Bucheli, M. G. V. (2020). Desarrollo de competencias investigativas y uso de herramientas tecnológicas en la gestión de información. *Revista Conrado*, 16(72), 96–102

Sanjuanelo, S. L., Caballero-Uribe, C. V., Lewis, V., Mazuera, S., Salamanca, J. F., Daza, W., & Fourzali, A. (2007). Consideraciones éticas en la publicación de investigaciones científicas. *Salud Uninorte*, 23(1), 64–78.

Santos, C., Pedro, N., & Mattar, J. (2021). Digital competence of higher education professors. *Obra digital*, (21), 69-92. https://doi.org/10.25029/od.2021.311.21

Sharafi, P., Hedman, L., & Montgomery, H. (2006). Using information technology: Engagement modes, flow experience, and personality orientations. *Computers in Human Behavior*, 22(5), 899-916. https://doi.org/10.1016/j.chb.2004.03.022

Sharma, L., & Srivastava, M. (2019). Teachers' motivation to adopt technology in higher education. *Journal of Applied Research in Higher Education*, 12(4), 673-692. https://doi.org/10.1108/jarhe-07-2018-0156

Shiue, Y. (2007). Investigating the sources of teachers' instructional technology use through the decomposed theory of planned behavior. *Journal of Educational Computing Research*, 36(4), 425-453. https://doi.org/10.2190/a407-22rr-50x6-2830

Simonson, M. R., Maurer, M., Montag-Torardi, M., & Whitaker, M. (1987). Development of a standardized test of computer literacy and a computer anxiety index. *Journal of Educational Computing Research*, 3(2), 231-247. https://doi.org/10.2190/7chy-5cm0-4d00-6jcg

Şimşek, A. S., & Ateş, H. (2022). The extended technology acceptance model for Web 2.0 technologies in teaching. *Innoeduca. International Journal of Technology and Educational Innovation*, 8(2), 165-183. https://doi.org/10.24310/innoeduca.2022.v8i2.15413

Stahl, B. C., Eden, G., Jirotka, M., & Coeckelbergh, M. (2014). From computer ethics to responsible research and innovation in ICT. *Information & Management*, 51(6), 810-818. https://doi.org/10.1016/j.im.2014.01.001

Teo, T. (2009). Examining the relationship between student teachers' self-efficacy beliefs and their intended uses of technology for teaching: A structural equation modeling approach. The Turkish *Online Journal of Educational Technology*, 8(4), 7–16.

Venkatesh, Morris, Davis, & Davis. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425. https://doi.org/10.2307/30036540

Vinzi, V. E., Chin, W. W., Henseler, J., & Wang, H. (2010). *Handbook of partial least squares: Concepts, methods and applications*. Springer Science & Business Media.

Yildirim, S. (2000). Effects of an educational computing course on Preservice and Inservice teachers. *Journal of Research on Computing in Education*, 32(4), 479-495. https://doi.org/10.1080/08886504.2000.10782293

Zhao, Y., Llorente, A. M. P., & Gómez, M. C. S. (2021). Digital competence in higher education research: A systematic literature review. *Computers & Education*, 168, 104212. https://doi.org/10.1016/j.compedu.2021.104212

Zvereva, E. (2023). Digital ethics in higher education: Modernizing moral values for effective communication in cyberspace. *Online Journal of Communication and Media Technologies*, 13(2), e202319. https://doi.org/10.30935/ojcmt/13033

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 20, No. 3 (2024), pp. 71-82

Exploring technology adoption measures among academicians and its influence on their research practices and performance

Indrajit Doddanavar[a,1], Amit Subramanyam[b], Vijaylaxmi Dombar[c], Lakshmi S[d], Latha B R[e], Chandana H S[f]

[a]*Jain College of Engineering and Research, Dept. of Business Administration – Belagavi (India)*

[b]*Rani Channamma University, Dept. of Business Administration – Belagavi (India)*

[c]*Government First Grade Women's College, Department of Management – Belagavi (India)*

[d]*Mount Carmel College, Dept. of Management – Bengaluru (India)*

[e]*Maharani Women'Arts Commerce and Management College, Dept. of Sociology – Bengaluru (India)*

[f]*Maharani Women's Arts Commerce and Management College, Dept. of Management – Bengaluru (India)*

(submitted: 31/8/2024; accepted: 13/10/2024; published: 30/10/2024)

Abstract

The advent of technology may dramatically alter academic research and performance. This study uses the Unified Theory of Adoption and Use of Technology (UTAUT) and Task-Technology Fit (TTF) theories to examine how technology adoption influence Research Performance conducted with sample size of 1,354 South Indian private institution Assistant Professors, with perception as a moderating factor. The research uses Structural Equation Modelling (SEM) with SmartPLS 4.0 to reveal that Performance Expectancy (PE) greatly influence Behavioral Intention (BI) to adopt technology. Higher Performance Expectancy (PE) leads to a stronger intention to use technology. Effort Expectancy (EE) also boosts BI, emphasizing the role of usability in setting user intentions. Technology adoption depends on Social Influence (SI), along with peer and social norms affect BI. Effective technology adoption requires Facilitating Conditions (FC) and enough resources and infrastructure. Task Characteristics (TC) and Technology Characteristics (TCh) greatly alter Task-Technology Fit (TTF), which enhances research procedures. TTF improves research practices but hurts research performance, demonstrating that improved techniques do not necessarily translate to better performance ratings, highlighting the intricacy of task-technology compatibility and research results.

KEYWORDS: Academicians, Research Practices, Research Performance, UTAUT, TTF.

DOI
https://doi.org/10.20368/1971-8829/1136038

CITE AS
Doddanavar, I., Subramanyam, A.m, Dombar, V., S, L., B R, L., & H S, C. (2024). Exploring Technology Adoption measures among Academicians and its Influence on their Research Practices and Performance. *Journal of e-Learning and Knowledge Society*, *20*(3), 71-82.
https://doi.org/10.20368/1971-8829/1136038

1. Introduction

Technology has revolutionized academic research, helping researchers improve efficiency and depth (Vega et al., 2016). Research was formerly constrained by manual techniques and physical resources. Digital resources, e-contents, and improved technology have expedited research methods to satisfy digital era expectations (Oguguo et al., 2023; Sabino & Almenara, 2021). Today's academic landscape relies on technology for data collection, processing, and dissemination, which improves research performance when Task-Technology Fit (TTF) is achieved by aligning Task Characteristics (TC) with Technological Characteristics (TCh).

Adoption of academic technology is influenced by Performance Expectancy (PE), Effort Expectancy (EE), Behavioral Intention (BI), and Social Influence (SI). PE and EE assess expected research success and

[1] corresponding author - email: doddanavar.ia@gmail.com

technological ease, whereas BI measures social influences on technology adoption (Zhang et al., 2020). Technology integration requires infrastructure and assistance (Omotayo & Haliru, 2019).

Perception (PER) moderates Use Behavior (UB), TTF, Research Practices (RP), and Research Performance (RPf), impacting research technology adoption (Ahmed et al., 2018). Positive impressions improve research habits and performance, promoting creativity and academic achievement (Hoppmann et al., 2020; Alonso, 2009). Using technology strategically and understanding its aspects might increase research productivity and innovation (Padilla-Hernández et al., 2019; Agustí López et al., 2023; Ozer Sanal, 2023).

2. Theoretical Framework

Today's fast-paced technological world requires understanding how academics use technology to improve research. The Unified Theory of Acceptance and Use of Technology (UTAUT) and Task-Technology Fit (TTF) provide light on technology uptake and efficacy in academic research. UTAUT, created by (Venkatesh et al., 2016), uses 8 technology acceptance models to describe user intents and behaviors, highlighting four essential factors: PE, EE, SI, and FC. PE refers to technology-enhanced research output, whereas EE refers to ease of use. SI measures the effect of important people on technology adoption, while FC supports research procedures organizationally and technologically. (Ayaz & Yanartas, 2020) demonstrate UTAUT's relevance to academic technology uptake.

The TTF, established by (Goodhue & Thompson, 1995), suggests that technology's efficacy relies on its fit with research activities. TTF is crucial in academic research, because technology's productivity depends on its compatibility with research activities, according to (Aljarboa & Miah, 2020) show that UTAUT and TTF are useful for research technology adoption analysis. Hence, TTF acts as prerequisite for expected research outcomes. This comprehensive approach provides a solid foundation for assessing academic technology usage and improving research performance (Alwadain et al., 2024).

3. Conceptual Framework and Hypothesis Development

3.1 Performance Expectancy (PE) and Behavioral Intention (BI)

PE shapes BI to utilize technology, especially in research and academic contexts. PE implies that a certain system improves performance, as it ease the flow of research process and execution (Faida et al., 2022). Technology's claimed benefits to efficiency, education, and research encourage its adoption in academia. Researchers who believe technology improves performance are more inclined to use it (Utomo et al., 2021). PE not only strongly impacts higher education use of online learning and research technology. Chao 2019, demonstrated that PE is significant in predicting BI towards e-records, documents required for drafting research papers. Academics are more likely to utilise technology if they feel it helps them achieve research objectives, such as accessing digital materials. PE is intimately linked to education technology uptake in the UTAUT paradigm.

Hypothesis 1: Performance Expectancy (PE) positively influences Behavioral Intention (BI) among academicians.

3.2 Effort Expectancy (EE) and Behavioral Intention (BI)

Unified Theory of Acceptance and Use of Technology (UTAUT) component Effort Expectancy (EE) strongly influence academics' BI to embrace new technology. In technology, EE is perceived ease of use (Ayaz & Yanartaş, 2020). Academics' desire to adopt technology depends on user-friendliness. Academics use technology that is simple to use and operate, according to research. If a learning management and mechanism system is easy, academicians are more likely to use it. EE strongly influence BI in educational and other situations, according to empirical investigations. (Fishman et al., 2020) showed a strong association between academic professionals' use of e-record management systems and its perceived ease of use, emphasizing the need for user-friendly designs to increase technology adoption.

Hypothesis 2: Effort Expectancy (EE) positively influences Behavioral Intention (BI).

3.3 Social Influence (SI) and Behavioral Intention (BI)

SI is how others' thoughts, actions, and behaviours affect an individual's ideas and choices, especially academics' technology uptake, specially the peer to peer. BI shows motivation to do a behavior. The influence of SI on BI is considerable, since academics may regard technology as desirable or required when backed by reputable leaders and support in their field. Technology adoption becomes desirable and anticipated in their professional community due to normative pressure. To remain relevant and competitive increases this ambition (Aditia et al., 2018). Peer praise boosts BI and encourages technological adoption. SI starts and amplifies BI, promoting academic technology adoption (Izuma, 2017).

Hypothesis 3: Social Influence (SI) positively affects Behavioral Intention (BI)

3.4 Facilitating Conditions (FC) and Use Behavior (UB)

FC are an individual's belief that organisational and technical assistance exists to employ technology. Academics need this notion, which underpins (Venkatesh et al., 2003) Unified Theory of Acceptance and Use of Technology (UTAUT). It includes training, technical assistance, and infrastructure (e.g., internet connection, devices, and software) for educational technology usage. FC eliminates technology adoption hurdles, boosting academics' confidence in adopting technology for teaching, research, and administration. By reducing barriers to new technology use, (Kamarozaman & Razak, 2021) found that this improves their Use Behaviour (UB). The cognitive strain of learning new systems is reduced by trustworthy technical assistance, enabling consistent technology usage (Hameed, 2024).

Hypothesis 4: Facilitating Conditions (FC) positively influence Use Behavior (UB).

3.5 Behavioral Intention (BI) and Use Behavior (UB)

Understanding academic technology involvement requires BI and UB. BI precedes UB and indicates a person's technology adoption readiness. According to (Hameed et al., 2024), BI towards technology learning shows how academics expect to employ technology in their research, based on perceived ease of use, usefulness, and attitude. In contrast, UB is the real-world use of technology, demonstrating involvement. (Brezavšček, 2016) demonstrates how taking use of statistical software in Slovenian social sciences leads to its application in academic work. The Theory of Reasoned Action (TRA) and Technology Acceptance Model (TAM) show that strong BI typically leads to technology usage.

Hypothesis 5: Behavioral Intention (BI) positively influences Use Behavior (UB).

3.6 Task Characteristics (TC), Technology Characteristics (TCh), and Task-Technology Fit (TTF)

Task-Technology Fit (TTF) depends on Task Characteristics (TC) and Technology Characteristics (TCh), which greatly affects academic technology use. Academic work characteristics like complexity and data analysis needs determine the technical assistance required to improve performance. Large-scale data processing requires complex analytical techniques. Technology Characteristics (TCh) including usability and adaptability must meet academic demands (Ma & Jing, 2023). This alignment affects productivity and user pleasure, making it essential for high TTF (Shih, 2013). TTF depends on TC and TCh, hence aligning these variables is crucial for optimising technology usage, task performance, and academic efficiency (Hoppmann et al., 2020).

Hypothesis 6: Task Characteristics (TC) positively influence Task-Technology Fit (TTF)

Hypothesis 7: Technology Characteristics (TCh) positively influence Task-Technology Fit (TTF)

3.7 Task-Technology Fit (TTF) and Research Practices (RP)

Modern culture is moulded by and influenced by technology (Orlikowski, 2000). Digital learning and technology greatly affect research. Digital technologies have a worldwide influence on education, especially academically (Cook & Triola, 2014; Talebian, 2014). This development has boosted education, research, and academia (Oguguo et al., 2023). The Task-technological Fit (TTF) idea betters researcher performance by matching task needs with technological capabilities. It states that task requirements influence technological effectiveness TTF enhances research by aligning technology with tasks, expediting data collecting, promoting communication, and increasing efficiency and quality (Hernández et al., 2015; Cigdem & Oncu, 2024; Doğan & Kalinkara, 2024).

Hypothesis 8: Task-Technology Fit (TTF) positively affects Research Practices (RP).

3.8 Task-Technology Fit (TTF) and Research Performance (RPf)

TTF helps academics improve RPf by supporting research activities with technology. Shih (2013) notes that optimum TTF reduces research work, enabling concentration on essential tasks and improving efficiency and production. (Ma, Lixia, & Jing, 2023) note that excellent fit enhances research findings and confirms TTF perception, producing a positive feedback cycle. Better research findings increase trust in technological instruments, improving TTF perception and research technology integration, according to (ALKursheh, 2024). High TTF increases researcher happiness, motivation, and productivity, increasing research outputs and boosting technology adoption (Talebian et al., 2014). Strong TTF promotes innovation and knowledge development, enhancing TTF and RPf's reciprocal advantages. Effective TTF helps academics and their RPf.

Hypothesis 9: Task-Technology Fit (TTF) positively influence Research Performance (RPf)

3.9 Use Behavior (UB) and Research Practices (RP)

UB with R, Python, SmartPLS, AMOS, and other AI applications is growing in academia (Gruzd, Staves & Wilk, 2012). Although these technologies are transforming research, many institutions still have incompatible software and communication infrastructures that impede innovation (Unsworth, 2008). Recent studies have substituted technology performance with research impacts (Dwivedi et al., 2019). (Menzies & Newson, 2007) found that new technology enhanced research skills and productivity but lowered creativity. To explain sustained UB), (Hong et al., 2006) utilise TAM model and emphasise that user learning and perceived usefulness drive engagement (Xu et al., 2011). Data collection and analysis are easier with digital technology, improving digital literacy and research efficiency (Agudo-Peregrina et al., 2014)

Hypothesis 10: Use Behavior (UB) positively influences Research Practices (RP).

3.10 Use Behaviour (UB) and Research Performance (RPf)

RPf depends on UB, especially technology use. RPF evaluates academic work's effect and efficacy, whereas UB uses technology for research and performance. According to (Bazeley, 2010), incorporating technology to RP may enhance productivity and efficiency when UB matches tasks. When tasks and technology match, RPf rises. According to (Aboagye et al., 2021), choosing research-enhancing technologies improves research performance by strategically matching research tasks with accessible technology. (Gruzd, Staves, & Wilk, 2012) demonstrate that digital networking and information sharing boost research efficacy and technology uptake. When task complexity and researcher skill meet, technology use enhances RPf, (Unsworth, 2008). Technological literacy affects RPf and digital literacy encourages technology use and research (MohdRasdi et.al, 2023). Effective technology use boosts research productivity and links UB and RPf.

Hypothesis 11: Use Behaviour (UB) positively influence Research Performance (RP)

3.11 Research Practices (RP) and Research Performance (RPf)

In today's academic environment, succeeding in RPf measures affirms our reputation as researchers at both personal and institutional levels, gaining time and money for future work and boosting esteem. Traditional RPf measurements include publication production, citation counts, and quality indices (Bazeley, 2010). Technology improves research efficiency and efficacy, increasing RPf. Digital technologies and platforms simplify data administration and publishing, saving time and expanding reach. (Javed et al., 2020) stress the need of investing in technology and training to improve research. Alonso et al. (2009) further note that improved Bibliometric tools monitor citations and analyse work impact, enhancing measures like the h-index and i10 index and creating a dynamic research environment.

Hypothesis 12: Research Practices (RP) positively influence Research Performance (RPf).

3.12 Moderation by Perception

3.12.1 Perception (PER) as Moderation between Use Behavior (UB) and Research Practices (RP)

UB is how researchers access, process, and share information using technology, impacted by fast tech breakthroughs and the digitalisation of research resources. Researchers' use of new innovation is heavily influenced by behavioural characteristics like adaptation and openness. Researchers that adapt effectively to technological changes use digital technologies more easily, increasing their RP (Ozer Sanal, 2023). (Atiqah et al., 2024) note that UB—how often, how, and why researchers use technology—affects their RPf in a tech-centric setting. PER moderates UB substantially; favourable evaluations of technology as user-friendly and useful boost engagement and innovation. Conversely, unfavourable opinions may limit technology utilisation and research efficiency (González & Leiva, 2022). PER affects technology acceptance and usage, with value views impacting researchers' relationships and RP continuity.

Hypothesis 13: Perception (PER) moderates the relationship between Use Behavior (UB) and Research Practices (RP).

3.12.2 Perception (PER) as Moderation between Task-Technology Fit (TTF) and Research Practices (RP)

User experience, ease of use, and perceived usefulness influence technology perception (PER), and its moderating impact may increase or decrease these perceptions. Positive moderating effects boost perceived usefulness, contentment, and adoption, whereas negative effects lower perceived advantages and raise resistance (Azam et al., 2023). (Mutahar et al., 2019) found that high technology perceived value improves TTF and user acceptability. This shows that researchers improve technology adoption when its qualities match their work. (Omotayo & Haliru, 2019) add that PER moderates TTF's effect on academic research practices. Data privacy and reliability may slow technology adoption, whereas (Sun & Zhang, 2006) note that PER influences technology-task fit and research practice adoption.

Hypothesis 14: Perception (PER) moderates the relationship between Task-Technology Fit (TTF) and Research Practices (RP)

3.12.3 Perception (PER) as Moderation between Research Practices (RP) and Research Performance (RPf)

PER moderates the relationship between RP and RPf, especially academics' technology utilisation. Academics see technology's influence on research as PER. A positive PER may boost RP and research outputs, whereas a negative perception may restrict technology's benefits. (González & Olivencia, 2022) stress that academics' technical viewpoints considerably affect research integration. Technologies that boost research performance are supported by positive attitudes. Good perceptions of tool usefulness and simplicity of use encourage tool usage, which affects study success in (Ozer, 2023). Perception (PER) stimulates technology use and improves research performance, according to (Ismail et al., 2024). Perception (PER) affects adaptability and resilience, enhancing research outcomes. Perception (PER) is linked to self-efficacy, with confident academics conquering difficult tasks, positive perceptions increase research effectiveness by fostering innovation and teamwork (Hong et al., 2006). These studies suggest that positive technological attitudes benefit research.

Hypothesis 15: Perception moderates the relationship between Research Practices (RP) and Research Performance (RPf).

4. Methodology

The study utilizes a non-experimental design ex post facto by surveys, as it effectively captures and analyze the present state of technology adoption among academicians, as well as its influence on their research practices and performance. Convenience sampling was employed to select 1,354 academicians from private universities in South India, and data was analysed employing the model mentioned in Figure 1, using SmartPLS 4.0 with Structural Equation Modelling (SEM) to examine the relationships between the constructs. In alignment with ethical standards, all participants were thoroughly briefed on the confidentiality protocols, ensuring that their privacy would remain protected. Moreover, the integrity and accuracy of the information collected were diligently safeguarded to maintain the study's credibility.

The study is grounded in the Unified Theory of Acceptance and Use of Technology (UTAUT) and Task-Technology Fit (TTF) theories, which explain how perceived usefulness, ease of use, and task-technology alignment influence technology adoption.

Reliability and validity of the constructs were ensured using the Fornell-Larcker criterion and Heterotrait-Monotrait (HTMT) ratio, confirming the distinctiveness and accuracy of the constructs. Path analysis in the structural model revealed that technology adoption, when aligned with research tasks, significantly enhances research performance. The findings emphasize the importance of supporting academicians in effectively integrating technology into their research practices to improve outcomes in South India's higher education sector.

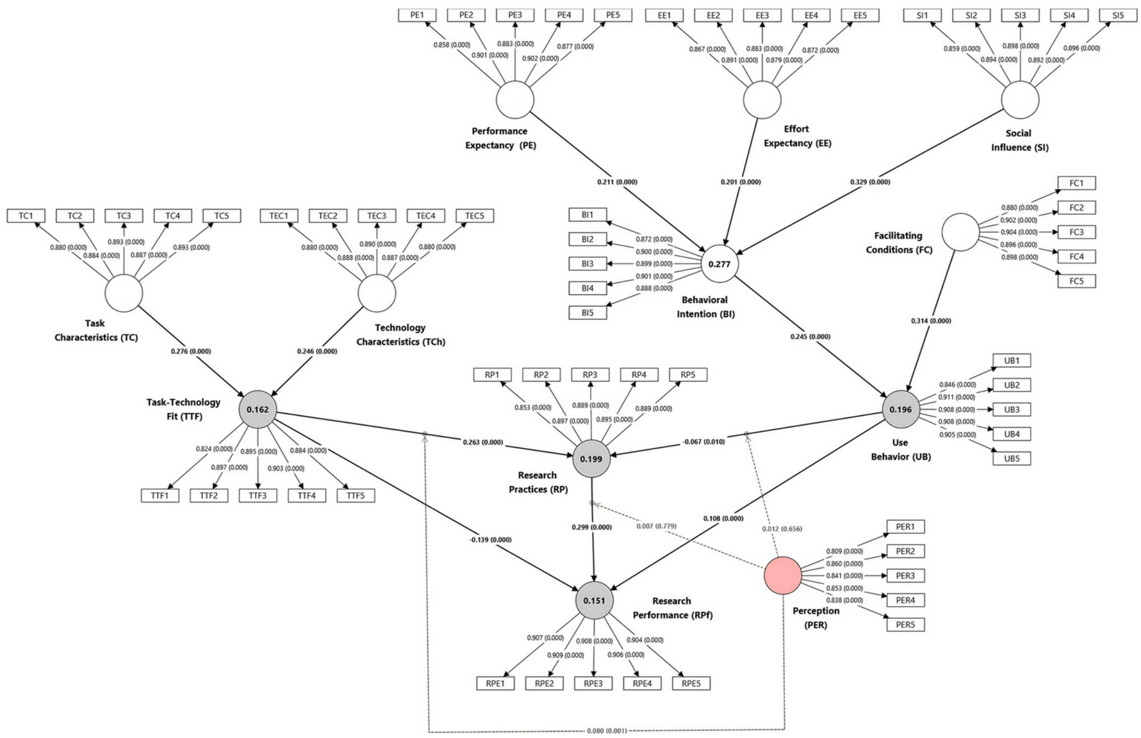

Figure 1 – Structural Model.

5. Data analysis and Findings

To understand technology adoption and its implications on research methods, the Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), and Task-Technology Fit (TTF) must be integrated. (Davis 1989) TAM emphasizes individual views like usefulness and ease of use. (Venkatesh et al., 2003) UTAUT includes social impact and conducive situations. TTF, emphasized by (Goodhue & Thompson, 1995), evaluates how effectively technology supports certain activities by aligning technological attributes with task needs. Combining these ideas gives researchers a complete picture of individual, societal, and environmental aspects driving technology adoption. This integrated method illuminates technology's involvement in research performance and reveals obstacles and facilitators at several levels, resulting in more effective interventions and initiatives. The model offers a solid foundation for studying academic technology use's complicated dynamics.

Task Characteristics (TC) and Technology Characteristics (TCh) significantly affect TTF, emphasizing the importance of aligning technology with specific task requirements (Goodhue & Thompson, 1995). TTF further impacts RP, illustrating that well-aligned technology enhances the effectiveness of research activities. The model also shows that both UB and RP directly influence RPf, demonstrating that the quality of RP and the extent of technology use are crucial for achieving better RPf.

Perception (PER) acts as a moderator, altering the relationships between TTF, UB, RP, and RPf, reflecting the importance of individual perceptions in shaping the effectiveness of technology use in research settings. This highlights the nuanced role of perceptions in influencing how well technology adoption translates into improved research performance (Dwivedi et al., 2019). Overall, the model underscores the complex dynamics of technology adoption in academic contexts, illustrating how well-integrated technology and positive perceptions can significantly enhance research productivity and outcomes.

The validity and reliability measures evaluate the model's constructs, assuring high internal consistency, construct validity, and measurement accuracy for dependable conclusions. With a Composite dependability (CR) of 0.947 and a Cronbach's Alpha (α) of 0.932, PE demonstrated high dependability, above the typical criterion of 0.70. The construct's convergent validity is supported by its AVE of 0.782, which is compatible with technology adoption theories that PE predicts BI (Venkatesh et al., 2003). With CR values of 0.944 and 0.949 and AVE values of 0.771 and 0.788, respectively, EE and SI both have excellent psychometric features, consistent with (Venkatesh & Bala's, 2008) extension of the Technology Acceptance Model. A CR of 0.946 and an AVE of 0.777 made TTF dependable for assessing user performance outcomes (Goodhue & Thompson, 1995). With a CR of 0.959 and an AVE of 0.823, RPf was the most reliable, assuring accurate measurement (Hair et al., 2017).

The Fornell-Larcker criterion confirms strong discriminant validity across all constructs, demonstrating that each variable is distinct and accurately reflects its intended concept. The square root of the Average Variance Extracted (AVE) for each construct surpasses its correlations with other constructs, ensuring that each variable shares more variance with its indicators than with any other variable. For instance, BI has an AVE square root of 0.892, exceeding its correlations with other constructs. Similarly, EE, FC, and PE have AVE square roots of 0.878, 0.896, and 0.884, respectively. Other constructs, including SI, TC, TCh, TTF, and UB, also maintain high discriminant validity.

In this model, most HTMT values are below 0.85, proving discriminant validity. BI and EE have moderate correlations, whereas FC and SI have low correlations, confirming their uniqueness. Overall, the HTMT analysis provides good discriminant validity, confirming the model's structural integrity and dependability. Overall, TTF impacts research practices and performance, as it evaluates user task technical assistance. Technology helps scholars analyse data, analyse literature, collaborate, and publish. TTF boosts productivity, accuracy, and data processing with the proper tech. Innovative discoveries, high-quality publications, and academic creativity boost research. TTF links researchers online to increase collaboration and diversity. TTF optimization improves research productivity and repute.

5.1 Structural Model Analysis

Referring to the Table 1, the structural model assessment and hypothesis testing results offer valuable insights into the relationships between constructs, underscoring the significance of various predictors on BI, UB, TTF, and RPf. Hypotheses were tested for significance using path coefficients (β), t-values, p-values, and effect sizes (f^2), while multicollinearity was assessed through Variance Inflation Factor (VIF) values, all below 5, indicating no multicollinearity issues.

PE significantly influences BI ($\beta = 0.211$, $t = 8.412$, $p < 0.001$), supported by moderate effect size ($f^2 = 0.056$) and aligned with TAM (Davis, 1989). EE also impacts BI ($\beta = 0.201$, $t = 8.744$, $p < 0.001$), as does SI ($\beta = 0.329$, $t = 13.554$, $p < 0.001$) with the largest effect size ($f^2 = 0.135$). FC significantly affect UB ($\beta = 0.314$, $t = 11.817$, $p < 0.001$), and BI influences UB ($\beta = 0.245$, $t = 8.964$, $p < 0.001$).

Table 1 - Structural model.

	Hypothesis	VIF	β	SD	t-value	p-value	Supported	f2
1	Performance Expectancy (PE) -> Behavioral Intention (BI)	1.104	0.211	0.025	8.412	0.000	Yes	0.056
2	Effort Expectancy (EE) -> Behavioral Intention (BI)	1.087	0.201	0.023	8.744	0.000	Yes	0.051
3	Social Influence (SI) -> Behavioral Intention (BI)	1.104	0.329	0.024	13.554	0.000	Yes	0.135
4	Facilitating Conditions (FC) -> Use Behavior (UB)	1.062	0.314	0.027	11.817	0.000	Yes	0.116
5	Behavioral Intention (BI) -> Use Behavior (UB)	1.062	0.245	0.027	8.964	0.000	Yes	0.070
6	Task Characteristics (TC) -> Task-Technology Fit (TTF)	1.034	0.276	0.026	10.529	0.000	Yes	0.088
7	Technology Characteristics (TEC) -> Task-Technology Fit (TTF)	1.034	0.246	0.026	9.377	0.000	Yes	0.070
8	Task-Technology Fit (TTF) -> Research Practices (RP)	1.181	0.263	0.029	8.988	0.000	Yes	0.073
9	Task-Technology Fit (TTF) -> Research Performance (RPE)	1.254	-0.139	0.029	4.846	0.000	Yes	0.018
10	Use Behavior (UB) -> Research Practices (RP)	1.114	-0.067	0.026	2.582	0.010	Yes	0.005
11	Use Behavior (UB) -> Research Performance (RPE)	1.115	0.108	0.027	4.041	0.000	Yes	0.012
12	Research Practices (RP) -> Research Performance (RPE)	1.282	0.299	0.030	10.121	0.000	Yes	0.082
13	PER x UB -> RP	1.114	0.012	0.026	0.446	0.656	No	0.000
14	PER x TTF -> RP	1.232	0.080	0.025	3.233	0.001	Yes	0.008
15	PER x RP -> RPE	1.376	0.007	0.024	0.280	0.779	No	0.000

TC ($\beta = 0.276$, $t = 10.529$, $p < 0.001$) and TCh ($\beta = 0.246$, $t = 9.377$, $p < 0.001$) significantly impact TTF, which in turn positively influences RP ($\beta = 0.263$, $t = 8.988$, $p < 0.001$) but negatively impacts RPf ($\beta = -0.139$, $t = 4.846$, $p < 0.001$). UB negatively affects RP ($\beta = -0.067$, $t = 2.582$, $p = 0.010$) but positively influences RPf ($\beta = 0.108$, $t = 4.041$, $p < 0.001$). Finally, RP strongly influence RPf ($\beta = 0.299$, $t = 10.121$, $p < 0.001$).

6. Conclusion

The research demonstrates that PE has a significant influence on BI, suggesting that a higher PE is associated with a larger inclination to utilize technology (Venkatesh et al., 2003). Perceived ease of use has a significant role in influencing user intentions, as shown by the positive influence of EE on BI. This finding aligns with the research of (Venkatesh & Bala, 2008), emphasising the significance of ease of use in moulding UB. SI has a considerable influence on BI, highlighting the importance of social norms in the adoption of technology. FC have a direct influence on the actual use of technology UB, emphasizing the need of having supporting resources. The qualities of a task and how well it aligns with technology may improve RPf. However, the alignment between task and technology can have a detrimental influence on the effectiveness of RPf, suggesting a complicated link between task-technology alignment and results.

7. Limitations

The study promotes research technology use but has downsides. Cross-sectional research cannot prove causality; short-term and longitudinal studies are required to capture technology's dynamic influence. Social desirability may skew self-reported data and findings. Objective metrics like usage logs may increase results reliability. The study's focus on academics restricts its generalizability since technology adoption characteristics differ by field and culture, underscoring the need for further research across demographics. The approach ignores technical skills, institutional backing, and moderating factors like age and experience that may explain technology's importance.

The study examines Task-Technology Fit but not task characteristics or technology quality, which are needed to understand how technology affects research outcomes. Diverse samples and expanded methodologies would substantially boost technological understanding and research performance.

8. Scope of future research

Future research should adopt longitudinal studies to examine the evolving impacts of technology (specifically the booming AI transpose in research) on research performance, enhancing causal insights. Expanding the sample to diverse fields and cultural contexts would improve generalizability. Incorporating objective data, such as usage analytics, alongside self-reports, can reduce biases. Exploring individual differences like technological skills, motivation, and task-specific characteristics will deepen understanding. Additionally, examining moderating factors such as age, experience, and organizational culture would provide insights into the varied effectiveness of technology adoption strategies, ultimately contributing to a more comprehensive understanding of its role in research contexts.

References

Aboagye, E., Jensen, I., Bergström, G., Björk Brämberg, E., Pico-Espinosa, O. J., et al. (2021). Investigating the association between publication performance and the work environment of university research academics: a systematic review. Scientometrics, 126(4), 3283-3301. https://doi.org/10.1007/s11192-020-03820-y

Aditia, Ezra and Tela, Nengah and Saleh, Nursyam and Ilona, Desi and Zaitul, Zaitul. (2018). Understanding the Behavioral Intention to Use a University Web-Portal. MATEC Web of Conferences. 248. 05004. https://doi.org/10.1051/matecconf/201824805004.

Agudo-Peregrina, Á. F., Hernández-García, Á., and Pascual-Miguel, F. J. (2014). Behavioral intention, use behavior and the acceptance of electronic learning systems: Differences between higher education and lifelong learning. Computers in Human Behavior, 34, 301–314. https://doi.org/10.1016/j.chb.2013.10.035

Agustí López, A. I., Martí Aras, A., Rodríguez Martín, A., and Gabarda Méndez, C. (2023). Personality, Burnout and Digital Competence in university professor, An approach to the current reality. Innoeduca. International Journal of Technology and Educational Innovation, 9(2), 162–176. https://doi.org/10.24310/innoeduca.2023.v9i2.15063

Ahmed M. Mutahar, Osama Isaac, Abhijit Ghosh, and Ahmed Hamoud Al-Shibami. (2018). Perceived Value As A Moderator Variable In Mobile Banking Context: An Extension Of Technology Acceptance Model (Tam). International Journal Of Management And Human Science (IJMHS), 2(1), 1-8. https://Ejournal.Lucp.Net/ Index.Php/Ijmhs/Article/View/825

Ahmet Ayaz, Mustafa Yanartaş. (2020) An analysis on the unified theory of acceptance and use of technology theory (UTAUT): Acceptance of electronic document management system (EDMS), Computers in Human Behavior Reports, Volume 2, ISSN 2451-9588, https://doi.org/10. 1016/j.chbr.2020.100032.

Aljarboa, Soliman and Miah, Shah. (2020). An Integration of UTAUT and Task-Technology Fit Frameworks for Assessing the Acceptance of Clinical Decision Support Systems in the Context of a Developing Country.

ALKursheh, T. (2024). Higher Tertiary Education Perspectives: Evaluating the Electronic Assessment Techniques of the Blackboard Platform for Fairness and Reliability. Innoeduca. International Journal of Technology and Educational Innovation, 10(1), 144–165. https:// doi. org/ 10.24310/ijtei.101.2024.17813

Alonso, S., Cabrerizo, F. J., Herrera-Viedma, E., and Herrera, F. (2009). h-Index: A review focused in its variants, computation and standardization for different scientific fields. Journal of Informetrics, 3(4), 273–289. https://doi.org/10.1016/j.joi.2009.04.001

Alwadain A, Fati SM, Ali K, Ali RF (2024) From theory to practice: An integrated TTF-UTAUT study on electric vehicle adoption behavior. PLoS ONE 19(3): e0297890. https://doi.org/10.1371/ journal.pone.0297890

Archer, L. 2008. Younger academics' constructions of 'authenticity', 'success' and professional identity. Studies in Higher Education 33, no. 4: 385–403

Ashish A. Linge , Tushar Chaudhari , Baldeo B. Kakde , and Mahesh Singh. (2023) Analysis of Factors Affecting Use Behavior towards MobilePayment Apps: A SEM Approach; Human Behavior and Emerging TechnologiesVolume 2023, Article ID 3327994, https://doi.org/10.1155/2023/ 3327994

Atiqah, S. N., Hanafiah, M. H., Ismail, H., and Kandappan, B. (2024). Preparing instructors to transition to online distance learning: a pandemic panacea? Innoeduca. International Journal of Technology and Educational Innovation, 10(1), 5–28. https://doi.org/10.24310/ijtei.101.2024. 16820

Azam, N. A. J., Kabiraj, S., Shaoyuan, W., and Azam, M. I. A. (2023). Adoption of TAM to Measure Consumer's Attitude Towards Self-Service Technology: Utilizing Cultural Perspectives as a Moderator Variable. Global Business Review, 0(0). https://doi.org/10.1177/09721509221142373

Bazeley, Pat(2010) 'Conceptualising research performance', Studies in Higher Education, 35: 8, 889 —903,

Bourdieu, P. 2001. Homo academicus. Cambridge: Polity Press

Brezavšček, A. (2016). Factors Influencing the Behavioural Intention to Use Statistical Software: The Perspective of the Slovenian Students of Social Sciences. EURASIA Journal of Mathematics, Science and Technology Education, 13(3). https://doi.org/10.12973/eurasia.2017.00652a

Burton-Jones, A., and Hubona, G. S. (2005). Individual differences and usage behavior. ACM SIGMIS Database, 36(2), 58–77. https://doi.org/10.1145/1066149. 1066155

Cantero Téllez, R., Romero Galisteo, R. P., and Rodriguez Bailón, M. (2022). Personal and teaching factors related to university professors' stress levels in the face of COVID-19. Innoeduca. International Journal of Technology and Educational Innovation, 8(1), 102–110. https://doi.org/10.24310/innoeduca.2022.v8i1.11920

Chan, S., and Lu, M. (2004). Understanding Internet Banking Adoption and Use Behavior. Journal of Global Information Management, 12(3), 21–43. https://doi.org/10.4018/jgim.2004070102

Chao, C.-M. (2019). Factors Determining the Behavioral Intention to Use Mobile Learning: An Application and Extension of the UTAUT Model. Frontiers in Psychology, 10. https://doi.org/10.3389/fpsyg. 2019.01652

Cigdem, H., and Oncu, S. (2024). Understanding the Role of Self-Regulated Learning in Academic Success. A Blended Learning Perspective in Vocational Education. Innoeduca. International Journal of Technology and Educational Innovation, 10(1), 45–64. https://doi.org/10.24310 /ijtei.101.2024.17432

Cook, D. A., and Triola, M. M. (2014). What is the role of e-learning? Looking past the hype. Medical education, 48(9), 930-937. https://doi.org/10.1111/ medu. 12484

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319-340. https://doi.org/10.2307/249008

Dishaw, M. T., and Strong, D. M. (1999). Extending the technology acceptance model with task–technology fit constructs. Information and Management, 36(1), 9-21. https://doi.org/10.1016/S0378-7206(98)00101-3

Dishaw, M. T., and Strong, D. M. (1999). Extending the technology acceptance model with task–technology fit constructs. Information and Management, 36(1), 9-21. https://doi.org/10.1016/S0378-7206(98)00101-3

Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., Williams, M. D. (2019). Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. International Journal of Information Management. https://doi.org/10.1016/j.ijinfomgt.2019.08.002

Dwivedi, Y. K., Rana, N. P., Jeyaraj, A., Clement, M., and Williams, M. D. (2019). Re-examining the unified theory of acceptance and use of technology (UTAUT): Towards a revised theoretical model. Information Systems Frontiers, 21(3), 719-734. https://doi.org/10.1007/s10796-017-9774-y

Faida, E. W., Supriyanto, S., Haksama, S., Suryaningtyas, W., Astuti, W., Nudji, B., and Hasina, S. N. (2022). The effect of performance expectancy and behavioral intention on the use of electronic medical record (EMR) intertie hospital in Indonesia. International Journal of Health Sciences, 6(S9), 1195– 1205. https://doi.org/10.53730/ijhs.v6nS9.12729

Fishman, J., Lushin, V. and Mandell, D.S. Predicting implementation: comparing validated measures of intention and assessing the role of motivation when designing behavioral interventions. Implement Sci Commun 1, 81 (2020). https://doi.org/10.1186/ s43058-020-00050-4

Fitrianie, S., Horsch, C., Beun, R.J. et al. Factors Affecting User's Behavioral Intention and Use of a Mobile-Phone-Delivered Cognitive Behavioral Therapy for Insomnia: A Small-Scale UTAUT Analysis. J Med Syst 45, 110 (2021). https://doi. org/10. 1007/s10916-021-01785-w

Front. Public Health 10:905968.doi: 10.3389/fpubh. 2022.905968

George, Rowena and Jonathan, Victoria and Michael, Florianna. (2020). The Relationship between Task Characteristics and Employee Engagement. Trends in Undergraduate Research. 3. 1-6. https://doi.org/10.33736/tur.1837.2020.

González Sodis, J. L., and Leiva Olivencia , J. J. . (2022). Perception of TIC conflicts among secondary school students in a private school. School mediation as a response. Innoeduca. International Journal of Technology and Educational Innovation, 8(2), 58–68. https://doi.org/10.24310/innoeduca.2022.v8i2.12655

Goodhue, D. L., and Thompson, R. L. (1995). Task-technology fit and individual performance. MIS Quarterly, 19(2), 213-236. 10.2307/249689

Goodhue, D.L.: Development and measurement validity of a task-technology fit instrument for user evaluations of information system. Decis. Sci. 29, 105–138 (1998). https://doi.org/10.1111/j. 1540-5915.1998.tb01346.x

Gruzd, A., Staves, K., and Wilk, A. (2012). Connected scholars: Examining the role of social media in research practices of faculty using the UTAUT model. Computers in Human Behavior, 28(6), 2340–2350. https://doi.org/10.1016/j.chb.2012.07.004

Hackman, J. R. (1968). Effects of task characteristics on group products. Journal of Experimental Social Psychology, 4(2), 162–187. https://doi.org/10.1016/0022-1031(68)90040-1

Hameed, F., Qayyum, A. and Khan, F.A. A new trend of learning and teaching: Behavioral intention towards mobile learning. J. Comput. Educ. 11, 149–180 (2024). https://doi.org/10.1007/s40692-022-00252-w

Hong, S., Thong, J. Y. L., and Tam, K. Y. (2006). Understanding continued information technology usage behavior: A comparison of three models in the context of mobile internet. Decision Support Systems, 42(3), 1819–1834. https://doi.org/10.1016/j.dss. 2006.03.009

Hoppmann, J., Anadon, L. D., and Narayanamurti, V. (2020). Why matter matters: How technology characteristics shape the strategic framing of technologies. Research Policy, 49(1), 103882. https://doi.org/10.1016/j.respol.2019.103882

Hoque, Md and Bao, Yukun. (2017). Investigating Factors Affecting Elderly's Intention to Use m-Health Services: An Empirical Study. Telemedicine and e-Health. 24. https://doi.org/10.1037/t40308-000

Ibadan, Nigeria. Interdisciplinary Journal of e-Skills and Lifelong Learning, 14, 95-115

Izuma, K. (2017). The Neural Bases of Social Influence on Valuation and Behavior. Decision Neuroscience, 199–209. https://doi.org/10.1016/b978-0-12-805308-9.00016-6

Javed, Y., Ahmad, S., and Khahro, S. H. (2020). Evaluating the Research Performance of Islamabad-Based Higher Education Institutes. SAGE Open, 10(1), 215824402090208. https://doi.org/10.1177/2158244020902085

Jiménez Sabino, M. J., and Cabero Almenara, J. (2021). The technological, pedagogical and content knowledge of Andalusian university professors on ICT. Analysis from the TPACK model. Innoeduca. International Journal of Technology and Educational Innovation, 7(1), 4–18. https://doi.org/10.24310/innoeduca.2021.v7i1.11940

Joseph C. Shih, Sophia Shu-Chuan Chang (2013) Journal of Advanced Management Science, Vol. 1, No. 1

Kaczmarek, L. D., Kashdan, T. B., Drążkowski, D., Enko, J., Kosakowski, M., Szäefer, A., and Bujacz, A. (2015). Behavioral Intention Scale. APA PsycTests.

Kesuma, F., and Syamsuar, D. (2021). Task-Technology Fit (TTF) dan Unified Theory of Acceptance and Use of Technology (UTAUT): Analisis Model Penerimaan Teknologi di Perguruan Tinggi. JUSIFO (Jurnal Sistem Informasi), 7(1), 21-31. https://doi.org/10.19109/ jusifo.v7i1.7870

Ma, Lixia and Jing, Jin. (2023). A study on content validity of TEM4 listening comprehension (2016-2023). Journal of Language Teaching. 3. 69-79. https://doi.org/10.54475/jlt.2023.031.

Mathieson, K. (1991). Predicting user intentions: Comparing the technology acceptance model with the theory of planned behavior. Information Systems Research, 2(3), 173-191. DOI: 10.1287/isre.2.3.173

Obinna C. Ojiaku; Ebuka Christian Ezenwafor; Aihie Osarenkhoe, (2023). International Journal of Technology Marketing, 2024 Vol.18 No.1, pp.113 - 135. https://doi.org/10.1504/IJTMKT.2024.135674

Oguguo, B., Ezechukwu, R. ., Nannim, F., and Offor, K. (2023). Analysis of teachers in the use of digital resources in online teaching and assessment in COVID times . Innoeduca. International Journal of Technology and Educational Innovation, 9(1), 81–96. https://doi.org/10.24310/innoeduca.2023.v9i1.15419

Omotayo, F. O., and Haliru, A. (2019). Perception of task-technology fit of digital library among undergraduates in selected universities in Nigeria. The Journal of Academic Librarianship, 102097. https://doi.org/10.1016/j.acalib.2019.102097

Onaolapo, S., and Oyewole, O. (2018). Performance expectancy, effort expectancy, and facilitating conditions as factors influencing smart phones use for mobile learning by postgraduate students of the University of

Orlikowski, W.J.: Using technology and constituting structures: a practice lens for studying technology in organizations. Organ. Sci. 11, 404–428 (2000). https://doi.org/10.1287/orsc.11.4. 404.14600

Ozer Sanal, S. (2023). Interactive and social reading intervention in design-based research. Innoeduca. International Journal of Technology and Educational Innovation, 9(1), 112–125. https://doi.org/10.24310/innoeduca.2023.v9i1.15403

Padilla-Hernández, A. L., Gámiz-Sánchez, V. M., and Romero-López, M. A. (2019). Proficiency levels of teachers' digital competence: ?a review of recent international frameworks. Innoeduca. International Journal of Technology and Educational Innovation, 5(2), 140–150. https://doi.org/10.24310/innoeduca.2019.v5i2.5600

Rahmiati, and Susanto, Perengki. (2021). Use Behavior of E-Money: Empirical Analysis Using The UTAUT Model. https://doi.org/10.2991/aebmr.k.210616.061.

Ramírez Hernández, M., Maldonado Berea, G. A., and Marín-Díaz, V. (2015). Internet use in the field of academic university. Innoeduca. International Journal of Technology and Educational Innovation, 1(2), 69–79. https://doi.org/10.20548/innoeduca.2015.v1i2.1058

Roy Setiawan, Anis Eliyana, Tatik Suryani, Tatik Suryani, Elias Gabriel Aristo, Aisha Anwar. (2022), A Study Of Behavioral Intention: The Practices For Mobile Payment Technology Users In Indonesia ; Webology (ISSN: 1735-188X)

Sánchez Vega, E., Cantero-Téllez, R., and Rodríguez-Martínez, M. del C. (2016). Internet addiction in future teachers. A case study with university students. Innoeduca. International Journal of Technology and Educational Innovation, 2(1), 46–53. https://doi.org/10.20548/innoeduca.2016.v2i1.1063

Sun, H., and Zhang, P. (2006). The role of moderating factors in user technology acceptance. International Journal of Human-Computer Studies, 64(2), 53–78. https://doi.org/10.1016/j.ijhcs.2005.04.013

Talan, T., Doğan, Y., and Kalinkara, Y. (2024). Digital Natives' Mobile Learning Adoption in terms of UTAUT-2 Model: a Structural Equation Model. Innoeduca. International Journal of Technology and Educational Innovation, 10(1), 100–123. https://doi.org/10.24310/ijtei.101.2024 .17440

Talebian, S., Mohammadi, H. M., and Rezvanfar, A. (2014). Infor-mation and communication technology (ICT) in higher education: advantages, disadvantages, conveniences and limitations of applying e-learning to agricultural students in Iran. Procedia-Social and Behavioral Sciences, 152, 300-305. https://doi.org/10.1016/j.sbspro.2014.09.199

Utomo, P., Kurniasari, F., and Purnamaningsih, P. (2021). The Effects of Performance Expectancy, Effort Expectancy, Facilitating Condition, and Habit on Behavior Intention in Using Mobile Healthcare Application. International Journal of Community Service and Engagement, 2(4), 183-197. https://doi.org/10.47747/ijcse.v2i4.529

Venkatesh, V., and Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. Decision Sciences, 39(2), 273-315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

Venkatesh, V., and Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. Management Science, 46(2), 186-204. https://doi.org/10.1287/mnsc.46.2.186.11926

Venkatesh, V., Brown, S. A., Maruping, L. M., and Bala, H. (2008). Predicting Different Conceptualizations of System Use: The Competing Roles of Behavioral Intention, Facilitating Conditions, and Behavioral Expectation. MIS Quarterly, 32(3), 483–502. https://doi.org/10.2307/25148853

Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS Quarterly, 27(3), 425-478. https://doi.org/10.2307/30036540

Viswanath Venkatesh, James Y. L. Thong, Xin Xu (2016). Unified Theory of Acceptance and Use of Technology: A Synthesis and the Road Ahead, Journal of the Association for Information Systems, Volume 17 Issue 5 pp. 328 – 376

Wahab E, Al-Rahmi WM, Alturki U, Aldraiweesh A and Almutairy S (2022) Integrating the Role of UTAUT and TTF Model to Evaluate Social Media Use for Teaching and Learning in Higher Education.

Wan, Liyong and Xie, Shoumei and Shu, Ai. (2020). Toward an Understanding of University Students' Continued Intention to Use MOOCs: When UTAUT Model Meets TTF Model. SAGE Open. 10. 215824402094185. https://doi.org/10.1177/2158244020941 858

Xu, Q., Erman, J., Gerber, A., Mao, Z., Pang, J., and Venkataraman, S. (2011). Identifying diverse usage behaviors of smartphone apps. Proceedings of the 2011 ACM SIGCOMM Conference on Internet Measurement Conference - IMC '11. https://doi.org/10.1145/2068816.2068847

Zarina Kamarozaman and Fahmi Zaidi Abdul Razak 2021 J. Phys.: Conf. Ser. 1793 012022

Zhang H, He J, Shi X, Hong Q, Bao J, Xue S. Technology Characteristics, Stakeholder Pressure, Social Influence, and Green Innovation: Empirical Evidence from Chinese Express Companies. Sustainability. 2020; 12(7):2891. https://doi.org/10.3390/su12072891

Zigurs, I., and Buckland, B. K. (1998). A theory of task/technology fit and group support systems effectiveness. MIS Quarterly, 22(3), 313-334. 10.2307/249668

Zigurs, I., and Buckland, B. K. (1998). A theory of task/technology fit and group support systems effectiveness. MIS Quarterly, 22(3), 313-334. https://doi.org/10.2307/249668

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 20, No. 3 (2024), pp. 83-89

Design and validation of a questionnaire to assess digital skills for research

Bexi Perdomo[a,1], Oscar Alberto Morales[b]

[a]*Universidad de Ciencias y Artes de América Latina (UCAL)*

[b]*Universidad de Los Andes (ULA), Venezuela*

(submitted: 18/8/2024; accepted: 13/10/2024; published: 30/10/2024)

Abstract

The fast evolution of technology makes digital competencies mandatories in all professional contexts. The aim was to systematize the design and validation of a questionnaire to measure digital skills for research. The methodology included a literature review to identify the theoretical bases and the dimensions or components of digital skills and the design of the questionnaire. Secondly, its validity was tested through the Content Validity Index (CVI) with the judgment of six experts and the Exploratory Factor Analysis (EFA) with a sample of 96 researchers. Finally, Cronbach's alpha coefficient test was performed to assess reliability. The Kaiser-Meyer-Olkin (KMO) determined sampling adequacy (KMO= .830) and the analysis showed significant Bartlett's sphericity test (p= .000). The anti-image matrix showed high values except for the first item that did not reach the critical threshold in the communality's values; so, it was removed. The validity test showed high content validity coefficient (IVC= .98). Regarding the EFA, the six-factor analysis revealed that nine out of the 14 items showed factor loading > 0.7. The reliability test also showed positive results (α=.874). The six dimensions measured with this questionnaire are consistent with the European Framework for Digital Skills and with previous proposals for the study of digital skills in teaching and learning contexts. Also, they match important theories that explain digital skills usefulness in research. In conclusion, this may be a useful instrument in the initial phases of policy planning for strengthening scientific production and closing gaps in digital competencies in universities.

KEYWORDS: Digital Skills, Researchers, Content Validity, Factorial Analysis.

DOI
https://doi.org/10.20368/1971-8829/1136008

CITE AS
Perdomo, B., & Morales, O.A. (2024). Design and validation of a questionnaire to assess digital skills for research. *Journal of e-Learning and Knowledge Society*, *20*(3), 83-89. https://doi.org/10.20368/1971-8829/1136008

1. Introduction

The mastery of digital competence has become a fundamental component both for daily life and for professional and academic performance in the contemporary era (Arroba-Freire et al., 2022; Centeno-Caamal, 2021; Vera & Aguilera, 2024). Digital competencies encompass a set of skills that enable individuals to effectively interact with digital technologies, manage complex information, communicate globally, and solve problems in dynamic digital environments (Massieu et al., 2024; Verdú-Pina et al., 2023). Those skills are needed for active participation in the digital society and for scientific research. Then, the study of digital competencies in the university should be part of all universities' agenda (Silva et al., 2023).

In addition, the development of digital and research skills empowers critical thinking and communication as well as other skills needed for the production of new knowledge (Churampi-Cangalaya et al., 2024; Perdomo, 2023).

In the academic and research arena, researchers need digital skills to access, manage, analyze and communicate information. In that context, the information literacy (i.e., the ability to identify, evaluate and effectively use information from diverse sources) is closely intertwined with the development of digital skills, providing an essential framework for

[1] corresponding author - email: bperdomo@ucal.edu.pe

evidence-based research and informed decision-making. That is why Kuhlthau's (2004) Theory of Information Literacy may be seen as part of the theoretical framework for digital skills study. It highlights the importance of a procedural approach to gather and use of information, which is fundamental for success in scientific production. This widely recognized theory has supported studies aiming to comprehensively explore the processes of undergraduate students engaged in becoming properly informed (Buba et al., 2021).

In the literature there is not consensus to reach a unique definition for digital skills (Barbazan et al., 2021; Paz et al., 2021; Perdomo et al., 2020). The General Directorate of Evaluation and Territorial Cooperation for the Reference Framework of Teaching Digital Competence (MRCDD) summarized digital skills as the safe, critical and creative use of information and communication technologies to achieve proposed objectives in the workplace and in educational, scientific and leisure contexts (Resolution of May 4th 2022, from the General Bureau of Territory Evaluation and Cooperation, 2022). However, for this research we share the definition provided by Le et al. (2023) who see digital skills as the ability and confidence to apply knowledge to complete tasks by using information technology that includes computing devices, software and the internet.

The development and evaluation of digital skills in the context of scientific research impacts the efficiency and effectiveness of research processes and results' quality and relevance (Perdomo & Morales, 2022). Previous studies have documented that university instructors must properly guide their students in research skills to increase their academic performance (Guillén-Gámez et al., 2020), they also have found evidence suggesting that digital research competences may be related to other transversal skills (Guillén-Gámez et al., 2023, 2024).

Researchers with a high level of digital skills are able to use of the technological tools to explore new methodologies, manage large volumes of data, and collaborate effectively with colleagues locally and internationally. In this regard, the Digital Competence Framework (DigComp) provides structured guidance on the necessary competences, covering areas such as digital content creation, security and technical problem solving (Mattar et al., 2020; Saidi et al., 2023; Segura et al., 2023).

In addition to specific technical skills, the mastery of digital competencies encompasses the ability to adapt to the continuous changing technological settings and the effective resolution of technical problems that may arise in the research process (Segura et al., 2023). The Self-Efficacy Theory proposed by Bandura (1997) suggest that digitally-skilled researchers are more likely to face technological challenges with confidence and overcome technology-related hindrances more effectively. These skills promote better performance when conducting rigorous and efficient research and also promote innovation and creativity in the generation of new knowledge. Finally, Davis' (1989) Technology Acceptance Model (TAM) helps to understand how perceptions of usefulness and ease of use of digital technologies can influence their adoption and use by researchers.

Various authors have addressed the study of digital skills. Some of them have been oriented towards their conceptualization and measurement in teachers (Barbazan et al., 2021; Churampi-Cangalaya et al., 2024; Claro et al., 2024; García-Ruiz et al., 2023; Vera & Aguilera, 2024) and students (Arroba-Freire et al., 2022; Martzoukou et al., 2020; Sánchez-Caballé et al., 2020). However, there is a gap in terms of the construction and validation of an instrument that measures digital competencies in researchers.

This study aimed to systematize the design and validation of an instrument for the measurement of digital skills for research. It was expected to offer a useful instrument to obtain evidence useful for planning policies to enhance digital competencies in researchers. This instrument was meant to facilitates evidence-based decision-making and to evaluate the results of the established programs and policies. Hence, we conducted a study through a process that included the confirmation of theoretical basis, design of the instrument and the use of different techniques to assess the questionnaire in terms of validity and reliability.

2. Methods

The first step was to conduct a literature review to identify the dimensions of digital competence. In this sense, the five dimensions proposed in the DigCom (Resolution of May 4th 2022, from the General Bureau of Territory Evaluation and Cooperation, 2022; Saidi et al., 2023; Segura et al., 2023) were included. The use of equipment and devices was added as a dimension, since this is linked to the other five (Vitezić & Perić, 2024). After this review and the operationalization of the variable and its dimensions, a 15-item questionnaire was designed.

The quantitative content validity was performed through the experts' judgment technique with the calculation of Lawshe's Content Validity Index (CVI) from the Content Validity Ratio (CVR') and the adjustment of minimum values for greater credibility of the evidence. The analysis was made with a constant minimum value of CVR' and CVI = .5823 (Tristán-López, 2008). The experts were six experimented researchers in the field of digital competence that accepted to assess the instrument anonymously. Their expertise was proved through their registered publications in high impact journals indexed in Scopus database and their h index.

Subsequently, the resulting formal questionnaire was sent through Google Forms to 120 researchers for a pilot test aiming to assess the questionnaire reliability and construct validity. The former was established through, the Cronbach's alpha coefficient. The latter was confirmed with the Exploratory Factor Analysis (EFA) (Osborne, 2014), following Watkins' (2018) recommendations for reliable results with the EFA. After those tests and analyses, we expected to get the final version of the instrument.

3. Results

3.1 Content validation

The initial version of the questionnaire contained 15 items in a five-options Likert scale ranging from totally disagree to totally agree. The six experts were provided with the questionnaire, the operationalization table and the format for content validity assessment.

The results showed high content validity index (CVI= .98). All items, except items two and seven obtained CVR'= 1.00; none was considered 'non-indispensable' (see Table 1).

Table 1 - Results of quantitative validation.
Source: own elaboration .

CONTENT VALIDITY INDEX: CVI

Item	Essential	Useful/non-essential	Not important	N judges /2	Include	CVR'
1	6	0	0	3	Yes	1.00
2	5	1	0	3	Yes	.90
3	6	0	0	3	Yes	1.00
4	6	0	0	3	Yes	1.00
5	6	0	0	3	Yes	1.00
6	6	0	0	3	Yes	1.00
7	5	1	0	3	Yes	.90
8	6	0	0	3	Yes	1.00
9	6	0	0	3	Yes	1.00
10	6	0	0	3	Yes	1.00
11	6	0	0	3	Yes	1.00
12	6	0	0	3	Yes	1.00
13	6	0	0	3	Yes	1.00
14	6	0	0	3	Yes	1.00
15	6	0	0	3	Yes	1.00
					CVI	**0.98**

Results in Table 1 evidence robust quantitative validity of the items according to the experts, considering that the minimum value of the CVI for this test is .5823. Also, when they were asked about the need of adding more items, they claimed the completeness of the instrument.

3.2 Construct validity and reliability

The questionnaire was sent to 120 researchers from different universities and research centers. The response rate was 79.6 % (n= 96). Then, a sample of 96 researchers (52 male and 44 female) answered the questionnaire. Their average age was 44.7 years (Min 25 – Max 67; SD: 9.7). A database was created in Microsoft Excel© and processed with IBM-SPSS (version 27.0) to calculate construct validity and reliability.

The authors used the EFA to assess the construct validity of this questionnaire. Before conducting the EFA, the authors confirmed the suitability of data for such assessment. The Kaiser-Meyer-Olkin (KMO) measure for sampling adequacy resulted in 0.830 and the Bartlett's sphericity test proved to be statistically significant (p= .000). The anti-image matrix showed high values except for the first item that did not reach the critical threshold in the communality's values; so, it was removed.

After proving data adequacy, the EFA was conducted for the six fixed factors using the Varimax method. The main component analysis was the extraction method with rotation, converging in nine iterations. Results are shown in Table 2.

Nine out of 14 items showed factor loading > 0.7. The lowest value was found for item 9 (0.507); however, it was inside the acceptable results to be included. All the values obtained are high enough to evidence the consistency of all the items because they are over the critical threshold (0.5). Then, reliability was calculated with Cronbach's alpha coefficient. This analysis showed high reliability (ɑ=.874).

3.3 Resulting data-gathering instrument

The authors recalculated the IVC of the final version by eliminating the evaluation to the excluded item and calculating averages of experts' evaluation for the remaining 14 items. The, IVC for the final questionnaire did not suffer any change. In few words, the tested instrument showed strong validity (CVI= .98), solid construct validity in the EFA, and high reliability (ɑ= .874).

The final version was a six-factor questionnaire with 14 items in Likert scale with the following options: Totally disagree (TD), partially disagree (PD), neutral position (NP), Partially agree (PA), and totally agree (TA) (see Table 3).

4. Discussion and Conclusions

The development of digital skills is a must for researchers to face and overcome challenges in a technology-mediated world (Kuzminska et al., 2021, 2023). Digital skills help researchers to access and manage information efficiently. They also facilitate collaborative work, innovation and high-quality knowledge production (Subaveerapandiyan et al., 2024). Researchers with advanced digital skills are better equipped to adapt to emerging technologies, optimize their research processes and contribute significantly to scientific progress. In that sense, fostering digital competencies through appropriate training programs and institutional policies is a central strategic investment for scientific and technological progress in academia. However, it is necessary to conduct research to assess those skills to identify strengths and weaknesses for proper planning.

The authors of the present study aimed to systematize the design and validation of an instrument for the measurement of digital skills in researchers. The instrument showed high reliability (α=.874). In addition, this questionnaire presented high content validity (IVC= .98 for a threshold of .58) and showed solid construct validity, as seen in the EFA. The result of this study was a valid and reliable instrument to assess digital skills in the field of research.

Table 2 - Rotated component matrix for the Exploratory Factor Analysis (EFA) .

Note. UDS: Use of devices and software. IL: Information Literacy. DC: Digital Communication. CC: Content Creation. DS: Digital Security. PS: Problem solving.

	Component / Factor					
	1 UDS	2 IL	3 DC	4 CC	5 DS	6 PS
1	0.796					
2	0.768					
3	0.701					
4		0.590				
5		0.766				
6			0.729			
7			0.786			
8			0.663			
9				0.507		
10				0.786		
11					0.665	
12					0.863	
13						0.797
14						0.589

Table 3 - Questionnaire to assess digital skills for research.

Item	TD	PD	NP	PA	TA
UDS: Use of devices and software					
I use digital devices (e.g., phone and tablet) to carry out scientific research.					
I feel comfortable using specific programs for scientific research (e.g., software for data analysis).					
I efficiently use digital tools to manage scientific literature and generate citations and references.					
IL: Information Literacy.					
I frequently search for scientific literature in academic databases.					
I evaluate the epistemological quality and relevance of scientific articles found online.					
DC: Digital Communication.					
I use email and online instant messaging applications to communicate with fellow researchers.					
I use of online collaborative tools for joint work on research projects.					
I easily participate in webinars and other scientific events in virtual mode to communicate the results of my research and listen to those of other researchers.					
CC: Content Creation.					
I comfortably use digital tools to write and edit research proposals and scientific manuscripts.					
I am skilled at using software to create and edit graphs and tables for data visualization in my research.					
DS: Digital Security.					
I troubleshoot technical issues with the software used for my research project.					
I troubleshoot technical issues with the hardware used for my research project.					
PS: Problem solving					
I troubleshoot technical issues with the software used in my research without external help.					
I troubleshoot technical issues with the hardware used in my research without external help.					

The limitation of the present study was the sample size which might be considered small to perform Confirmatory Factorial Analysis (CFA). The next step in research should be assessing the internal consistency of factors with a larger sample.

This questionnaire fills the gap of a tool to measure digital competencies in researchers. The present study provides evidence supporting its quality to be recommended for use in future research. This is a contribution for institutions aiming to explore the digital skills of their researchers. This questionnaire differs from the instruments analyzed by González-Rodríguez & Urbina-Ramírez (2020), which only measure digital competencies in teachers or students for teaching and learning purposes. It also differs from the versions of the TPACK (Alemán et al., 2023; Barajas et al., 2023; Paidican & Arredondo, 2022) and TPACK questionnaires applied to artificial intelligence (Ning et al., 2024; Saz-Pérez et al., 2024).

The six dimensions measured with this questionnaire are consistent with the European Framework for Digital Skills (Mattar et al., 2020) and with previous proposals for the study of digital skills in teaching and learning contexts (Saidi et al., 2023; Segura et al., 2023). Also, they match important theories that can explain digital skills usefulness in research (Bandura, 1997; Davis, 1989; Falloon, 2020; Kuhlthau, 2004). Hence, the authors recommend using it.

Some of the indicators considered in this instrument are similar to those analyzed by Peinado (2023) in his study on digital competences in university students. However, unlike Peinado (2023), in the present study, the evidence of the respective validations is provided and readers are offered the instrument in its entirety so that it can be used when studying these skills in researchers and researcher trainees. We suggest to conduct further research using this questionnaire with undergraduate students and the teaching staff to evidence their weaknesses and potential in terms of digital skills for research.

In conclusion, the results obtained in this study validate this questionnaire as an accurate and reliable tool for assessing digital competencies of researchers. This instrument might be useful in the initial phases of policy planning aiming to strengthen scientific production and to close gaps in digital competencies in faculties and students conducting or aiming to conduct research.

With the application of this questionnaire, institutional policy makers can have an evidence-based baseline to reinforce the aspects that need to be strengthened, directing resources appropriately. Likewise, with the application of this questionnaire, decisions can be made for the formation of research groups and mentoring programs. It makes it easier to form teams with people that complement each other and designate mentors according to their potential and needs.

References

Alemán, S. A., Deroncele-Acosta, A., & Robles-Mori, H. (2023). Traducción, adaptación cultural y validación del cuestionario TPACK-21 en docentes en servicio [Translation, adaptation and validity of the TPACK-21 questionnaire in teachers]. *Revista de Ciencias Sociales*, 29(3), 453-469.

Arroba-Freire, E., Bonilla-Jurado, D., Guevara, C., & Ramírez-Casco, A. (2022). Factor analysis: An application of the digital competencies questionnaire in students of the business administration career of the Instituto Tecnológico Superior España (ISTE). *Journal of Higher Education Theory and Practice*, 22(18), 201.

Bandura, A. (1997). *Self-Efficacy: The Exercise of Control*. W. H. Freeman.

Barajas, S., García, R., & Cuevas, O. (2023). Adaptación y validación de un instrumento basado en el modelo TPACK para docentes universitarios [Adaptation and validation of an instrument based on the TPACK model for university teachers]. *IE Revista de Investigación Educativa de La REDIECH*, 14, e1831. https://doi.org/10.33010/ie_rie_rediech.v14i0.1831

Barbazan, D., Ben, Khaddouja., & Montes, C. (2021). La competencia digital docente en educación superior: estado del arte en España y Latinoamérica [Digital Competence for Teachers in Higher Education: State of the Art in Spain and Latin America]. *Etic@net. Revista Científica Electrónica de Educación y Comunicación En La Sociedad Del Conocimiento*, 21(2), 267-282. https://doi.org/10.30827/eticanet.v21i2.20837

Centeno-Caamal, R. (2021). Formación tecnológica y competencias digitales docentes [Technological training and digital teaching skills]. *Revista Tecnológica-Educativa Docentes 2.0*, 11(1), 174-182. https://doi.org/10.37843/rted.v11i1.210

Churampi-Cangalaya, R. L., Inga-Ávila, M. F., Coz, K. R. L., Churampi-Cangalaya, J. J., Huamán-Pérez, F., Caballero, E. M., & Quispe, M. A. (2024). The impact of digital skills on teaching performance in higher education: A meta-analysis. International *Journal of Data and Network Science*, 8(4), 2185-2192. https://doi.org/10.5267/j.ijdns.2024.6.01

Claro, M., Castro-Grau, C., Ochoa, J., Hinostroza, J., & Cabello, P. (2024). Systematic review of quantitative research on digital competences of in-service school teachers. *Computers and Education*, 215, 105030. https://doi.org/10.1016/j.compedu.2024.105030

Davis, F. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. Management Information Systems Research Center, University of Minnesota.

Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Educational Technology Research and Development*, 68(5), 2449-2472. https://doi.org/10.1007/s11423-020-09767-4

García-Ruiz, R., Buenestado-Fernández, M., & Ramírez-Montoya, M. S. (2023). Assessment of digital teaching competence: Instruments, results and proposals. Systematic literature review.

Educacion XX1, 26(1), 273-301. https://doi.org/10.5944/educxx1.33520

González-Rodríguez, C., & Urbina-Ramírez, S. (2020). Análisis de instrumentos para el diagnóstico de la competencia digital [Analysis of instruments for the diagnosis of digital competence]. *Revista Interuniversitaria de Investigación En Tecnología Educativa*, 9, 1-12. https://doi.org/10.6018/riite.411101

Kuhlthau, C. (2004). *Seeking Meaning. A Process Approach to Library and Information Services* (2nd ed.). Bloomsbury Academic.

Kuzminska, O., Mazorchuk, M., Morze, N., Prokopchuk, M., & Danylchuk, H. (2023). Integrating digital competencies of researchers into Ph.D. curricula: a case study on open science education. *CEUR Workshop Proceedings*, 195-208.

Kuzminska, O., Morze, N., Varchenko-Trotsenko, L., Boiko, M., & Prokopchuk, M. (2021). Digital competence of future researchers: Empirical research of PhD students of ukrainian university. *ACM International Conference Proceeding Series*, 177-184. https://doi.org/10.1145/3526242.3526258

Le, T., Galperin, H., & Traube, D. (2023). The impact of digital competence on telehealth utilization. *Health Policy and Technology*, 12(1), 100724. https://doi.org/10.1016/j.hlpt.2023.100724

Martzoukou, K., Fulton, C., Kostagiolas, P., & Lavranos, C. (2020). A study of higher education students' self-perceived digital competences for learning and everyday life online participation. *Journal of Documentation*, 76(6), 1413-1458. https://doi.org/10.1108/JD-03-2020-0041

Massieu, A., Díaz, F., Sánchez, M., & Martínez, A. (2024). Evidencias de validez de un instrumento para evaluar la competencia digital docente en educación médica [Evidence of validity of an instrument to assess teaching digital competence in medical education]. *Investigacion En Educacion Medica*, 13(51), 82-92. https://doi.org/10.22201/fm.20075057e.2024.51.23584

Mattar, J., Piovezan, M., Souza, S., Santos, C., & dos Santos, A. (2020). Apresentação crítica do Quadro Europeu de Competência Digital (DigComp) e modelos relacionados [Critical presentation of the European Digital Competence Framework (DigComp) and related models]. *Research, Society and Development*, 9(4), e172943062. https://doi.org/10.33448/rsd-v9i4.3062

Ning, Y., Zhang, C., Xu, B., Zhou, Y., & Wijaya, T. (2024). Teachers' AI-TPACK: Exploring the relationship between knowledge elements. *Sustainability* (Switzerland), 16(3), 978. https://doi.org/10.3390/su16030978

Osborne, J. W. . (2014). Best practices in exloratory factor analysis. [CreateSpace Independent Publishing Platform].

Paidican, M., & Arredondo, P. (2022). Evaluación de la validez y fiabilidad del cuestionario de conocimiento tecnológico pedagógico del contenido (TPACK) para docentes de primaria [Evaluation of the validity and reliability of the Pedagogical Content Knowledge Questionnaire (TPACK) for primary school teachers]. *Revista Innova Educación*, 5(1), 38-58. https://doi.org/10.35622/j.rie.2023.05.003

Paz, D., Pontarolo, E., Santos, G., & Bernartt, M. (2021). Análisis de conteúdo sobre as definições de competência, competência digital e competência digital docente [Content analysis on the definitions of competence, digital competence and teacher digital competence]. *Trabalho & Educação*, 30(2), 207-225. https://doi.org/10.35699/2238-037x.2021.32817

Peinado, J. (2023). Uso de herramientas digitales y competencias de investigación en estudiantes de posgrado [Use of digital tools and research competencies in graduate students]. *Conrado*, 19(92), 8-17.

Perdomo, B., Gonzalez, O., & Barrutia, I. (2020). Competencias digitales en docentes universitarios: una revisión sistemática de la literatura [Digital competencies in university teachers: A systematic review of the literature]. *EDMETIC*, 9(2), 92-115. https://doi.org/10.21071/edmetic.v9i2.12796

Perdomo, B., & Morales, O. A. (2022). Errores y dificultades en la elaboración de las tesis de pre y postgrado del estudiantado peruano: Implicaciones pedagógicas [Errors and Difficulties Faced During the Elaboration of Undergraduate and Graduate Thesis by Peruvian Students: Pedagogical Implications]. *Revista Electronica Educare*, 26(1), 1-21. https://doi.org/10.15359/ree.26-1.21

Resolution of May 4th 2022, from the General Bureau of Territory Evaluation and Cooperation (2022). https://www.boe.es

Saidi, M., Nasir, G., Musa, J., & Kalinaki, K. (2023). Assessing digital competence in higher education: A gender analysis of DigComp 2.1 framework in Uganda. *SAGA: Journal of Technology and Information Systems*, 1(4), 114-120. https://doi.org/10.58905/SAGA.vol1i4.210

Sánchez-Caballé, A., Gisbert-Cervera, M., & Esteve-Mon, F. (2020). The digital competence of university students: a systematic literature review.

Revista de Psicologia, Ciències de l'Eduació i de l'Esport, 38(1), 63-74.

Saz-Pérez, F., Pizá-Mir, B., & Lizana, A. (2024). Validación y estructura factorial de un cuestionario TPACK en el contexto de Inteligencia Artificial Generativa (IAG). Hachetetepé. *Revista Científica de Eeducación y Comunicación*, 28, 1-14. https://doi.org/10.25267/hachetetepe.2024.i28.1101

Segura, R. I., Garrido, Y. C., Morueta, R. T., & Rodríguez-Miranda, F. P. (2023). Adapting digital competence 2.1 from the DigCom model in the context of active ageing. *2023 XIII International Conference on Virtual Campus (JICV)*, 1-4. https://doi.org/10.1109/JICV59748.2023.10565720

Subaveerapandiyan, A., Sinha, P., & Ugwulebo, J. (2024). Digital literacy skills among African library and information science professionals - an exploratory study. *Global Knowledge, Memory and Communication*, 73(4/5), 521-537. https://doi.org/10.1108/GKMC-06-2022-0138

Tristán-López, A. (2008). Modificación al modelo de Lawshe para el dictamen cuantitativo de la validez de contenido de un instrumento objetivo [Modification to Lawshe's model for quantitative assessment of the validity of content of an objective instrument]. *Avances En Medición*, 6(1), 37-48.

Vera, M., & Aguilera, A. (2024). Medición de las competencias digitales en Europa y España una revisión crítica [Medición de las competencias digitales en Europa y España una revisión crítica]. *Anales de Documentación*, 1-21. https://doi.org/10.6018/analesdoc.587551

Verdú-Pina, M., Lázaro-Cantabrana, J., Grimalt-Álvaro, C., & Usart, M. (2023). El concepto de competencia digital docente: revisión de la literatura [The concept of teaching digital competence: A literature review]. *Redie Revista Electrónica de Investigación Educativa*, 25, e11.

Vitezić, V., & Perić, M. (2024). The role of digital skills in the acceptance of artificial intelligence. *Journal of Business & Industrial Marketing*, 39(7), 1546-1566. https://doi.org/10.1108/JBIM-04-2023-0210

Watkins, M. W. (2018). Exploratory Factor Analysis: A guide to best practice. *Journal of Black Psychology*, 44(3), 219-246. https://doi.org/10.1177/0095798418771807

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 20, No. 3 (2024), pp. 90-100

Comparison of digital research skills between Spain and Ecuador

Juan José Victoria-Maldonado[a,1], Yosbanys Roque-Herrera[b],
Blanca Berral-Ortiz[a], Alejandra Salomé Sarmiento Benavides[c]

[a]*Universidad de Granada (Spain)*

[b]*Escuela Superior Politécnica de Chimborazo (Ecuador)*

[c]*Universidad Nacional de Chimborazo (Ecuador)*

(submitted: 30/8/2024; accepted: 13/10/2024; published: 7/11/2024)

Abstract

The idea of the university as a mere transmitter of knowledge has long been obsolete. In the context of educational research and innovation, it is university teachers who fulfill these roles. This shift, along with the technological advancements of the 21st century, highlights the need for a thorough investigation into how well university teachers are equipped to face these new challenges. Consequently, various tools have been developed to provide a research framework that allows for comparisons between countries. Tools such as DigCompEdu have been used to assess teachers' digital competencies and to facilitate cross-country comparisons.

However, this study does not focus on teaching competencies but rather on exploring research competencies related to ICTs. In this context, a comparison is made between Spain and Ecuador to examine how two institutions from different countries operate, as well as how they function in relation to gender and the stage of academic career development. This aims to identify aspects that can serve as distinguishing factors.

The results show that there are no significant differences in the comparison of researchers from the two universities, finding significant changes only for specific aspects, establishing as differentiating factors the idea of a greater intention to use ICT for research by researchers at the University of Granada and showing how during the training of university teachers, confidence is acquired to train new researchers, establishing the ideal time for training once they have more than 10 years of research and with a permanent university link.

KEYWORDS: ICT, Research Competences, Digital Competences, Correlation, Education Research.

DOI
https://doi.org/10.20368/1971-8829/1136031

CITE AS
Victoria-Maldonado, J.J., Roque-Herrera, Y., Berral-Ortiz, B., & Sarmiento Benavides, A.S. (2024). Comparison of digital research skills between Spain and Ecuador. *Journal of e-Learning and Knowledge Society*, *20*(3), 90-100. https://doi.org/10.20368/1971-8829/1136031

1. Introduction

Technology in the educational environment has seen significant development, especially since the Covid pandemic (Romero-Rodríguez et al., 2022). As a result, various technology-based projects have been proposed within educational institutions, gaining essential relevance (Paiva et al., 2018).

Therefore, different frameworks have been designed to identify which digital competencies are being developed. One notable framework is DigComp, which outlines basic competencies that all individuals should possess (Van Audenhove et al., 2024). This reference framework was proposed by the European Joint Research Center (JRC) to ensure that societies have a minimum level of technological knowledge.

1.1 ICT in educational context

In the educational context, reference frameworks such as DigComp have been insufficient. Although DigComp outlines some essential knowledge, teachers cannot limit themselves to these skills alone. They need not only a basic understanding of technologies

[1] corresponding author - email: jvictoria@ugr.es

but also the ability to apply various tools in the classroom and effectively transmit these competencies. For this reason, the TPACK model was developed, which is based on three fundamental, intertwined elements (Saubern et al., 2020). These elements are content knowledge (theoretical knowledge of the tool), technical knowledge (the ability to apply a tool), and pedagogical knowledge (the capacity to integrate all variables), collectively known as the TPACK model, which stands for Technological Pedagogical Content Knowledge (Mishra & Koehler, 2006).

Recognizing the need for teachers to work with both technology and pedagogy, the JRC developed an extension of DigComp focused on education, resulting in the DigCompEdu reference framework (Mora-Cantallops et al., 2022). This framework is particularly impactful, as it has been adopted not only in Europe but also in several Latin American countries, becoming a benchmark across much of the continent (Vergara et al., 2023).

1.2 University as institution for educational research

These teaching frameworks have been utilized in multiple research studies in higher education to highlight elements that differentiate this institution from others. Firstly, it is important to note the ability to access a diverse sample, which helps in testing various elements. For instance, Alonso-García et al. (2024) use DigCompEdu to evaluate digital competencies in future teachers, while Moreira et al. (2023) use the same tool to assess the digital competencies of university teachers. This has enabled comparisons between different countries, such as the research conducted by Vergara et al. (2023).

The results from comparing the digital competencies of Spain with those of countries in Latin America do not show significant differences (Carranza-Yuncor et al., 2024; Pin-Posligua, 2022).

However, this perspective only takes into account the part of teaching digital competence, i.e. the ability to teach with technology and through it, transmitting different skills (Palacio et al., 2018). Universities, on the other hand, no longer have the sole function of training, since the university is not only focused on the transmission of content, but also has the function of generating new knowledge in such a way that the teachers of the universities themselves are the researchers to generate scientific content (García & Aznar, 2017).

There are various indications that suggest university teachers may lack necessary skills. Alonso-García et al. (2022) highlight that, from the students' perspective, university teachers have deficiencies when working with technology. This view is supported by other research, such as Al-Daihani et al. (2018), which notes that social networks focused on research are underutilized by some university teachers. Guillén-Gámez et al. (2024) emphasize that while the average level of digital competence use at universities is moderate, the most notable strength is researchers' ability to search efficiently. They effectively manage different databases such as WOS, Scopus, and Google Scholar, including writing search equations. However, this proficiency does not extend to knowledge dissemination, as scientific social networks are not being effectively developed by this group of teacher-researchers.

2. Digital competences for research

Although the digital competencies of teachers are well researched, the use of ICT tools for research purposes is less developed. In the scientific literature, ICT tools are considered fundamental, since one of the indices that determine quality in university teaching is the ability to conduct research (Sanchez, 2021).

Various essential elements are identified as necessary to understand how scientific knowledge is constructed. The management of bibliographic references and databases are key digital competencies considered fundamental for the development of scientific knowledge (Nuñez et al., 2020).

Database management requires a range of skills, including the ability to define data using specific software, determine how they are categorized, labeled, and synthesized, and organize them into relational and non-relational categories (De Aparicio & Barrios, 2020).

Database management has traditionally been applied to research with quantitative data. However, current research trends have a mixed-methods approach, making the management of qualitative data equally important. Managing qualitative data also requires specific skills, as highlighted by Rojano et al. (2021).

As mentioned earlier, empirical research and specific interventions are not the only approaches to consider; systematic reviews and meta-analyses are two methodologies that support such research. In this context, the inclusion of technology has been crucial, particularly with the use of bibliography management tools (Roa et al., 2022). Bibliographic managers such as Zotero, Mendeley, and EndNote not only assist in generating references for scientific articles but also function as document and information management tools.

On the other hand, the capacity for transmission and dissemination of knowledge has expanded through various online platforms. The open science model has had positive effects, as it has made research more accessible. Often, publishing a paper in open access leads to greater impact and increased knowledge transfer through citations (Ronal, 2016).

However, this open-access diffusion has also led to a distortion of science, with some journals accepting papers despite dubious research quality due to the cost of publication, ultimately leading to the creation of the so-called Black List (Alonso-Arévalo et al., 2020).

2.1 Country comparisons

This study compares the competencies of researchers in Spain and Ecuador. The comparison is based on differing viewpoints found in the scientific literature, suggesting that Spain, compared to Latin American countries, has greater economic and infrastructural development. This provides greater access to technology, resulting in higher technological competence (Hampton et al., 2021). This could explain the results presented by Martín-Párraga and colleagues (2023).

In contrast, studies comparing Hispanic American countries with Spain highlight a key difference in approach. While Spain demonstrates greater problem-solving abilities, its network communication is weaker than in other countries (Rueda, 2023). For instance, despite Spain's near-total access to various technological resources, countries like Brazil, classified as developing nations, show significantly higher digital competencies among students. Moreover, when compared to Portugal, a country with a similar context, the digital competencies of both Spanish students and teachers are found to be relatively low (Romero-Rodríguez et al., 2019).

This comparison is particularly interesting as Spain, represented by the University of Granada, conducts the most research on digital teaching competencies (Betancur Chicué & García-Valcárcel, 2022), while Ecuador, represented by the National University of Chimborazo, has less focus on this subject. One might assume that Spain has a higher level of digital teaching competencies; however, Guillén-Gámez et al. (2023a) argue that the number of publications on the subject is limited and should not be considered reliable predictors.

2.2 Gender digital divide

Another important aspect to consider is the gender gap and how it manifests. Given the population under study, it is important to examine whether there are gender differences in research. The starting point is the disparity in the number of male and female researchers in both countries.

In Spain, national reports indicate that while the ratio of male to female researchers is currently close to 50%, men still hold the majority of research positions (Ministerio de Ciencia e Innovación, 2023). In Ecuador, this disparity is even more pronounced, with 65% male and 35% female researchers (Zambrano, 2019).

Given the disparity in the number of male and female researchers, it is essential to understand the factors driving this difference. For the purpose of this research, it is important to focus on the concept of the Gender Digital Divide, which stems from differences in how technology is used.

In the different regions where, significant differences have been found, women tend to a more monotonous use, leisure and through smartphones, while men tend to make a broader search and focused on the search for knowledge through active listening of different audiovisual materials (Ali & Oystein, 2023). Despite this idea, it is worth mentioning that the review by Ali & Oystein (2023), although it generally concludes with the aforementioned results, it is noteworthy that for the contexts on which this study focuses, it mentions that for Spain this digital divide does not seem to be so evident and in the case of Latin America the role is reversed, with men having a greater use of social networks and dedicated to leisure than women, although there are no differences in terms of the ability to use them.

Specifically, in relation to digital competence in teaching, Guillén-Gámez and colleagues (2021) highlight a disparity across all dimensions, showing that male researchers exhibit greater digital competence in research compared to their female counterparts. In 2024, Guillén-Gámez and colleagues reaffirm this finding, emphasizing the need for further research in various contexts to identify areas where more focused efforts are required to mitigate this gap.

2.3 Career development as a researcher

The final key point in this discussion is the development of a research career. This involves two fundamental aspects of university operations: positions and ranks, which largely determine one's role within the institution. Therefore, the position held at the university and the time dedicated to publishing are crucial factors in this context.

Broadly speaking, researcher competencies can be grouped into three categories (Rivas, 2011):

1. Competences on philosophy and epistemology.
2. Competencies on the research process.
3. Competencies in research techniques.

To these competencies must be added the aforementioned research dissemination skills.

These competencies are not immovable or innate characteristics; rather, it is necessary to design and carry out specific training that focuses on developing these skills.

Thus, teachers who have obtained a certification or a contract with a permanent link are the teachers who have achieved a greater capacity for the development of research (Antúnez & Veytia, 2020). Despite the fact that there are specific proposals for teacher training during university degrees and master's degrees such as those proposed by (Reynosa et al., 2020 and Soto & Hanna, 2020), there seems to be a global consensus on the training that accredits these competencies, establishing the doctorate and doctoral thesis as the result of research as a before and after in terms of research (Vásquez et al., 2020).

This means that, depending on the number of years a research line has been developed, it means a higher category, since after the completion of the doctoral thesis, the first five years of a researcher's work are usually completed.

3. Objective

This literature review identifies factors that may contribute to differences in the use of technology for research. Therefore, the objective of this study is to compare the digital competencies for research of educational researchers in Spain and Ecuador while identifying factors that may influence their development. Therefore, the following specific objectives have been generated.

O1. Determine whether the countries and universities where research is conducted have an impact on digital research skills.

O2. To assess the relationship between a researcher's institutional position and their digital competence for research, with the aim of determining whether the position has any impact on their digital skills.

O3. To evaluate the relationship between a researcher's gender and their digital competence for research, with the aim of determining whether gender has any influence on their digital skills.

O4. To examine the relationship between the time spent in research and competence in using ICT for research, with the aim of determining whether the duration of research experience influences ICT skills.

To achieve these objectives, the following hypotheses are proposed, which will address the study's overall objective:

H1: The university in which the researcher is located does not influence the digital competencies for research.

H2: The researcher's position within their institution has no effect on digital competence for research.

H3: The researcher's gender has no influence on digital competence for research.

H4: The time spent in research has no influence on the competence to use ICT in research.

4. Methodology

An ex post facto retrospective design was used for the study, aiming to determine which independent variables affect a previously defined dependent variable – in this case, the digital research competence of university teacher-researchers (Ato et al., 2013).

It is important to mention that the sample collection employed non-probability convenience sampling. This method was chosen due to the difficulty of collecting a sample from the target population, as it is relatively small, and convenience sampling allowed for rapid sample collection (Otzen & Manterola, 2017).

4.1 Tools

Regarding the instrument used, the scale developed and validated by Guillén-Gámez and colleagues (2023b) was employed, which has undergone exploratory and confirmatory validation, demonstrating its validity and reliability. The questionnaire is a seven-point Likert scale with 29 items grouped into the following dimensions:

1. Digital skills
2. Digital Ethics
3. Flow Digital
4. Anxiety towards ICT
5. Quality
6. Intention to use ICT
7. Integration ICT

4.2 Sample

The sample is composed of a total of 340 educational researchers, ranging from master's students to teachers with permanent links to the University. This makes that groups are generated according to the time from less than 1 year developing their research to more than 10 years. In addition, a separation has been made according to men and women and to the University to which they belong, leaving the relative distribution of the sample defined in Table 1.

The questionnaire has been validated by Guillén-Gámez et al. (2023b), demonstrating the instrument's reliability and validity. To assess the reliability of the sample, Cronbach's Alpha yielded a result of 0.850. Additionally, composite reliability was calculated, confirming the instrument's reliability for the sample. The indicators in Table 2 were established for the questionnaire.

Finally, we calculated eta squared to measure the effect size relative to the total variance of the experiment. The calculated eta squared values were less than 0.001 for all variables, indicating a low effect size. To account for potential bias in the data, we calculated Cohen's D, which was less than 0.2 for all items, indicating a low effect of publication bias (Cohen, 1988). After establishing data consistency, we applied the Shapiro-Wilk and Kolmogorov-Smirnov normality tests, indicating the need for nonparametric tests for group relationships.

Table 1 - Sample description.

University	Variable	Frequency	Percentage
National University of Chimborazo		193	56.76%
University of Granada		147	43.24
Total		*340*	*100%*
National University of Chimborazo	Women	92	47.7%
	Man	101	52.3%
University of Granada	Women	74	50.3%
	Man	73	49.7%
Total		*340*	*100%*
National University of Chimborazo	Less than a year	38	19.7%
	Between 1 and 5 years	72	37.3%
	Between 5 and 10 years	54	28.0%
	More than 10 years	29	15.0%
University of Grana	Less than a year	21	14.3%
	Between 1 and 5 years	45	30.6%
	Between 5 and 10 years	48	32.7%
	More than 10 years	33	22.4%
Total		*340*	*100%*
National University of Chimborazo	Degree Student	22	11.4%
	Master Student	24	12.4%
	PhD Student	11	5.7%
	Professor/ Researcher with no permanent bonding with the University	64	33.2%
	Professor/ Researcher with permanent bonding with the University	51	26.4%
	Not specified above	21	10.9%
University of Granada	Degree Student	5	3.4%
	Master Student	19	12.9%
	PhD Student	28	19.0%
	Professor/ Researcher with no permanent bonding with the University	56	38.1%
	Professor/ Researcher with permanent bonding with the University	37	25.2%
	Not specified above	2	1.4%
Total		*340*	*100%*

Table 2 - Reliability for the sample.

Alpha Cronbach	AVE	CR
0.850	0.565	0.973

Table 3 - Shapiro-Wilk and Kolmogorov-Smirnov normality tests.

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	gl	Sig.	Statistic	1020	<.001
A	.191	1020	<.001	.915	1020	<.001
B	.244	1020	<.001	.814	1020	<.001
C	.161	1020	<.001	.899	1020	<.001
D	.133	1020	<.001	.929	1020	<.001
E	.168	1020	<.001	.919	1020	<.001
F	.204	1020	<.001	.819	1020	<.001

3. Results

To enhance the clarity of this document, the results are organized according to the hypotheses outlined above.

3.1 Contrasting hypothesis H1

The Mann-Whitney U test is conducted to determine if there is a comparation between ICT competencies for research and the university where the research is conducted. This highlights a significant difference between the two universities in two of the areas. The comparisons between the universities and the items are now developed (Table 4).

For the present sample, there is only one area where a significant difference between the universities is observed. The area where these differences have been found is "Intention to use ICT," which relates to the attitude toward the use of technology.

In this case, although differences are observed when measuring the items individually, differences are found when measuring individual items. (Table 5). The collected sample indicates that the Spanish university has a better evaluation of technology use, as participants consider it more enjoyable to use (Table 6).

3.2 Contrasting hypothesis H2

To test Hypothesis 2, the Kruskal-Wallis test will be conducted, which is used to determine whether there are significant differences between the groups, as shown in Table 7. None of the universities showed significant differences between the defined groups.

Having found differences in the area of Intention to use ICT for the Universidad Nacional del Chimborazo and Integration ICT, we compared them by performing a Mann-Whitney U test comparing all the possibilities, although we will only point out the significant differences between doctoral students, staff with permanent and non-permanent links with their university, since the sample of bachelor's and master's degree students is small, limiting their scientific interest.

Table 4 - Mann-Whitney U divided by areas.

Null Hypothesis	Test	Sig.a, b	Decision
The distribution of A is the same across categories of Universidad.	Independent-Samples Mann-Whitney U Test	.725	Retain the null hypothesis.
The distribution of B is the same across categories of Universidad.	Independent-Samples Mann-Whitney U Test	.061	Retain the null hypothesis.
The distribution of C is the same across categories of Universidad.	Independent-Samples Mann-Whitney U Test	.100	Retain the null hypothesis.
The distribution of D is the same across categories of Universidad.	Independent-Samples Mann-Whitney U Test	.135	Retain the null hypothesis.
The distribution of E is the same across categories of Universidad.	Independent-Samples Mann-Whitney U Test	.873	Retain the null hypothesis.
The distribution of F is the same across categories of Universidad.	Independent-Samples Mann-Whitney U Test	.006	Reject the null hypothesis.
The distribution of G is the same across categories of Universidad.	Independent-Samples Mann-Whitney U Test	.978	Retain the null hypothesis.

Table 5 - Mann-Whitney U divided by items.

	F1	F2	F3	F4	F5
Mann-Whitney U	13121.500	13009.000	13107.500	13662.000	13234.500
Wilcoxon W	31842.500	31730.000	31828.500	32383.000	31955.500
Z	-1.241	-1.384	-1.266	-.616	-1.107
Asymp. Sig. (2-tailed)	.215	.166	.206	.538	.268

Table 6 - Mean and SD divided by university.

		F1	F2	F3	F4	F5
Universidad Nacional del Chimborazo	N Valid	193	193	193	193	193
	Mean	5.76	5.85	5.85	5.91	5.76
	Std. Deviation	1.215	1.207	1.272	1.246	1.241
Universidad de Granada	N Valid	147	147	147	147	147
	Mean	5.97	6.08	6.10	6.06	5.92
	Std. Deviation	.968	.940	.924	.960	1.095

Having compared all possible groups, no statistically significant differences have been found except when comparing permanent and non-permanent teachers of the National University of Chimborazo, so we understand that the difference previously found in the Integration ICT section is due to the influence of the undergraduate and master students who have participated from the University of Granada (Table 8).

3.3 Contrasting hypothesis H3

For the analysis of differences between the sexes, the areas of the questionnaire are once again used as a reference to identify where significant differences exist. Pearson's correlation test reveals that, despite the absence of differences noted in the literature, significant differences are found in some items (Table 9).

After identifying a significant difference with respect to sex, we propose using the Mann-Whitney U test to determine between which groups the difference occurs, given that in this case, there is a significant difference regarding the question, "I enjoy using software for data analysis, both quantitative (SPSS, JAMOVI, R...) and qualitative (Atlas.ti, NVivo...) when planning my research." Men have an average score of 5.31, while women have an average score of 4.99. This indicates that men have a more positive attitude toward using software for both quantitative and qualitative data analysis (Table 10).

Table 7 - Krustal-Wallis for categories and Universities.

	Sig.[a,b]	Decision
The distribution of A is the same across categories of Categoría.	.938	Retain the null hypothesis.
The distribution of B is the same across categories of Categoría.	.190	Retain the null hypothesis.
The distribution of C is the same across categories of Categoría.	.170	Retain the null hypothesis.
The distribution of D is the same across categories of Categoría.	.507	Retain the null hypothesis.
The distribution of E is the same across categories of Categoría.	.942	Retain the null hypothesis.
The distribution of F is the same across categories of Categoría.	.339	Retain the null hypothesis.
The distribution of G is the same across categories of Categoría.	.906	Retain the null hypothesis.
Universidad Nacional del Chimborazo		
The distribution of A is the same across categories of Categoría.	.135	Retain the null hypothesis.
The distribution of B is the same across categories of Categoría.	.677	Retain the null hypothesis.
The distribution of C is the same across categories of Categoría.	.925	Retain the null hypothesis.
The distribution of D is the same across categories of Categoría.	.688	Retain the null hypothesis.
The distribution of E is the same across categories of Categoría.	.657	Retain the null hypothesis.
The distribution of F is the same across categories of Categoría.	.757	Retain the null hypothesis.
The distribution of G is the same across categories of Categoría.	.383	Retain the null hypothesis.
Universidad de Granada		

Table 8 - Mann-Whitney U for the areas where differences were found.

	Comparative groups	Sig.	Sig. adjust.
ITEM A2	PhD Student-Professor/Researcher with permanent bonding with the University	.015	.232
ITEM B2	PhD Student-Professor/Researcher with no permanent bonding with the University	.030	.455
	PhD Student-Professor/Researcher with permanent bonding with the University	<.001	.009
ITEM C1	PhD Student-Professor/Researcher with no permanent bonding with the University	.014	.217
	PhD Student-Professor/Researcher with permanent bonding with the University	<.001	.005
ITEM C2	PhD Student-Professor/Researcher with no permanent bonding with the University	.005	.080
	PhD Student-Professor/Researcher with permanent bonding with the University	<.001	.007
ITEM C3	PhD Student-Professor/Researcher with no permanent bonding with the University	.012	.183
	PhD Student-Professor/Researcher with permanent bonding with the University	.002	.030
ITEM D4	PhD Student-Professor/Researcher with no permanent bonding with the University	.009	.140
ITEM G4	PhD Student-Professor/Researcher with no permanent bonding with the University	.042	.624

Table 9 - Correlation between gender by area.

	Statistic	A	B	C	D	E	F	G
Sex	**Pearson's correlation**	-.009	.021	-.111	-.058	-.010	.047	-.018
	Sig. (bilateral)	.864	.698	.042	.286	.853	.389	.740
	N	340	340	340	340	340	340	340

Table 10 - Mann-Whitney U for items by gender.

	C1	C2	C3
Mann-Whitney U	13464.500	12655.000	13637.500
Wilcoxon W	27325.500	26516.000	27498.500
Z	-1.110	-2.023	-.912
Asymp. Sig. (2-tailed)	.267	.043	.362

3.4 Contrasting hypothesis H4

The Kruskal-Wallis test is performed again to compare the different areas and identify the statistical differences between the groups. However, no significant differences were found between the groups, except for purchasing at extreme points, such as less than 1 year and more than 10 years. In these instances, no significant differences were identified. Consequently, we selected all items from the questionnaire and compared cases where researchers had been working for more than 1 year, excluding undergraduate students due to their limited scientific interest. Only the significant differences will be indicated, highlighting the most relevant results (Table 11).

Table 11 - Comparative according to the time period under investigation.

	Comparative groups	Sig.	Sig. adjusts.
ITEM A1	Between 1 and 5 years - More than 10 years	.008	.050
ITEM A2	Between 1 and 5 years - Between 5 and 10 years	.009	.057
	Between 1 and 5 years - More than 10 years	.001	.007
ITEM A4	Between 1 and 5 years - Between 5 and 10 years	.005	.031
ITEM D1	Between 1 and 5 years – Less than a year	.023	.141
ITEM F1	Less than a year - Between 5 and 10 years	.001	.007
ITEM F3	Between 1 and 5 years - More than 10 years	.033	.200

Thus, the significant differences are primarily observed between researchers with a doctorate and those with more than 10 years of research experience (Table 12). These results are similar to those presented earlier, where individuals with 1 to 5 years of research experience received lower evaluations in all items except for D1, where a higher mean indicates a worse evaluation.

Table 12 - Mean and SD according to the time period under investigation.

		A1	A2	A4	D1	F1	F3
Between 1 and 5 years	Mean	5.03	5.31	5.15	3.43	5.78	5.87
	N	117	116	117	117	117	117
	SD	1.200	1.145	1.302	1.516	1.060	1.200
Between 5 and 10 years	Mean	5.28	5.69	5.56	3.25	6.04	6.07
	N	102	102	102	102	102	102
	SD	1.396	1.266	1.651	1.681	1.033	.967
More than 10 years	Mean	5.50	5.90	5.37	3.11	6.10	6.26
	N	62	62	62	62	62	62
	SD	1.251	1.067	1.571	1.812	1.003	.940

4. Discussion

The results extracted from the sample reveal an ambiguous comparison with the existing scientific literature, as findings both support and challenge previous research.

Firstly, differences between countries must be highlighted. The literature presents two distinct viewpoints: one suggests that countries like Ecuador, with lower developmental status compared to Spain, face challenges in accessing and effectively using ICTs (Hampton et al., 2021). The other viewpoint acknowledges that while Spain is a leader in researching digital competencies (Betancur Chicué & García-Valcárcel, 2022), it still experiences significant shortcomings. Interestingly, some less developed countries exhibit better digital competencies (Romero-Rodríguez et al., 2019).

From our sample results, we can draw a conclusion that reconciles both perspectives. No significant differences were found between the two universities, aligning with Romero-Rodríguez et al. (2019). However, a notable difference emerged regarding the intention to integrate ICTs for research. This suggests that while some differences may exist, others may not, depending on the context.

After examining the differences between countries, it is important to address the controversial issue of the gender digital divide. The collected data indicate that there were more male researchers than female researchers in the sample. As previously noted, the gender digital divide is influenced by technology use, varying by region (Ali & Oystein, 2023).

In this study, no significant differences were observed, except for the item: 'I enjoy using software for data analysis, both quantitative (SPSS, JAMOVI, R...) and qualitative (Atlas.ti, NVivo...) when planning my research.' This item revealed that female researchers reported less enjoyment in using technology, which may help explain the differences observed in certain contexts.

Finally, it is essential to discuss the development of a research career. This academic journey evolves over the years, fostering confidence in one's abilities. Both the duration of one’s research experience and the classification of professional categories are crucial factors, particularly concerning confidence and the ability to mentor others, as indicated by Antúnez and Veytia (2020).

The findings suggest that once individuals achieve a certain level of stability, their research capabilities significantly improve, including their ability to train other researchers. The doctoral thesis represents an initial stage where individuals begin to understand research but may lack the skills to teach it effectively, as noted by Vásquez et al. (2020).

This scenario illustrates that the evaluation and promotion system for university faculty, despite potential shortcomings and the presence of individuals who do not meet standards, appears to function effectively. It incorporates a training phase through advanced degrees, such as master's programs (Reynosa et al., 2020; Soto & Hanna, 2020), followed by courses with research contracts like University Teacher Training or Research Staff Training (Antúnez & Veytia, 2020). Finally, researchers reach a stage of stability where they can focus on mentoring new researchers, having already acquired the necessary competencies identified by Rivas (2011).

5. Conclusion

The main conclusion of this research is that there are no significant differences between teachers from different countries regarding digital competencies necessary for research development. While this conclusion is based on reliable and representative results, it may not encompass all possible alternatives.

Despite Spain being a leader in research on digital competencies for university teachers, there is a pressing need for more targeted interventions and specific planning to enhance these skills. When compared to countries that theoretically have lower performance levels, Spain's strengths in this area are not clearly demonstrated.

Interestingly, the intentions of Spanish teachers and educational researchers are positive, showing a willingness to use digital resources. However, enhanced training on effectively utilizing these digital tools could further empower Spanish researchers.

Emphasizing the need for improved specific training in digital competencies is crucial. The current training system appears to effectively initiate research careers, as leading university figures excel in training capacities. Nevertheless, the dissemination of knowledge and engagement with social research networks do not seem to be limiting factors for those who began their research careers before these networks existed. Thus, young researchers should be encouraged to leverage these modern tools for their advancement.

Finally, it is essential to highlight the issue of the gender digital divide. While the data appears to accurately represent reality, it raises important questions. Despite no significant differences being observed in this sample, a possible explanation for the gender digital gap may lie in the greater interest that men typically show toward technology. This interest could contribute to their improved digital competencies.

To address this gap, it is crucial to focus on promoting the development of digital skills, particularly among women. Continued efforts in this area are necessary to foster greater equity in technology usage and digital competency.

References

Acilar, A., & Sæbø, Ø. (2021). Towards understanding the gender digital divide: a systematic literature review. *Global Knowledge Memory and Communication,72*(3), 233-249. https://doi.org/10.1108/gkmc-09-2021-0147

Al-Daihani, S. M., Al-Qallaf, J. S., & AlSaheeb, S. A. (2018). Use of social media by social science academics for scholarly communication. *Global Knowledge, Memory and Communication, 67*(7), 412-424. https://doi.org/10.1108/GKMC-11-2017-0091.

Alonso-Arévalo, J., Saraiva, R., & Flórez-Holguín, R. (2020). Revistas depredadoras: fraude en la ciencia. *Cuadernos de documentación multimedia, 31*, 1-6.

Alonso-García, S., Victoria-Maldonado, J. J., García-Sempere, P. J., & Lara-Lara, F. (2023). Student evaluation of teacher digitals skills at Granada University. *Frontiers in education, 7.* 1-4, https://doi.org/10.3389/feduc.2022.1069245

Alonso-García, S., Victoria-Maldonado, J.J., Martínez Domingo, J.A., & Berral-Ortiz, B. (2024). Analysis of self-perceived digital competences in future educators: A study at the University of Granada. *Journal of Technology and Science Education, 14*(1), 4-15. https://doi.org/10.3926/jotse.2521

Antúnez Sánchez, A. G., & Veytia Bucheli, M. G. (2020). Desarrollo de competencias investigativas y uso de herramientas tecnológicas en la gestión de información. *Conrado, 16*(72), 96-102. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1990-86442020000100096&lng=es&tlng=es

Ato, M., López, J.J., & Benavente, A. (2013). Un sistema de clasificación de los diseños de investigación en psicología. *Anales de Psicología, 29*(3), 1038-1059. https://dx.doi.org/10.6018/analesps.29.3.178511

Betancur Chicué, V., & García-Valcárcel Muñoz-Repiso, A. (2022). Necesidades de formación y referentes de evaluación en torno a la competencia digital docente: revisión sistemática. *Fonseca, Journal of Communication,* (25), 133–147. https://doi.org/10.14201/fjc.29603

Carranza-Yuncor, N. R., Rabanal-León, H. C., Villena Zapata, L. I., & Mora Mau, M. E. (2024). Competencia digital. Análisis comparativo pospandemia en maestros de instituciones urbanas y rurales. *Bordón Revista de Pedagogía, 76*(1), 31–48. https://doi.org/10.13042/bordon.2024.99045

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences.* Erbaum Press.

García, Z. del P., & Aznar, I. (2017). Childhood educator training, a challenge to educative innovation in higher education. *Innoeduca. International Journal of Technology and Educational Innovation*, *3*(2), 98–108.https://doi.org/10.24310/innoeduca.2017.v3i2.2451

Guillén-Gámez, F. D., Gómez-García, M., & Ruiz-Palmero, J. (2024). Competencia digital en labores de Investigación: predictores que influyen en función del tipo de universidad y género del profesorado de Educación Superior. *Pixel bit, 69*, 7–34. https://doi.org/10.12795/pixelbit.99992

Guillén-Gámez, F. D., Ruiz-Palmero, J., & Gómez-García, M. (2023b). Digital competences in research: creativity and entrepreneurship as essential predictors for teacher training. *Journal of Computers in Education.* 1-20. https://doi.org/10.1007/s40692-023-00299-3

Guillén-Gámez, Francisco D., Ruiz-Palmero, J., & García, M. G. (2023a). Digital competence of teachers in the use of ICT for research work: development of an instrument from a PLS-SEM approach. *Education and Information Technologies, 28*(12), 16509–16529. https://doi.org/10.1007/s10639-023-11895-2

Hampton, K. N., Robertson, C. T., Fernandez, L., Shin, I., & Bauer, J. M. (2021). How variation in internet access, digital skills, and media use are related to rural student outcomes: GPA, SAT, and educational aspirations. *Telematics and Informatics, 63*, 101666, 1-15. https://doi. org/ 10. 1016/j. tele. 2021.101666

Martín-Párraga, L.; Llorente-Cejudo, C.; Barroso-Osuna, J. Self-Perception of Digital Competence in University Lecturers: A Comparative Study between Universities in Spain and Peru According to the DigCompEdu Model. *Societies 2023, 13*(6) 142, 1-14. https://doi.org/10.3390/ soc13060142

Ministerio de Ciencia e Innovación. (2023). *Científicas en Cifras 2023.* Secretaría General Técnica del Ministerio de Ciencia e Innovación. https://www.ciencia.gob.es/dam/jcr:f4f6bb28-cae5-4da2-85f4-067508c410eb/CientiificasCifras2023.pdf

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework or Teacher Knowledge.*Teachers College Record, 108*(6), 1017-1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Mora-Cantallops, M., Inamorato Dos Santos, A., Villalonga-Gómez, C., Lacalle Remigio, J. R., Camarillo Casado, J., Sota Eguizábal, J. M., et al. (2022). *Competencias digitales del profesorado universitario en España: Un estudio basado en los marcos europeos DigCompEdu y OpenEduThe Digital Competence of Academics in Spain: A study based on the European frameworks DigCompEdu and OpenEdu.* Luxembourg: Publications Office of the European Communities.

Nuñez Benítez, A., Wexell Machado, L. E., & Sotomayor Ortellado, R. I. (2020). Competencias TIC para investigación en docentes de la FOUNC con la implementación del Programa de Formación a Investigadores 2015-2018: Information Technology Communication Competences for research in FOUNC teachers with the implementation of the Training Program for Researchers 2015-2018. *Scientia Oralis Salutem 1*(1), 58–64. https://revistas.unc.edu.py/index.php/founc/article/view/13

Otzen, T., & Manterola, C. (2017). Técnicas de Muestreo sobre una Población a Estudio. *International Journal of Morphology, 35*(1), 227-232. https://dx.doi.org/10.4067/S0717-95022017000100037

Paiva, A. de F., Romero-Rodríguez, J. M., & Gómez-García, G. (2018). Desenvolvimento profissional e formação contínua de professores: uma análise do contexto da educação em Angola. *Innoeduca International Journal of Technology and Educational Innovation, 4*(1),71–78. https://doi.org/10.24310/innoeduca.2018.v4i1.4081

Palacio, J. A., Hinojo-Lucena, M. A., & García, S. A. (2018). Higher education in agricultural technology with a territorial approach. *Innoeduca. International Journal of Technology and Educational Innovation*, *4*(2), 159–171. https://doi.org/10.24310/innoeduca.2018.v4i1.2453

Peraza, C. X., & Zurita-Barrios, N. Y. (2020). Las bases de datos como estrategia didáctica para investigadores noveles. Análisis del comportamiento de las líneas de crédito a través de la corporación financiera nacional y su aporte al desarrollo de las PYMES en Guayaquil 2011-2015. *RECIMUNDO: Revista Científica de la Investigación y el Conocimiento4*(4), 19–29. https://doi.org/10.26820/recimundo/4.(4).noviembre.2020.19-29

Pin-Posligua, G. M. (2022). Análisis comparativo del desarrollo de las competencias digitales y uso de las TIC, en el docente ecuatoriano. *Código Científico Revista De Investigación, 3*(3), 349–366.

Reynosa, E., Serrano, E. A., Ortega-Parra, A. J., Navarro, O., Cruz-Montero, J. M., & Salazar, E. O. (2020). Estrategias didácticas para investigación científica: relevancia en la formación de investigadores*. Revista Universidad y Sociedad, 12*(1), 259-266.

Rivas, L. A. (2011). Las nueve competencias de un investigador. *Investigación Administrativa, 40*(108), 34-54. http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2448-76782011000200034&lng=es&tlng=es

Roa, L. I., Díaz, T., & Estrada, L. (2022). Gestores de referencias bibliográficas y su impacto en las investigaciones. *e-Ciencias de la Información*, *12*(1), 96-113.

Rojano, Y., Contreras, M. & Cardona, D. (2021). El proceso etnográfico y la gestión estratégica de datos cualitativos con la utilización del aplicativo Atlas.ti. *Revista Saber, Ciencia y Libertad, 16*(2), 175 – 192. https://doi.org/10.18041/2382-3240/saber.2021v16n2.65001

Romero-Rodríguez, J. M., Hinojo-Lucena, F. J., Aznar-Díaz, I., y Gómez-García, G. (2022). Digitalización de la Universidad por Covid-19: impacto en el aprendizaje y factores psicosociales de los estudiantes. *RIED-Revista Iberoamericana de Educación a Distancia, 25*(2), 153-172. https://doi.org/10.5944/ried.25.2.32660

Romero-Rodríguez, L. M., Contreras-Pulido, P., & Pérez-Rodríguez, M. A. (2019). Media competencies of university professors and students. Comparison of levels in Spain, Portugal, Brazil and Venezuela / Las competencias mediáticas de profesores y estudiantes universitarios. Comparación de niveles en España, Portugal, Brasil y Venezuela. *C&E, Cultura y Educación, 31*(2), 326–368. https://doi.org/10.1080/11356405.2019.1597564

Rueda, G. (2023). Competencias digitales en educación superior en tiempos de pandemia COVID-19: Estudio comparativo Perú y España.*Revista Educación y Sociedad,4*(8), 56-66.https://doi.org/10.53940/reys.v4i8.161

Sánchez, L. (2022). Competencias TIC y uso de herramientas digitales para la investigación en docentes universitarios. *Conocimiento educativo, 9*(1), 25–41. https://doi.org/10.5377/ce.v9i1.14568

Saubern, R., Henderson, M., Heinrich, E., & Redmond, P. (2020). TPACK – time to reboot?. *Australasian Journal of Educational Technology, 36*(3), 1–9. https://doi.org/10.14742/ajet.6378

Snijder, R. (2016). Revisiting an open access monograph experiment: Measuring citations and tweets 5 years later. *Scientometrics, 109*(3), 1855–1875. https://doi.org/10.1007/s11192-016-2160-6

Soto, M., & Hanna, S. (2020). Desarrollo de competencias investigativas en participantes de maestría organizacional. *Gente Clave, 4*(1), 108-128.

Van Audenhove, L., Vermeire, L., Van den Broeck, W. and Demeulenaere, A. (2024), "Data literacy in the new EU DigComp 2.2 framework how DigComp defines competences on artificial intelligence, internet of things and data". *Information and Learning Sciences, 125* (5), 406-436. https://doi.org/10.1108/ILS-06-2023-0072

Vásquez, S., Vásquez, S. A., Vásquez, C. A., Alania, R., Díaz, M., & Gonzáles, M. del Águila. (2020). El perfil del docente investigador: hacia sus dimensiones y su fortalecimiento. *Apuntes Universitarios*, *10*(4), 69–88. https://doi.org/10.17162/au.v10i4.492

Vergara, D., Antón-Sancho, A., & Fernández-Arias, P. (2023). Engineering professors' habits: didactic use of Information & Communication Technologies (ICT). *Education & Information Technologies.* https://doi.org/10.1007/s10639-023-12110-y.

Zambrano, J. L. (2020). La sociedad del conocimiento: cantidad, categoría y género de los investigadores en Ecuador. *Mundos Plurales - Revista Latinoamericana de Políticas y Acción Pública, 6*(1), 73-92.

https://doi.org/10.17141/mundosplurales.1.2019.3855

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 20, No. 3 (2024), pp. 101-111

Factors influencing K-12 teachers' experiences of using Generative AI Tools: opportunities and barriers

Memnüne Kokoç[1]

Karadeniz Technical University, Scientific Research Center – Trabzon (Türkiye)

(submitted: 1/9/2024; accepted: 15/10/2024; published: 8/11/2024)

Abstract

Artificial intelligence (AI) teaching is becoming an increasingly popular topic among educators and researchers. Its importance in the research field stems from its ability to process and analyze large datasets, identify patterns and trends, provide new insights, and automate complex tasks. Educational policies make serious plans to develop teachers' professional competencies and implement many in-service training. Concerns about the accuracy of the outputs produced by AI systems arise due to inaccuracies or biases that may be present in the data on which they are trained. The aim of the study was to identify teachers' views on their digital skills in research studies using AI tools. In this study, a qualitative research method was used to find answers to the research questions. The data of the study were collected through a semi-structured interview form. The obtained data were analyzed with content analysis. The study group consisted of 14 (female=8; male=6) secondary school teachers.

The findings of this study comprehensively examine the experiences of secondary school teachers using generative AI tools. The findings obtained in terms of opportunities and barriers reveal the importance of broad policy changes and supportive education programs to support the integration of technology in education. In addition, future expectations emphasize the need to strengthen the technological infrastructure and provide comprehensive training programs for teachers.

KEYWORDS: Generative AI Tools, Secondary School Teacher, AI Usage Experiences, Barriers and Opportunities.

DOI
https://doi.org/10.20368/1971-8829/1136039

CITE AS
Kokoç, M. (2024). Factors influencing K-12 teachers' experiences of using Generative AI Tools: opportunities and barriers. *Journal of e-Learning and Knowledge Society*, *20*(3), 101-111. https://doi.org/10.20368/1971-8829/1136039

1. Introduction

Artificial Intelligence (AI) in K-12 education is a new and increasingly popular innovation. However, due to its limited scope, controversial interpretations, contextual irrelevance, and ethical issues, AI seems to have limited reference value for use (Akgün & Greenhow, 2022). In order to use AI successfully, planned and programmed educational steps need to be taken. In particular, educational programs need to be planned and implemented to facilitate teachers' skills development through professional development. AI literacy is widely accepted as a new set of skills that people use AI effectively and ethically in daily life. AI teaching is becoming an increasingly popular topic among educators and researchers. However, it seems that research on AI curricula in K-12 education is not sufficiently researched. AI is used to describe the use of machines to imitate human intelligence and perform human-like tasks. Building AI requires creating computer programs and algorithms with human-like cognitive abilities (Entezari et al., 2023). AI has become a growing focus of attention in various fields such as health, social sciences, academia, and research. Its importance in the research field stems from its ability to process and analyze large datasets, identify patterns and trends, provide new insights, and automate complex tasks. For example, artificial neural networks,

1 corresponding author – email: mempeksen@gmail.com

which constitute a subset of deep learning models, aim to simulate the structure and functions of the human brain. In this context, Generative Pre-Trained Transformers (GPTs) are a type of deep learning models that are increasingly used in the qualitative research community for various purposes such as knowledge generation, translation, summarization, and analysis (Brown et al., 2020; Radford et al., 2019; Sharma et al., 2021). Text summaries of research publications can be automatically generated using GPTs, allowing researchers to quickly focus on the most relevant studies; However, this process may not always provide reliable or in-depth qualitative outputs (Hakam et al., 2024). In addition to generating research questions and suggesting relevant research topics, deep learning models can be used to support teachers' research skills in the research process (Alqahtani et al., 2023). However, the quality of the product produced through such models is debatable. As an example of these discussions, since the results are based on statistical patterns in large amounts of data rather than expert knowledge or critical analysis, they may not always provide accurate or reliable information (Kasun et al., 2024). Therefore, in order to ensure validity and reliability in research processes using AI, verification should be done by referring to different sources such as expert knowledge and digital content. In the research process, detailed and correct data should be entered into the AI for the solution of the problem addressed and it should be ensured that it produces results. The result produced by the AI should be checked and checked whether it produces a solution to the problem. The faulty and missing parts should be determined and the process should be continued by providing new data entry for the correction or rearrangement of these sections.

In an age where there is so much information, sifting through the data to find what you need can be daunting. AI has the potential to revolutionize your research skills by automating tedious tasks, providing insights from large data sets, and even predicting trends. Whether you're an academic researcher, a student, or a professional looking to stay ahead of the curve, understanding how to leverage AI can significantly improve your research capabilities. The goal of this article is to offer practical ways to use AI to improve the research skills of K-12 teachers.

1.1 Teachers' Research Skill

Educational policies make serious plans to develop teachers' professional competencies and implement many in-service training. Professional development has been expressed as improving teachers' mastery of knowledge and skills and providing teachers with opportunities to maintain or apply new knowledge (Nasir et al., 2024). However, lifelong learning has emerged as one of the biggest challenges for the future worldwide knowledge society. Educational researchers have shown the importance of professional development in improving teacher competence, school leadership, and student achievement. Both teachers and schools are constantly expanding their knowledge and skills to develop the best educational practices (Byrd & Alexander, 2020).

Teachers' research skills constitute one of the strongest characteristics among competency standards (Geerdink et al., 2016). An examination of studies on developing researchers' research skills has revealed some important research skills such as information seeking skills, writing skills, methodological skills, and data analytics (Gyuris, 2018).

1.2 Barriers Affecting Teachers' Use of AI

Concerns about the accuracy of the outputs produced by AI systems arise due to inaccuracies or biases that may be present in the data on which they are trained. This is a significant problem, especially in complex and sensitive research areas. In addition, the lack of access to certain specialized databases by AI tools limits the scope of information that can be provided and can negatively affect the accuracy of research outputs. The fact that these tools cannot fully grasp complex research queries and rely heavily on pre-existing data also creates limitations on the precision of the results obtained.

Teachers naturally encounter various obstacles when dealing with change when faced with innovation. Ertmer's (1999) typology, a widely accepted and used obstacle classification in the research literature, stands out to overcome these obstacles and design interventions. In these conceptual classifications, other typologies such as the Concern Stage (Hall, 2011) and the Technology Acceptance Model (Venkatesh & Davi, 2000) look at the barriers to innovation adoption from an individual perspective, while Ertmer's (1999) typology takes both teachers and institutional environments into account by addressing the barriers using a holistic approach. Using a holistic perspective typology can help researchers gain a more comprehensive understanding of the barriers in question. Ertmer (1999) divided the barriers that teachers face in technology integration into two main categories: first-order barriers and second-order barriers. First-order barriers are external factors that are beyond the control of teachers and usually include lack of access to resources, insufficient time, lack of support, and insensitive policies. In contrast, second-order barriers arise from internal factors such as teachers' attitudes, self-confidence, and beliefs (Dinç, 2019). Different types of barriers have been identified in the literature, and these barriers are likely to occur at various stages of integrating innovations into the teaching process. Therefore, it is necessary to develop appropriate strategies to cope with these barriers. For example, Dignath and others (2022) suggested that capacity building of teachers based on pedagogical reasons can be an effective strategy, especially in overcoming barriers based on teachers' beliefs. With the increasing use of educational technologies in schools, many barriers defined as first-order have ceased to act as barriers. However, second-order barriers continue to have a stronger effect. Considering the problems experienced in the use of innovative AI in the field of education and the proposed studies to solve these problems, it becomes clear that more work needs to be done in this area.

The first-order barriers to the use of AI are classified as limitations in the curriculum guide and the uncertainty of hardware and learning tools. The second-order barriers can be summarized as controversial views on AI learning, insufficient teacher knowledge of AI, biased teacher attitudes, lack of confidence, and immature pedagogical understanding of AI-Enhanced Education (AIED) (Chounta et al., 2022).

1.3 Building research skills Using AI

AI plays an important role in the development of library and research skills, facilitating various stages of the research process from planning and design to data analysis and content production. Especially in the field of business education, the integration of AI into these skills leads to radical changes in the way students access and use information. AI-powered search engines increase the efficiency of information access, allowing students to access academic articles and business literature with higher precision (Kenchakkanavar, 2023). These tools also encourage students to examine topics in more depth by providing personalized recommendations based on their interests and reading habits.

AI-powered content summarization technologies help complex research findings to be more easily digested, while data analysis and visualization tools enable students to extract meaningful insights from large data sets. In generating research ideas, AI supports the process of narrowing down research focuses and generating innovative ideas by providing researchers with relevant keywords or phrases. In addition, AI tools provide an efficient literature review and information access process by curating articles, reports, and other resources related to researchers' areas of interest. AI can also generate automatic titles and concise abstracts for research articles, allowing researchers to effectively convey the essence of their work and capture the attention of readers (Venkatesh, 2022). These innovative capabilities provided by AI tools increase quality and efficiency at every stage of the research process, while enabling researchers to obtain more useful outputs with more specific, targeted, and context-sensitive prompts. Generative AI is capable of producing high-quality outputs in the form of code, reports, summaries, business communications, audio, video, and various other types of content, making it much easier to achieve the desired results. In this context, it is necessary to follow the right steps for AI applications to produce the desired results.

- Clearly define the problem or task; before approaching ChatGPT, the problem or task needs to be well defined. The more specific and detailed the problem situation or task, the better ChatGPT can understand and make relevant suggestions.
- Expressing input in natural language; when ChatGPT is asked a question or asked for code snippets, it is necessary to express the input in natural language, as if you were asking for help from a colleague. This ensures that ChatGPT can understand the problem and produce relevant and accurate output. For example, instead of entering "Python for loop", a better input would be "How can I use a for loop in Python to iterate over a list of integers?"
- Providing a comprehensive context; include information about the programming language or framework used, existing code or solutions that have been tried, or specific requirements or constraints.
- Improving and iterating the output; after receiving the output from ChatGPT, it should be reviewed and improved. To get better results, ChatGPT needs to be guided with additional context, feedback, and questions, and trained to train the AI tool. Instead of thinking of ChatGPT as an output machine, think of it as a peer being chatted with.
- Check the work; since ChatGPT can hallucinate and lie, verifying the output is critical. Instead of delegating judgment to the AI tool, researcher expertise should be brought into the chat.

The aim of the study was to identify teachers' views on their digital skills in research studies using AI tools. The following research questions were explored in this context.

Research Questions:

1. What are the most important factors that affect secondary school teachers' experiences using generative AI tools?
2. What are the opportunities and advantages that secondary school teachers face when using generative AI tools in the classroom?
3. What are the barriers and challenges that secondary school teachers face in the process of using generative AI tools?

2. Methods

In this study, a qualitative research method was used to find answers to the research questions. The data of the study were collected through a semi-structured interview form. The obtained data were analyzed with content analysis. The maximum diversity sampling method, which is one of the purposeful sampling methods, was used in the study. The study group consisted of 14 (female=8; male=6) secondary school teachers (Table 1). The schools where the data were collected were randomly selected from among the accessible schools.

In line with the purpose of the research, semi-structured interview questions were prepared to be applied to 14 teachers working in secondary schools. Face-to-face interviews were conducted with the teachers to obtain their opinions about the factors affecting the use of AI and their digital skills in research studies using AI tools. The interviews were conducted on a voluntary basis. Each interview lasted approximately 40 minutes. The interviews were recorded. The identities of the teachers were kept confidential during the data collection process. The data obtained at the end of the interviews were analyzed.

In order to provide sample diversity, secondary education teachers from five different branches (science, math, English, social science, information technology) working in five different public schools in Turkey (Trabzon) were selected. Accessible schools located in the city center were preferred when selecting schools. In cases where the teachers to be interviewed are wanted to be directly related to the research topic, researchers generally tend to use the purposive sampling method (Karataş, 2015). Therefore, teachers who volunteered to participate in the research and used the Generative AI tool were included as the sample. In the first stage of the sample determination process, teachers who used the Generative AI tool were determined. In the determination process, a short online usage status survey including the questions "Do you use Generative AI tools in your research processes?" and "How long have you been using them?" was used. In the second stage, teachers who used them for at least one academic year were selected as a result of the survey and groups were formed from this group consisting of teachers in different fields.

According to Table 1, it is seen that there are secondary education level teachers working in five different fields who are determined to use generative AI tools from 5 different schools that can be reached to provide data diversity.

2.1 Data analysis

Qualitative data were obtained from the interviews conducted to determine the opinions of teachers regarding their digital skills in research studies using AI tools.

The data obtained through the interviews using a voice recorder were transcribed and analyzed. During the analysis of the answers given to the questions in the interview form, the field teachers working in secondary schools were coded as T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13, T14. The concepts that emerged were coded and the cause-effect relationships between the findings were also taken into account and explained. The qualitative data that emerged during the data analysis process were checked by having two different field experts read them. The following steps were followed during the data analysis process.

Table 1 - Demographic Characteristics of the Research Group.

School Code	Participant Code	Field of Teachers	Gender	Work of years
S1	T1	Science	Female	25
S1	T2	English	Male	5
S2	T3	English	Female	21
S2	T4	Math	Female	13
S3	T5	English	Male	14
S3	T6	Information Technology	Female	13
S3	T7	Math	Female	19
S4	T8	Math	Female	13
S4	T9	Social Studies	Male	15
S4	T10	Math	Female	9
S5	T11	Social Studies	Male	29
S5	T12	Social Studies	Male	15
S5	T13	Science	Female	8
S5	T14	English	Male	20

2.1.1. Coding Process

In the interviews conducted with the sample group, a voice recorder and note-taking techniques were used together. The recordings were then analyzed. The obtained data were first transferred to the Office program and read several times, and coding was created within the scope of the research questions. Then, the codes were brought together, themes that would form the main lines of the research findings were revealed, and content analyses were conducted. Code examples are presented in Table 2.

Table 2 - Code Examples.

Code	Description
Insufficient Infrastructure	Problems experienced by teachers due to insufficient technological infrastructure.
Educational Needs	Training that teachers need to use AI tools more effectively.
Student Experiences	How students interact with these tools and how the tools provide feedback.
Purpose of Use of Tools	For what purposes teachers use these tools (e.g., providing feedback, creating learning materials).

The analyses were completed according to the code examples given in Table 2, and the data were processed according to the determined themes and the findings were interpreted with direct quotes. To ensure the reliability of the data, the records and the transcription of the record were examined by another researcher other than the researchers and compared with the researchers' transcriptions and edits were made. After reviewing the codes, similar codes were combined and grouped to create broader categories.

- Technological Infrastructure and Access
- Pedagogical Integration
- Training and Support Needs
- Student Experience and Feedback

Based on the codes, main themes were determined within the scope of the research problems with the consensus of two different field experts.

3. Results

The analyzed data were examined depending on the research questions and are given separately below.

3.1. Research Problem 1: Factors affecting the experience of using AI tools

Within the scope of the first research problem, the results of the qualitative data analysis conducted to determine the experiences of secondary school teachers in using generative AI tools and the factors affecting these experiences are presented. The findings were divided into themes using the content analysis method, and details about the experiences of teachers under each theme are given together with the number of participants with similar views. Information on the themes and codes is provided in Table 3.

Table 3 - Factors affecting the experience of using AI tools.

Theme	Codes	f
Inadequacy of Technological Infrastructure and Resources	• Old computers • Inadequate internet connection • Inadequate hardware • Access to technology	8
Need for Professional Development	• Lack of education • Pedagogical guidance • Need for technical education • Educational programs	6
Student Experience and Feedback	• Student motivation needs • User friendly tools • Complex issues • Positive feedback	9
Pedagogical Appropriateness of AI Tools	• Course outcomes • Integration into the educational process • Pedagogical suitability • Limitations of AI Tools	3

Research results are presented under subheadings according to the themes presented in Table 3.

3.1.1. Inadequacy of Technological Infrastructure and Resources

As seen in Table 2, most of the participants (n = 8) stated that the current technological infrastructure limits the effective use of AI tools. Information Technologies Teacher T6 expressed this situation as follows:

> *"The computers in our school are quite old and our internet connection is often insufficient. This situation makes it difficult for us to use AI-based applications, especially those that require more processing power".*

Similarly, Mathematics Teacher T10 (n = 2) also drew attention to the infrastructure deficiencies and stated the following:

> *"I want to give instant feedback to students by using AI-based tools in Mathematics class, but our technological equipment does not allow this. We cannot use the full potential of these tools".*

These findings reveal that the inadequacy of the technological infrastructure limits teachers' capacity to use AI tools and that this problem needs to be resolved.

3.1.2. Need for Professional Development

More than half of the participants (n = 6) stated that they need professional development opportunities in order to use productive AI tools more effectively. English Teacher T2 (n = 3) stated the following on this issue:

> *"I want to use AI tools in the classroom, but we haven't received enough training on this subject. We need to learn how to integrate technology not only technically but also pedagogically".*

Similarly, Social Studies Teacher T12 (n = 2) stated the following:

> *"I understand the potential of the tools, but I don't know how to use them effectively in the classroom. I think more guidance and training should be provided".*

This finding reveals that teachers need sufficient training and guidance to use AI tools effectively.

3.1.3. Student Experience and Feedback

A large portion of the participating teachers (n = 9) stated that students' interactions with AI tools were generally positive. English Teacher T3 (n = 3) summarized this situation as follows:

> *"Students find the language learning process more interesting using AI tools. In particular, applications that allow them to practice speaking motivate them".*

However, some teachers (n = 2) also stated that the complexity of these tools could be an obstacle for students. Mathematics Teacher T7 made the following comment on this issue:

> *"Some students find the tools complicated to use, which reduces their motivation. Simpler and more user-friendly interfaces can solve this problem".*

These findings show that AI tools are effective in increasing student motivation, but the complexity of the tools can create difficulties for some students.

3.1.4. Pedagogical Appropriateness of AI Tools

Some of the participants (n = 5) stated that AI tools are compatible with the course objectives. Social Studies Teacher T11 (n = 2) shared his view on how AI tools can be used in his courses as follows:

> *"In history classes, we use AI-based applications that simulate different outcomes of events. This helps students understand historical events more deeply".*

On the other hand, Mathematics Teacher T8 (n = 1) stated that the integration of tools into the teaching process may be limited:

> *"Some tools do not fit well into the flow of the course. For example, although they are suitable for in-depth analysis of a certain topic, they are not sufficient to teach basic concepts".*

The findings suggest that teachers should carefully evaluate the pedagogical suitability of AI tools and that they may not always be fully compatible with course objectives. The findings obtained in this study detail the challenges teachers face when using generative AI tools and the effects of these tools on educational processes. The findings show that factors such as technological infrastructure deficiencies, need for professional development, student experiences, and pedagogical suitability of tools shape how effectively teachers use these technologies. It was concluded that in order for teachers to use these tools more effectively, technological infrastructure should be improved and pedagogical integration should be supported.

3.2. Research Problem 2: Opportunities and Advantages of Using Generative AI Tools in Education

In this study, the findings obtained regarding the opportunities and advantages of secondary school teachers in using generative AI tools were evaluated according to the content analysis method. Table 4 provides detailed information about the main themes and related codes for these experiences.

Table 4 - Opportunities and Advantages of Using Generative AI Tools in Education.

Theme	Codes	f
Benefits of AI Tools in Education	• Improving the learning process • Personalized learning • Interactive content • Student participation	9
Opportunities	• Improving the teaching process • Student motivation • Reducing teacher workload	9
Supportive Strategies	• Additional training and guidance • Technical support • User-friendly tools • Good practice examples	7
Future Usage Expectations	• Increasing usage rate • Advanced vehicle features • Changes in education policies • Innovative education models	6

3.2.1. Benefits of AI Tools in Education

Table 4 is examined, it is seen that most of the participants think that AI tools make various contributions to the education process. Four main subthemes stand out: "improving the learning process, personalized learning, interactive content and student participation".

Under the theme of improving the learning process, teachers stated that AI tools make students' learning processes more efficient. For example, English Teacher T2 said:

> *"AI tools make students' language learning processes more effective. They are especially helpful in developing language skills".*

Similarly, the Social Studies Teacher T9 stated on personalized learning,

> *"Students can work at their own pace, and this allows them to learn according to their personal needs".*

It was emphasized that interactive content increases student participation. Social Studies Teacher T12 said on this subject,

> *"Interactive content increases students' interest in the lesson and ensures their participation".*

Regarding student participation, Information Technologies Teacher T6 commented,

> *"Students participate in the lesson more actively with AI tools. This makes them more interested in the lesson".*

3.2.2. Opportunities

Participants stated that AI tools offer various opportunities in education (Table 4). The opportunities are grouped under three main subthemes, improving the teaching process, student motivation, and reducing teachers' workload.

The theme of improving the teaching process emphasizes that AI tools contribute to making lessons more effective and interesting. English Teacher T5 said,

> *"AI tools make course content more attractive and make students' learning processes more effective".*

Increasing student motivation was also stated as an important opportunity. Mathematics Teacher T8 said,

> *"AI tools increase students' motivation and enable them to participate more in the learning process".*

In addition, reducing teachers'' T11 said,

> *"These tools reduce teachers' workload by automating some routine tasks and giving us more teaching time".*

3.2.3. Supportive Strategies

The supportive strategies suggested for the effective use of AI tools are grouped under four main subthemes as additional training and guidance, technical support, user-friendly tools and good practice examples. The need for additional training and guidance was emphasized. English Teacher T2 said,

> *"We need to receive more training and guidance to be able to use AI tools more effectively".*

It was stated that technical support services should be increased. Information Technologies Teacher T6 said,

> *"Technical support services need to be faster and more effective, otherwise it becomes difficult to deal with technical problems".*

It was stated that user-friendly tools should be developed. Mathematics Teacher T10 said,

> *"Making the tools more user-friendly will provide great convenience for both teachers and students".*

It was also stated that sharing good practice examples could be instructive for other teachers. Social Studies Teacher T12 said,

> *"Sharing good practice examples could be instructive for other teachers and facilitate the implementation processes".*

3.2.4. Future Usage Expectations

It is predicted that AI tools will be used more widely in education in the future. Participants stated that the tools will have more advanced features and that education policies should change to support AI tools. Mathematics Teacher T7 said,

> *"I think AI tools will be used more widely in education in the future".*

It is expected that the tools will have advanced features. English T3 said,

> *"I expect the features of the tools to develop further and offer more functions".*

It was stated that education policies should be updated to support AI tools. Social Studies Teacher T11 said,

> *"Updating education policies to support AI tools will be an important step".*

It was also emphasized that innovative education models should be developed. Mathematics Teacher T8 said,

> *"Developing new and innovative education models will support the effective use of AI tools".*

These findings comprehensively reflect the effects of AI tools on education and the challenges teachers face. The themes help us better understand the role of AI tools in education by systematically presenting teachers' experiences.

3.3. Research Problem 3: Barriers and challenges of Generative AI Tools in Education

In this study, the barriers and challenges regarding the experiences of secondary school teachers in using generative AI tools were evaluated through content analysis. The main themes of these experiences and the related codes are presented in Table 5.

Table 5 - Barriers and Challenges of Generative AI Tools in Education.

Theme	Codes	f
Challenges Encountered	• Technical issues • Tool complexity • Educational gaps • Student resistance	8
Barriers	• Technical issues • Low access and lack of infrastructure • High cost • Insufficient training	8
Future Expectations	• Increased accessibility • Supportive education policies • Improving technological infrastructure	6

3.3.1. Challenges Encountered

The difficulties encountered in the use of the tools are grouped under three main subthemes, technical problems, complexity of the tools, and lack of training. Technical problems cause the tools to encounter problems such as system crashes and malfunctions. Mathematics Teacher T7 said,

> *"Technical failures and system crashes disrupt our lessons, which affects students' motivation".*

The complexity of the tools causes difficulties for teachers and students. Mathematics Teacher T8 stated,

> *"The use of the tools can sometimes be complicated. This can be challenging, especially for students who are not familiar with technology".*

Lack of training causes teachers to use the tools without having sufficient knowledge. English Teacher T3 said,

> *"We did not receive sufficient training on how to use AI tools, and this makes our use process difficult".*

It was also stated that some students resisted new technologies, and this affected the teaching process. Social Studies Teacher T11 commented on this issue as,

> *"Some students are resistant to the transition to new technologies, and this negatively affects the teaching process".*

3.3.2. Barriers

The barriers of AI tools in education are grouped under four main subthemes, technical problems, low access and lack of infrastructure, high costs, and inadequate training.

Technical issues refer to the problems teachers encounter when using AI tools. Science Teacher T13 said,

> *"We often experience technical problems with the tools, and this disrupts our lessons".*

Low access and lack of infrastructure indicate that AI tools are not sufficiently accessible in some schools. Information Technologies Teacher T6 said,

> *"The school's infrastructure is insufficient to support these tools, so we cannot benefit from some features".*

High costs indicate that AI tools are expensive to procure. Science Teacher T1 said,

> *"The costs of these tools are quite high, which makes it difficult for them to be widely used in schools".*

Insufficient training indicates that teachers do not receive the necessary information to use these tools effectively. Social Studies Teacher T12 commented,

> *"We did not receive sufficient training on how to use AI tools, and this makes it difficult for us to use them".*

3.3.3. Future Expectations

The expectation that AI tools will be used more effectively in education in the future is prominent. Participants hope that these tools will become more accessible and that education policies will support the tools. English Teacher T2 said,

> *"I expect AI tools to be more widespread and accessible in the future".*

It was also emphasized that education policies should be updated to support AI tools. Social Studies Teacher T11 said,

> *"It will be important to update education policies to support AI tools".*

It was also stated that the technological infrastructure should be improved. Mathematics Teacher T7 said,

> *"Improving the technological infrastructure will enable these tools to be used more effectively".*

These findings comprehensively reflect the opportunities that teachers face in education with AI tools and the obstacles they face. The themes help us better understand the potential and challenges of AI tools in education by systematically presenting teachers' experiences.

4. Discussion

This study provides important findings about the effects of AI in education and the opportunities and obstacles that teachers experience with these tools by examining the experiences of secondary school teachers using generative AI tools in detail. These findings have the potential to expand and deepen existing understandings in the literature.

According to the findings, teachers evaluate the opportunities offered by AI tools in education quite positively. In particular, it is emphasized that AI tools make teaching processes more interesting and effective and support students' active participation in learning processes. Contents and interactive materials that can be adapted to students' individual needs provide great advantages in terms of personalizing the teaching process and creating targeted teaching strategies. These findings are consistent with the literature supporting the potential of technology to increase student motivation and participation in education (Moybeka et al., 2023; Mayer, 2009; Deci & Ryan, 1985). The fact that teachers stated that the rich content and adaptive learning materials offered by AI tools make teaching processes more effective concretizes the potential of these tools in education. Obstacles: On the other hand, technical problems and infrastructural deficiencies are among the obstacles experienced by teachers. Other obstacles such as high costs and insufficient training make it difficult to adopt AI tools more widely in education. In particular, it is seen that technical problems and limited access opportunities disrupt teaching processes and limit technology integration in education. These findings indicate that broader policy changes and supportive education programs are needed regarding the integration of technology in education. As studies such as Ertmer (1999) and Hew & Brush (2007) indicate, overcoming these obstacles is critical to realizing the potential of technology in education.

The findings of the study explain in detail the effects of artificial intelligence tools in education. In particular, the experiences of teachers while using these tools are important for understanding the role of artificial intelligence in education. The capacity of AI tools to monitor student performance, provide personalized feedback, and adapt teaching materials increases teachers' contributions to the educational process. These findings are consistent with existing literature (Luckin et al., 2016; Adıgüzel et al., 2023) that emphasizes the potential of AI in education to support student achievement. Teachers' statements about how personalized feedback provided by AI tools improves students' learning processes support the positive effects of these tools in education.

However, the barriers experienced by teachers include the inability to effectively integrate AI tools, the inadequacy of some teachers' technological skills, and the limited availability of existing infrastructure. These obstacles reduce the effectiveness of AI tools in teaching processes. This situation emphasizes the importance of support and infrastructure improvements required for wider adoption of technology in education.

The findings for future expectations reveal teachers' expectations regarding the future use of AI tools. Teachers want AI tools to be more widely available and for education policies to support these tools. These expectations highlight the necessary steps for effective use of technology in education. In particular, it is stated that technological infrastructure should be strengthened, and comprehensive training programs should be provided for teachers (Elsayary, 2023). These findings emphasize the need for educational policies to be updated and to support technological innovations. Teachers' hopeful expectations for the improvement of educational policies and infrastructure so that AI tools can be used more effectively in education reveal the importance of the changes necessary to strengthen the role of these tools in education.

5. Conclusion

The findings of this study comprehensively examine the experiences of secondary school teachers using generative AI tools. The data obtained on the opportunities offered by AI tools, the barriers encountered, and future expectations highlight the steps required to realize the potential of technology in education. The findings obtained in terms of opportunities and barriers reveal the importance of broad policy changes and supportive education programs to support the integration of technology in education. In addition, future expectations emphasize the need to strengthen the technological infrastructure and provide comprehensive training programs for teachers.

The results obtained in this study emphasize the potential of AI tools to improve the teaching process and increase student motivation, and the role of these tools in education. However, barriers such as technical problems, lack of infrastructure, and high costs make it difficult to use these tools effectively. In order for AI tools to be more widely adopted in education in the future, it is necessary to update education policies, strengthen the technological infrastructure, and provide comprehensive training programs for teachers. These steps are of critical importance to realize the potential of AI tools in education.

6. Recommendations

According to the research results, suggestions were made for practitioners and researchers.

- *Technical Support and Infrastructure Development*: Technical support and infrastructure should be strengthened to ensure the effective use of AI tools in schools. Continuous maintenance and support should be provided to minimize technical problems and improve the user's experience.
- *Reducing Costs*: Reducing the costs of AI tools can ensure wider adoption of these tools. Adjustments to be made in education budgets and financial support can increase the accessibility of these tools.
- *Education and Training Programs*: Creating comprehensive training programs for teachers will provide practical information on how to use AI tools. This will help teachers use the tools more effectively.
- *Policy Development*: Education policies need to be updated and support technological innovations. Developing policies that encourage and support the integration of technology in education can ensure that AI tools are used more effectively in education.
- *Future Research*: Research should be conducted that examines the effects of AI tools in education in broader and more diverse contexts. In addition, studies that offer solutions to the obstacles encountered will support the integration of technology in education. These studies can provide important information for understanding the effects of AI tools in different cultural and geographical contexts.

References

Adıgüzel, T., Kaya, M. H., & Cansu, F. K. (2023). Revolutionizing education with AI: Exploring the transformative potential of ChatGPT.*Contemporary Educational Technology*.

Alqahtani, T., Badreldin, H. A., Alrashed, M., Alshaya, A. I., Alghamdi, S. S., bin Saleh, K., ... & Albekairy, A. M. (2023). The emergent role of artificial intelligence, natural learning processing, and large language models in higher education and research. *Research in Social and Administrative Pharmacy*, *19*(8), 1236-1242.

Akgun, S., & Greenhow, C. (2022). Artificial intelligence in education: Addressing ethical challenges in K-12 settings. *AI and Ethics*, *2*(3), 431-440.

Brown, T., Mann, B., Ryder, N., Subbiah, M., Kaplan, J., Dhariwal, P., ... & Amodei, D. (2020). Language models are few-shot learners. Proceedings of the 34th Conference on Neural Information Processing Systems (NeurIPS 2020). https://arxiv.org/abs/2005.14165

Byrd, D. R., & Alexander, M. (2020). Investigating special education teachers' knowledge and skills: Preparing general teacher preparation for professional development. *Journal of Pedagogical Research*, *4*(2), 72-82.

Chounta, I. A., Bardone, E., Raudsep, A., & Pedaste, M. (2022). Exploring teachers' perceptions of artificial intelligence as a tool to support their practice in Estonian K-12 education. *International Journal of Artificial Intelligence in Education*, *32*(3), 725-755.

Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. Springer.

Dinc, E. (2019). Prospective teachers' perceptions of barriers to technology integration in education. *Contemporary Educational Technology*, *10*(4), 381-398.

Dignath, C., Rimm-Kaufman, S., van Ewijk, R., & Kunter, M. (2022). Teachers' beliefs about inclusive education and insights on what contributes to those beliefs: a meta-analytical study. *Educational Psychology Review*, *34*(4), 2609-2660.

ElSayary, A. (2023). The impact of a professional upskilling training programme on developing teachers' digital competence. *Journal of Computer Assisted Learning*, *39*(4), 1154-1166.

Entezari, A., Aslani, A., Zahedi, R., & Noorollahi, Y. (2023). Artificial intelligence and machine learning in energy systems: A bibliographic perspective. *Energy Strategy Reviews*, *45*, 101017.

Ertmer, P. A. (1999). Addressing first-and second-order barriers to change: Strategies for technology integration. Educational Technology Research and Development, vol. 47, no. 4, pp. 47-61

Geerdink, G., Boei, F., Willemse, M., Kools, Q., & Van Vlokhoven, H. (2016). Fostering teacher educators' professional development in research and in supervising student teachers' research. *Teachers and Teaching*, *22*(8), 965-982.

Gyuris, E. (2018). Evaluating the effectiveness of postgraduate research skills training and its alignment with the Research Skill Development framework. *Journal of University Teaching & Learning Practice*, *15*(4), 5.

Hakam, H. T., Prill, R., Korte, L., Lovreković, B., Ostojić, M., Ramadanov, N., & Muehlensiepen, F. (2024). Human-Written vs AI-Generated Texts in Orthopedic Academic Literature: Comparative Qualitative Analysis. *JMIR Formative Research*, *8*, e52164.

Hew, K. F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. Educational Technology Research and

Development, 55(3), 223-252. https://doi.org/10.1007/s11423-007-9021-8

Karataş, Z. (2015). Sosyal bilimlerde nitel araştirma yöntemleri. *Manevi temelli sosyal hizmet araştırmaları dergisi*, *1*(1), 62-80.

Kasun, M., Ryan, K., Paik, J., Lane-McKinley, K., Dunn, L. B., Roberts, L. W., & Kim, J. P. (2024). Academic machine learning researchers’ ethical perspectives on algorithm development for health care: a qualitative study. *Journal of the American Medical Informatics Association*, *31*(3), 563-573.

Kenchakkanavar, A. Y. (2023). Exploring the artificial intelligence tools: Realizing the advantages in education and research. *Journal of Advances in Library and Information Science*, *12*(4), 218-224.

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). Intelligence unleashed: An argument for AI in education. Pearson. https://www.pearson.com/us/higher-education/program/Luckin-Intelligence-Unleashed-An-Argument-for-AI-in-Education/PGM328135.html

Mayer, R. E. (2009). Multimedia learning (2nd ed.). Cambridge University Press.

Moybeka, A. M., Syariatin, N., Tatipang, D. P., Mushthoza, D. A., Dewi, N. P. J. L., & Tineh, S. (2023). Artificial Intelligence and English classroom: the implications of AI toward EFL students’ motivation. *Edumaspul: Jurnal Pendidikan*, *7*(2), 2444-2454.

Nasir, M., Hasan, M., Adlim, A., & Syukri, M. (2024, April). Utilizing artificial intelligence in education to enhance teaching effectiveness. In *Proceedings of International Conference on Education* (Vol. 2, No. 1, pp. 280-285).

Radford, A., Wu, J., Child, R., Luan, D., Amodei, D., & Sutskever, I. (2019). Language models are unsupervised multitask learners. *OpenAI blog*, *1*(8), 9.

Sharma, U., Tomar, P., Bhardwaj, H., & Sakalle, A. (2021). Artificial intelligence and its implications in education. In *Impact of AI technologies on teaching, learning, and research in higher education* (pp. 222-235). IGI Global.

Venkatesh, V. (2022). Adoption and use of AI tools: a research agenda grounded in UTAUT. *Annals of Operations Research*, *308*(1), 641-652.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science*, *46*(2), 186-204.

PERMANENT CALL

- PEER REVIEWED PAPERS -

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 20, No. 3 (2024), pp. 112-125

Integration of Educational Clusters with Open Badges and Blended Intensive Program (ECOBI): a comprehensive approach to future university education

Tommaso Minerva[1], Annamaria De Santis, Katia Sannicandro, Claudia Bellini

University of Modena and Reggio Emilia – Reggio Emilia (Italy)

(submitted: 2/10/2024; accepted: 1/11/2024; published: 4/11/2024)

Abstract

This paper introduces an integrated educational model for higher education, ECOBI, which combines Educational Clusters (teaching programs), the Blended Intensive approach, and the issuance of Open Badges within university curricula. Adopted by EDUNEXT, a network of 35 Italian universities aimed at digital educational innovation and university network development, ECOBI proposes a competency-based design that makes degree courses and Educational Clusters planned to develop specific skills relevant to the 21st-century landscape. The Intensive Blended approach integrates online teaching activities with intensive in-person training weeks, combining the strengths of both experiences. This model offers modularity and flexibility, promotes interdisciplinary learning and interchangeability of content, and meets the needs of current higher education. The article describes the ECOBI approach, its characteristics, strengths and advantages, and highlights its implementation within the EDUNEXT network.

KEYWORDS: University, Blended Learning, Open Badges, Competencies, Interuniversities Collaboration.

DOI
https://doi.org/10.20368/1971-8829/1136068

CITE AS
Minerva, T., De Santis, A., Sannicandro, K., & Bellini, C. (2024). Integration of Educational Clusters with Open Badges and Blended Intensive Program (ECOBI): a comprehensive approach to future university education. *Journal of e-Learning and Knowledge Society*, *20*(3), 112-125.
https://doi.org/10.20368/1971-8829/1136068

1. Introduction

Higher education is undergoing a significant transformation due to rapid technological advancements, globalization, and evolving labor market demands. Traditional educational models, characterized by rigid curricula and face-to-face instruction, are increasingly challenged to meet the needs of modern learners who require flexibility, personalization, and acquisition of competencies relevant to the 21st-century landscape (Selwyn, 2014). Students starting university today need to acquire digital, social, and hard skills and learn the approaches to continue training and combine new skills with existing ones because, in part due to rapid technological development, they are likely to perform new jobs just emerged for which training systems cannot always provide the necessary competencies (Beke et al., 2020; Stephany & Teutloff, 2024; Suhasini & Santhosh Kumar, 2019). Higher education institutions may struggle to cultivate complex, interdisciplinary, and soft competencies in graduates effectively, necessitating the adoption of different teaching and learning models just like blended learning and competency-based approach can be.

Blended learning (Hrastinski, 2019) has emerged as a promising approach to combine the strengths of online and face-to-face experiences (Garrison & Vaughan, 2008; Graham, 2013; Bonk & Graham, 2013), to offer flexibility and cater to diverse learning preferences, which is crucial in accommodating today's heterogeneous student populations and promoting accessibility. Research has presented the effectiveness of blended learning in higher education settings (Means et al., 2013; Garrison & Kanuka, 2004; Han et al., 2023) and the critical role in tutoring and supporting students (MacDonald, 2008; Baran et al., 2011; Langesee, 2023; Helleken et al., 2024).

Some universities have started using competency-based education that focuses on developing and assessing

[1] corresponding author – email: tommaso.minerva@unimore.it

specific competencies rather than time spent in class. Well-known frameworks have underlined the role of skills and goals in the course design. *Backward design* (Wiggins & McTighe, 2005) advocates for starting with the end in mind by identifying desired learning outcomes and designing curriculum accordingly. The *constructive alignment in teaching* (Biggs & Tang, 2011) highlights that the link among learning activities, assessments and the intended learning outcomes ensures students acquire the competencies necessary for their professional and personal development.

Global Education Movement (GEM), an online initiative of Southern New Hampshire University, offers competency-based education university programs to refugees around the world allowing students to earn degrees by demonstrating mastery of specific competencies (gem.snhu.edu). The University of Wisconsin provides the UW Flexible Option, a self-paced, competency-based online program designed for adults where students progress by demonstrating knowledge and skills acquired at their own pace (flex.wisconsin.edu).

A means of recognizing and verifying competencies acquired by learners is the use of digital badges, particularly Open Badges, that are portable, shareable, and contain metadata that provides detailed information about the skills and achievements they represent (Clements et al., 2020). Studies highlight the potential of digital badging to motivate learners and provide formal acknowledgment of skills in higher education settings (Carey & Stefaniak, 2018). Universities and organizations worldwide are adopting digital badges to certify micro-credentials and competencies (HolonIQ, 2023; Iniesto et al., 2022; Gish-Lieberman et al., 2021; Cedefop, 2023). This trend reflects a shift towards more granular recognition of learning, allowing students to showcase specific skills to employers and academic institutions.

The Open University in the United Kingdom provides free online resources and courses through the free learning platform OpenLearn. Completing all sections of the badged course and passing the assessments, students can obtain a badge and demonstrate an interest in a subject and evidence of professional development (open.edu/openlearn/badged-courses). In the perspective of credentialing and badging, Deakin University in Australia offers the service “professional practice credentials” to certify credentials on soft skills with digital badge aligned with industry needs. They assess and recognize skills acquired through work and life experiences without participating in a course but only showing evidence of skill acquisition (credentials.deakin.edu.au). Similarly, the University of California Davis implemented a digital badging initiative to recognize co-curricular learning and competencies gained outside the traditional classroom in continuing and professional education (cpe.ucdavis.edu/digital-badges).

Networks of higher education institutions are exploring collaborative models to leverage shared resources and expertise, fostering innovation, enhancing quality, and addressing common challenges (Huxham & Vangen, 2005). European networks like the Coimbra Group, long-established European multidisciplinary universities of high international standard (coimbra-group.eu), and the League of European Research Universities, LERU (leru.org) promote collaboration among universities to enhance quality and innovation in research and teaching. The nonprofit organization Open Universities Australia (open.edu.au) provides a catalogue of higher education programs (undergraduate and postgraduate degrees, university certificates, microcredentials, and short courses) from 25 leading Australian universities online offering personalized guidance to students in online campuses.

In the Italian context, an initiative of the Ministry of University and Research for teaching innovation led to the establishment of three Digital Education Hubs (DEHs) in the country (Decree n. 983 of 24.07.2023) within the actions of the National Recovery and Resilience Plan (NRRP), part of the European program Next GenerationEU.

Thirty-five universities, along with five conservatories and academies, have united to form EDUNEXT, one of the DEHs dedicated to innovating traditional university education. EDUNEXT aims to design and produce bachelor’s and master’s degree courses using a modular and blended approach, as well as develop online courses, micro-credentials, and MOOCs. Coordinated by the University of Modena and Reggio Emilia, which has a 20-year history in online learning activities, the network is supported by 55 external partners, including regional institutions, cultural organizations, associations, and businesses (see edunext.eu for the list of universities and partners).

EDUNEXT’s inter-university collaboration builds upon the experience of EduOpen (learn.eduopen.org), a nationwide initiative launched in 2016 that remains active in MOOC production by aggregating 24 universities and 7 cultural or educational institutions. The EduOpen experience provided guidelines for course development processes, recommended technologies, staff composition, and insights into student behaviors (De Santis et al., 2023; Sannicandro et al., 2019).

Embodying a collaborative spirit, EDUNEXT adopts a unified model called ECOBI, which stands for “Educational Clusters with Open Badges and Blended Intensive Program”. ECOBI integrates educational clusters, blended intensive programs, competency-based design, micro-design elements, comprehensive tutoring, and open badging to create a flexible and student-centered educational experience.

The ECOBI model can be applied to degree programs, comprehensive educational offerings of a university or training institution, or networks of institutions and universities (such as EDUNEXT), where standardized processes ensure the interchangeability of content and quality assurance procedures.

This paper presents the ECOBI model, detailing its components and its advantages. By reviewing relevant literature and aligning with international trends, the ECOBI model positions EDUNEXT at the forefront of educational innovation, addressing the challenges and opportunities of modern higher education. The already described international initiatives share similarities with the ECOBI model, demonstrating a commitment to the same topics, providing valuable insights, and reinforcing the relevance of ECOBI in a global context.

After this brief introduction on the global trends and initiatives, the second section of the paper describes the ECOBI components; the third section discusses the integration of technologies in the model. Section 4 presents the advantages of ECOBI for students, teachers, institutions, the whole society, and the labor market. Conclusions follow in Section 5.

2. The ECOBI model

ECOBI integrates its key components, that are educational clusters, open badges, blended approach, micro-design elements, and tutoring, to provide a complete and innovative learning experience in higher education.

In brief, faculty members (also from different universities) work together to develop degree courses, incorporating competency-based design and micro-design elements. The combination of online and in-person activities, supported by a team of expertise, allows for personalized learning experiences and an effective use of technologies for educational purposes.

The degree courses are structured into educational clusters that are teaching programs on a specific domain and are composed of small modules focused on the acquisition of micro-skills. Upon passing cluster and module assessments, students receive open badges that attest to their competencies, enhancing transparency and portability of skills.

ECOBI model ensures consistency, fairness and constant improvement of the educational offering by uniforming assessment criteria, shared standards for open badges, continuous monitoring and regular evaluation of the program, with contributions from all stakeholders.

We describe the key elements of ECOBI in more detail in the following paragraphs.

2.1 Educational Clusters

A key element of the ECOBI model is the Educational Cluster, defined as a coherent set of modules within a university program, each worth 3 ECTS credits (24 hours of instruction, based on 8 hours per credit).

The modules, by content and objectives, contribute to the acquisition of specific learning outcomes that more broadly characterize the integrated teaching program (cluster). So, clusters can be either *multidisciplinary*, integrating modules from different scientific disciplines to promote interdisciplinary learning, or *monodisciplinary*, focusing on a single discipline for specialized, in-depth study.

We have chosen the term "cluster" instead of course or similar since these are modules of training that need not necessarily succeed one another but can enable students to achieve a specific educational goal together. In fact, modules can be delivered *sequentially* so that each is preparatory to the next or *concurrently* if they are independent, although they are part of the same cluster.

The organization into clusters fosters modularity and flexibility.

Additionally, standardizing parameters such as the number of hours per credit (8) and of credits per module (3) facilitates the exchange of credits, modules, and programs among degree courses and, more generally, as aimed in EDUNEXT, among universities. Students can attend and combine modules from different degree courses and institutions, creating personalized educational pathways aligned with their interests and professional objectives.

At the European level, each ECTS matches a student's commitment of between 25 and 30 hours, including class hours, individual study, and other learning activities. Italian regulations bring the amount of hours to 25. The allocation of 1/3 of the hours for class activities and 2/3 for individual study in the credits system reflects a well-established educational tradition in the Italian university system, supported by the internal regulations of many Italian universities and considered an effective teaching practice to balance guided learning and student autonomy.

2.2 Competency-Based Design

ECOBI emphasizes the design phase (Reiser et al., 2017) of clusters and modules, given their complexity in a blended approach to ensure they are meaningful to the student's learning path.

Each module and cluster is built in a process of competency-based design. By focusing on competencies, the ECOBI model promotes the development of relevant and transferable skills to real-world contexts (Yorke, 2006; Tomlison, 2017).

The design process (Wiggins & McTighe, 2005; Biggs & Tang, 2011), carried out with the support of instructional designers, involves:

- identifying competencies: the teacher's board has to articulate what students should know and be able to do upon completion of the degree path and at the end of each cluster and modules.
- creating assessments: assessments have to accurately measure the defined competencies using practical and authentic tasks.
- designing learning activities and teaching methods: teachers have to choose lectures, activities, and teaching strategies that facilitate the acquisition of the defined skills.

2.3 Assessment and Open Badges

Assessment strategies are designed to measure and validate the competencies acquired by students at both the module and cluster levels, ensuring academic integrity, rigor, and alignment with learning outcomes. ECOBI provides the recognition of achievements through Open Badges.

Each module consists of a specific assessment to measure the competencies acquired (or knowledge in the basic modules or clusters). It may include essays, practical tasks, or projects, and multiple-choice questions, depending on the module's nature and can be conducted online or at designated testing centers or university facilities using secure proctoring software. Upon successful completion, students don't receive university credits, but detailed feedback and an Open Badge that formally certifies the competencies gained in that module. The badges, shareable on professional platforms, contain metadata about the issuer, criteria, and evidence of learning. They can also have an expiration date, just like acquired skills that may be valid for a certain period or effective in a given context, especially with the increasingly pressing technological transformation that requires people to adapt and update their skills continually.

Upon completing all modules within a cluster and passing the cluster's final assessment (in-presence), students receive ECTS and a Milestone Open Badge. The final assessment highlights and validates the comprehensive competencies acquired across all modules and can be a project integrating knowledge and skills from each module (Guo et al., 2020), a portfolio of work completed throughout the modules (Barrett, 2007), or oral examinations or presentations to a panel of faculty members. The Milestone Open Badge represents a significant achievement, conditioned upon the acquisition of the individual module badges, and symbolizes the integration and mastery of the cluster's competencies.

Table 1 presents an example of the structure of a cluster, namely "Techniques for data analysis in educational research", corresponding to 18 credits and 144 teaching hours distributed between online and in-presence activities. The table also contains the competencies acquired by students at the end of the training and listed in the design phase and the assessments for each module and for the whole cluster.

Modules in pairs (1 and 2, 3 and 4, 5 and 6) can be delivered simultaneously.

Table 1 - Example of modules in the Educational Cluster "Techniques for data analysis in educational research".

Cluster	Techniques for data analysis in educational research		
Competencies (at the end of the program students will be able to...)	- define the characteristics of multivariate statistical analysis techniques and their application in education - perform analyses using the R/R-studio package - write a scientific report		
Final exam	Test + Group project work (analysis of a dataset) with report, presentation and discussion		
Module	**Credits**	**Study field**	**Assessment**
1. Educational Research and Learning Analytics	3	Education	Proctored test
2. Introduction to R	3	Statistics	Brief data analysis report + script with R
3. R and regression techniques	3	Statistics	Brief data analysis report + script with R
4. Regression analysis in educational research	3	Education	Brief report on a case study
5. R, classification and data reduction techniques	3	Statistics	Brief data analysis report + script with R
6. Classification and data reduction techniques in educational research	3	Education	Brief report on a case study

2.4 *Intensive* Blended approach and micro-design

Programs in the ECOBI model are delivered according to a blended approach. We propose a system in which both online and face-to-face educational practices are valued meaningfully, making their integration a daily and fundamental practice.

As said before, the standard instructional load is 8 hours per ECTS credit, excluding interactive and tutoring activities.

In the ECOBI model, the division between in-person and online teaching hours can vary between a minimum of 50% online teaching to a maximum of 75%, with a standard model of one-third in-person and two-thirds online. This flexible structure accommodates different disciplines and teaching strategies.

In Table 2 we propose, as an example, the amount of activities to plan in a module delivered in the standard model (67% of online activities).

Table 2 - Distribution of classroom and online activities for a module (3 ECTS = 24 hours excluding interactive activities) in the standard model of one-third in-person and two-thirds online.

Activities in a Module (67% online)	Hours
Classroom lectures	8
VideoLectures	16
Estimated time for e-tivity	6
Online meetings with disciplinary tutors	6

Online activities primarily consist of pre-recorded videolectures with a maximum duration of 15 minutes. These micro-lectures enhance engagement and cater to students' shorter attention spans in online environments facilitating a better understanding of complex topics (Guo et al., 2014). Guidelines emphasizing the importance of clear objectives and interactive elements for creating effective educational videos have been proposed (Brame, 2016).

The videolectures are counted for teaching load calculations with a correction factor of 2, acknowledging the additional effort required for their preparation. The same doubled amount of hours is calculated for students because videos are denser and more concise in language and content than a classroom lecture and may require students to listen several times for effective content acquisition. So, in the proposal of Table 2, the actual number of hours to record is 8 instead of the 16 declared.

In addition to videolectures, faculty with the help of disciplinary tutors are required to design and provide e-tivities (Salmon, 2013), structured online interactive activities also included in Italian ministerial documents, quantifiable as at least 2 hours of student engagement per ECTS. E-tivities promote active learning and collaboration and facilitate deeper understanding of the material. Some examples include forum discussions, group projects, simulations, and formative assessments.

Integrating micro-design elements such as micro-lectures, e-tivities, and comprehensive tutoring can enhance the effectiveness of blended learning environments (Graham & Draper, n.d.; Borup et al., 2022; Kossen & Ooi, 2021; Liu et al., 2024; Bower et al., 2015).

In-person sessions are organized in intensive weeks and includes practical laboratories, workshops, simulations and collaborative projects (Johnson et al., 2014; Vlachopoulos & Makri, 2017; Guo et al., 2020). These sessions are crucial for hands-on experiences and face-to-face interactions that enrich the learning process (Prince, 2004; Qureshi et al., 2023). The Blended Intensive Program (BIP) approach, captured from the well-known mobility projects of European Erasmus+ Programme, is the methodological component of ECOBI that effectively integrates online learning with intensive in-person sessions for each module, optimizing the learning process by leveraging the strengths of both teaching methods.

Even if requiring careful planning, concentrating practical activities in one week optimizes the use of teaching and logistical resources, better managing time and infrastructure. Subjects who are not full-time students see thus facilitated class attendance. Generally, for all students, the intensive blended approach creates the opportunity for direct interaction with faculty and colleagues. Additionally, it enriches the educational experience, preparing students for professional dynamics often based on autonomous training (Zimmerman, 2002) and practical and collaborative activities.

The mix of e-tivities and in-presence activities aims to create community of learning and research among students and teachers reflecting the main university mission.

Table 3 describes an example of scheduling in weeks of a semester when educational clusters cover 30 ECTS. The online and in-presence activities are organized in 12 weeks.

Table 3 - Example of weekly distribution of activities for a semester according to the ECOBI Blended Intensive approach.

Blended Intensive approach for a semester - 30 ECTS 240 hours of teaching activities plus e-tivities and online meetings: - 80 hours of in presence activities - 160 hours of online activities			
Week	**Mode**	**Hours**	**Activities**
1	In-presence	16 (2 days)	Starting lectures on requirements and modules' scheduling
2-3	Online	20 per week	Videolectures (10 hours), e-tivities, virtual meetings with tutors
4	In-presence	24 (3 days)	Laboratories, workshops, and collaborative projects
5-7	Online	20 per week	Videolectures, e-tivities, virtual meetings with tutors
8	In-presence	24 (3 days)	Laboratories, workshops, and collaborative projects
9-11	Online	20 per week	Videolectures, e-tivities, virtual meetings with tutors
12	In-presence	16 (2 days)	Closing activities

The described blended approach derives from and complies with Italian regulations on higher education institutions and quality evaluation system for universities and research bodies. To name a few:

- Ministerial Decree No. 509 of November 24, 1999, introduced university credits corresponding to 25 hours of student effort, of which not less than half should be devoted to individual study (with some exceptions for experimental or practical training activities). In agreement with this and with long-established practices in Italian universities, in the ECOBI model, 8 hours are devoted to co-presence activities between students and teachers.
- since the 2014 accreditation guidelines for degree courses and subsequent updates produced by ANVUR (Italian National Agency for the Evaluation of Universities and Research Institutes), each university credit in online programs has to contain lectures (videos) and interactive activities. Credit is matched to a minimum number of 6 hours (a threshold to exceed hopefully), individual or collaborative e-tivities are to be included, and videolectures duration has to be considered double because students are likely to listen to them more times to acquire concepts. Our model fits these principles.
- M.D. No. 1154/2021 and M.D. 773/2024 provide for establishing *blended* degree programs with a percentage between 20 and 67 percent of online educational activities and *mainly online* degree programs with more than two-thirds of the activities online. The ECOBI model, with online activities between 50% and 75%, falls entirely within the two cases of the decrees.

2.5 A system of expertise: teaching, design, production and tutoring

In the ECOBI model, the degree courses resulted from the joint work of professional figures, namely teachers, technicians, instructional designers, and tutors. With different expertise and skills, they are involved in recurrent training and contribute to making learning paths structured, quality, and sustainable.

Teachers and students are the central figures of the process. Competency-based design requires a different learning approach by learners and a rethinking of faculty' tasks in a student-based approach that emphasizes the evolving roles and competencies needed of online teachers (Baran et al., 2011; Laferrière et al., 2006; Bates, 2022), highlighting the importance of professional development and support structures (Stensaker, 2018).

Technicians as Application Managers provide assistance to students in the use of digital systems and platforms and support to lecturers by configuring virtual and LMS environments, managing audio-video equipment installed in classrooms, specific software for screen recording and videoconferencing activities, and applications (including in the cloud) for the multimedia production. Performing a particular function among the technicians are the Media Producers responsible for producing educational videos and working primarily with faculty.

Considering the critical role in supporting students and faculty in blended models, ECOBI incorporates two levels of tutoring (Massuga et al., 2021; MacDonald, 2008; Li et al., 2017), system tutoring and disciplinary tutoring.

System tutors, as Instructional Designers (Halupa, 2019; Magruder et al., 2019; Koszalka et al., 2013), supply support to faculty assisting in the design and development of modules, ensuring alignment with competency-based approaches, effective pedagogical strategies and use of technology.

Disciplinary tutors in each module within a cluster are experts in the specific subject area and engage directly with students, providing subject-specific support, facilitating discussions, and monitoring progress (Vegliante & Sannicandro, 2020; López-Gómez et al., 2020). Their roles include:

- student interaction: engaging with students, proposing e-tivies, fostering a supportive learning environment, and addressing content-related inquiries.
- online tutoring sessions: conducting at least 1 hour per week, providing additional explanations, and facilitating discussions.
- monitoring and feedback: tracking student performance, providing timely feedback, and initiating interventions to support student success.

2.5 Quality Assurance and Standardization

A quality assurance system (Staring et al., 2022) based on the standardization of clusters structure, content production and procedure, continuous monitoring and regular evaluation of the program, assessment criteria and shared standards for open badges within ECOBI ensures consistency, fairness, and skills recognition.

Faculty, technicians, instructional designers, and tutors receive regular training in blended learning, competency-based instruction, and educational technologies. The panel of professionals works in the production of degree courses, assuring that each phase's results comply with the guidelines we summarize in Table 4.

Alignment with national and European frameworks, such as the European Credit Transfer and Accumulation System (ECTS), the European Qualifications Framework and the Bologna Process, allows recognition of credits and facilitates national and international collaboration.

3. Open and emerging technologies in ECOBI model

The technologies in the ECOBI model replay as much as possible to two adjectives: *open* and *emerging*.

The infrastructure underpinning the e-Learning system for educational content distribution, interaction and monitoring uses an "Open Source First" approach favoring established Open Source solutions (e.g., Moodle, PeerTube, BigBlueButton) in the first instance. It includes basic systems such as Learning Management System, Video Catalog, Collaborative Environments, Data Storage, Web Conferencing, Multimedia Production Environments (Minerva et al., 2022).

Meanwhile, the ECOBI model embraces emerging technologies to enhance the educational experience, support instructional design, and monitor the learning process. By integrating Artificial Intelligence (AI), Virtual Reality (VR), Augmented Reality (AR), and Machine Learning Analytics, ECOBI leverages cutting-edge tools to provide immersive, personalized, and data-driven education.

The incorporation of these emerging technologies aligns seamlessly with the ECOBI model:

- enhancing e-tivities and micro-lectures: AI and VR/AR technologies enrich online components, making learning more interactive and engaging (Popenici, & Kerr, 2017).
- supporting tutoring roles: AI tools assist system and disciplinary tutors in monitoring student progress and customizing support (Ait Baha et al., 2024; Labadze et al., 2023).
- improving assessment methods: advanced analytics inform the design of assessments and provide deeper insights into student learning (Knight et al., 2014; Lang et al., 2022).

While leveraging emerging technologies, ECOBI remains mindful of ethical considerations (Ferguson et al., 2016; Willis et al., 2016; Slade & Prinsloo, 2013; Drachsler & Greller, 2016; Bellini et al., 2019):

- data privacy: ensuring the confidentiality and security of student data collected through AI and analytics tools.
- equity and inclusion: providing access to necessary technologies and accommodating diverse student needs to prevent a digital divide (Liasidou, 2014).
- transparency: being clear about how AI systems and analytics are used in the educational process, maintaining trust and accountability.

Some specifics on the emerging technology to be implemented are in the following paragraphs.

Artificial Intelligence in instructional design and learning

Artificial Intelligence systems and tools are utilized in education (Chen et al., 2020) to assist faculty and instructional designers in creating effective and personalized learning experiences and serve as educational tools within the ECOBI model.

In fact, AI tools can be helpful in developing curricula, analyzing vast amounts of educational content to recommend resources aligned with learning objectives and competencies, and creating adaptive learning paths based on individual student profiles and prior knowledge. They are also used for content generation in developing assessments, e-tivities, and instructional materials that are tailored to competency-based design, to provide students with immediate feedback and support through AI-driven virtual tutors (Intelligent Tutoring Systems) and enable interactive learning experiences based on Natural Language Processing, such as AI-powered chatbots that answer student queries and facilitate discussions (Ilieva et al., 2023).

Virtual Reality (VR) and Augmented Reality (AR) for Immersive Learning

VR and AR technologies (Billinghurst et al., 2015) creates immersive learning environments that enhance understanding and engagement (Radianti et al., 2020; Jensen et al., 2020) and are functional for both online and in-presence teaching. They offer the possibility to students of experimenting and learning from practices, procedures, and contexts they might not otherwise experience. Some examples are:

- virtual laboratories that allow students to conduct experiments and practice skills in a risk-free, simulated environment.
- field simulations that enable experiences that would be difficult or impossible in real life, such as exploring historical sites or complex systems.
- interactive scenarios that provide opportunities for problem-solving and decision-making in realistic contexts, supporting the development of competencies.

During the intensive in-person weeks organized in the ECOBI model, in equipped educational laboratories, VR and AR technologies enrich hands-on activities through the realization of collaborative projects where students work together in virtual environments, fostering teamwork and communication skills and in the use of augmented learning materials.

Analytics for Monitoring and Improvement

Reporting, analysis, and monitoring systems are fundamental to the ECOBI model since many learning activities and formative and summative assessments are conducted online.

These systems are integrated into LMS or are custom-developed on AI processes, multivariate analysis, and Machine Learning on data generated in the interaction of students and teachers among them and with the platform.

Data analysis is made accessible to those involved in various capacities in the process (faculty, tutors, IDs, technicians) to monitor and enhance the educational process at different levels for supporting decision-making and quality assurance. They allow the forecasting of student outcomes and identify students at risk or who may benefit from additional support, enabling disciplinary tutors/teachers to provide timely and targeted assistance (Akçapınar et al., 2019; Ifenthaler & Yau, 2020).

The ECOBI system includes monitoring solutions such as Learning Analytics Dashboards (Verbert et al., 2013; Schwendimann et al. 2017; Ramaswami et al., 2023; Masiello et al., 2024; De Santis et al., 2024) that provide real-time data on student engagement, progress, programs and server use.

Table 4 - Brief Guidelines of the ECOBI Model.

ECOBI main features	Topic	Description
Competency-based design	Competency-based education	To reply to society requests, ECOBI proposal is based on the skills students need to acquire to become good and competent citizens. The design of degree courses and teaching activities starts from the knowledge, ability, and behaviors students will show at the end of the training.
	Constructive alignment	Strict matching is designed among educational goals, assessments, and learning activities/strategies.
	Micro-design	Short videolectures, e-tivities, and tutoring process are key elements in ECOBI online teaching programs.
Educational Clusters and Modules	Educational clusters	Educational Clusters represent university programs on a specific domain within a degree that are composed of modules and last 12-15-18 ECTS. They can be multidisciplinary or monodisciplinary, sequential or parallel.
	Modules	Each module is worth 3 ECTS credits and aims to make students achieve a micro-skill.
	Teaching hours	The standard instructional load is 8 hours per ECTS, excluding interactive and tutoring activities.
Intensive blended approach	Blended approach	Modules consist of a combination of in-person and online hours, with online teaching comprising 50% to 75% of total hours with a standard model of one-third in-person and two-thirds online. The mix of online and in-presence collaborative activities aims to value both practices meaningfully, make their integration a daily and fundamental practice in the educational contexts, and create a community of learning and research among students and faculty.
	Online components	• Videolectures: pre-recorded, maximum 15 minutes, counted with a correction factor of 2 for teaching and learning load. • E-tivities: interactive online activities amounting to at least 2 hours of student engagement per ECTS. • Tutoring: online classrooms or individual meetings with tutors/teachers.
	In-person intensive week	In each cluster, teachers define some in-presence weeks with a structured timetable dedicated to practical application, labs, workshops, group work, and direct instructor interaction that encourages active student participation and collaboration.
Assessments	Competency-based approach	Assessments are designed to directly evaluate the specific competencies outlined in the module/cluster objectives.
	Assessment formats	Assessment may include multiple-choice questions, essays, practical tasks, presentations, or projects, depending on the module and cluster's nature, emphasizing real-world problems and interdisciplinary issues.
	Proctored examinations	Modules may conclude with proctored assessments online or at designated testing centers.

(continue...)

Table 4 - Brief Guidelines of the ECOBI Model.

ECOBI main features	Topic	Description
Badges	Open badges for modules	It is awarded upon successful completion of each module's assessment.
	Milestone open badge	It is awarded upon completion of all module badges and the cluster's final examination, symbolizing the integration of competencies.
	Feedback mechanisms	Detailed feedback is provided on e-tivities to guide future learning, facilitated by disciplinary tutors, also using AI-based tools.
Technology	Open Source First	When possible, ECOBI model propose the use of Open Source solutions.
	Use of technology	ECOBI model focuses on emerging technologies and their use in educational settings.
	Artificial Intelligence and Machine Learning	Their use supports cluster design, personalized learning, adaptive assessments, and predictive analytics for student success.
	Virtual and Augmented Reality	VR and AR are used to create immersive learning environments for simulations, practical applications, and collaborative projects in both online and in-presence activities.
	Learning Analytics	It provides insights at the module, cluster, and program levels, informing decision-making and quality assurance and allows the creation of LA Dashboards to visualize data and process directly.
	Equity and Inclusion	ECOBI fosters access to necessary technologies for diverse student needs to prevent the digital divide.
Roles	Teachers	Teachers design, collaborate, and deliver programs on a competency-based and student-based approach that requires a rethinking of their skills and tasks.
	System Tutors (Instructional Designers)	They guide and support faculty in module design and effective use of educational technologies.
	Disciplinary Tutors	They: • engage with students, maintain regular communication, and foster a supportive learning environment; • create and manage e-tivities; • conduct at least 1 hour per week of online tutoring and support during in-person sessions; • monitor student performance and provide feedback.
	Application Managers and Media Producers	Technicians take care of digital and cloud environments, produce videos and other educational content, and support students and faculty in the use of teaching tools.
Quality Assurance	Standardization	Standardization in clusters and micro-design elements foster the monitoring of good and effective practices.
	Work Team	A panel of professionals works in the production of degree courses, assuring that each phase results compliant with ECOBI key elements.
	Professional Development/ Knowledge building	Faculty, technicians, ID, and tutors receive regular training in blended learning, competency-based instruction, and educational technologies.
	Continuous Improvement	Regular monitoring aligns educational practices with ECOBI guidelines.
	Data Privacy	Data Privacy process that ensures the confidentiality and security of student data collected through AI and analytics tools are planned in ECOBI model.

4. Advantages of ECOBI model for students, teachers, institutions, labor market and society

The ECOBI model offers significant advantages to various stakeholders, including students, teachers, institutions, the whole society, and the labor market.

By integrating emerging technologies into its core components, the ECOBI model not only addresses the immediate educational needs but also prepares students, faculty, and institutions for the future trying to remain at the forefront of educational innovation and the evolving demands of the 21st-century landscape.

For Students

Students in the ECOBI model experience a personalized learning pace, increased engagement (Kahu, 2013; Chen et al., 2010; Henrie et al., 2015), skill recognition, networking, and collaboration.

They benefit from flexible pathways, competency-based design, AI-driven adaptive learning systems that cater to individual needs.

Micro-lectures, interactive e-tivities, immersive VR/AR experiences, and supportive tutoring may increase their motivation and engagement.

Open Badges and Milestone Open Badges formally acknowledge skills, allowing students easy sharing on professional platforms and enhancing employability.

In the blended intensive approach, students build relationships with peers and faculty (potentially also from different institutions), facilitated by collaborative projects and virtual environments beyond geographical and physical limitations.

For Teachers

Instructors in the ECOBI model can benefit of professional development, collaborative opportunities, support structures.

They participate in knowledge building training on modern instructional strategies and educational technologies with colleagues involved in the same teaching process and enhance their teaching and digital skills.

Working with peers (also across institutions) fosters professional growth, the exchange of ideas and collaborative research.

For Institutions

For institutions, adopting the ECOBI model means improving quality and resource efficiency. Shared materials, technological infrastructure, and tutoring roles optimize resources and reduce costs (McGill et al., 2014; Abdekhoda & Dehnad, 2023).

Teachers participating in training acquire skills that strengthen the university's human capital and collaboration among colleagues and other professional figures creates opportunities for innovative and interdisciplinary research and curriculum development.

Collaborative efforts and the adoption of an innovative model enhance the reputation and attract students and faculty.

For Society and Labor Market

ECOBI aims to train competent graduates, cultivate skills aligned with society's needs on labor and citizenship issues, and improve innovation and flexibility in education to increase the number of students entering tertiary education.

Competency-based design and the integration of emerging technologies ensure relevance to current market demands (Ehlers & Kellermann, 2019) and empower students to carry out autonomous and collaborative activities by cultivating a sense of community and responsibility. Graduates trained with advanced technologies on hard and soft skills can bring valuable perspectives to organizations and society.

Open badges system provides detailed insights into students' skills, facilitating better profile recognition.

5. Conclusions

The ECOBI model embodies several distinctive characteristics that collectively enhance the educational experience and align with contemporary and global educational trends by integrating Educational Clusters, the Blended Intensive approach, competency-based design, micro-design elements, and the use of Open Badges. These characteristics are deeply intertwined with the integration of emerging technologies, fostering a modern and effective university education.

It effectively responds to the demand for flexibility, personalization, and relevance in higher education.

The model is inherently scalable and adaptable. It can expand to include more programs, partnerships, and networks, adapt to different disciplines, introduce new perspectives and continuous improvement based on ongoing research and feedback from stakeholders.

While ECOBI presents significant advantages for different categories as described in the paper, implementing such a comprehensive model requires careful consideration of potential challenges:

- resource allocation: developing high-quality online materials, training tutors and teachers, and maintaining technological infrastructure necessitates investment that institutions and governments must allocate.
- faculty engagement: encouraging faculty to adopt new teaching methods and participate in collaborative curriculum design requires institutional support and incentives.

- quality assurance: providing robust quality assurance mechanisms, data protection, regular evaluations, standardization of practices, and feedback loops.
- accessibility, and inclusivity: institutions need to assume responsibility for students with difficulties, such as disabilities and economic restraints, to provide equal educational opportunities for all.

The ECOBI model represents a holistic approach to reimagining higher education for institutions seeking to enhance the relevance and effectiveness of their educational offerings, by prioritizing students and contributing meaningfully to the advancement of the 21st-century society.

Acknowledgments

EDUNEXT (Project Name DEH2023-00003; Single Project Code - CUP: E83C23003480007) is financed by National Recovery and Resilience Plan (NRP), Mission 4 "Education and research" - Component 1 "Strengthening the provision of education services: from creches to universities", Investment 3.4 "Advanced university teaching and skills", Sub-investment 3 "Digital Education Hub", funded by the European Union – NextGenerationEU, referred to Directorial Decree No. 2100 of Dec. 15, 2023.

The collaboration and joint efforts of the community that conceived EDUNEXT contributed to the development of the ECOBI model, as presented in this paper. Over the past two years, representatives and experts from universities and partners have worked together, sharing their experiences in online education and their vision of future university education. All of them contributed with insights, ideas, and reflection.

Authors contributions

According to CRediT system: Tommaso Minerva: Conceptualization, Methodology, Supervision, Project Administration, Writing - Original Draft; Annamaria De Santis: Resources, Visualization, Writing - Review and Editing; Katia Sannicandro: Resources; Claudia Bellini: Resources.

References

Abdekhoda, M., & Dehnad, A. (2023). Effective organizational factors in adopting e-Learning in education: extracting determinants and frameworks. *Journal of E-Learning and Knowledge Society*, *19*(4), 1-8. https://doi.org/10.20368/1971-8829/1135669

Ait Baha, T., El Hajji, M., Es-Saady, Y., & Fadili, H. (2024). The impact of educational chatbot on student learning experience. *Education and Information Technologies*, *29*(8), 10153-10176.

Akçapınar, G., Altun, A., & Aşkar, P. (2019). Using learning analytics to develop early-warning system for at-risk students. *International Journal of Educational Technology in Higher Education*, 16(1), 40.

Baran, E., Correia, A.-P., & Thompson, A. (2011). Transforming online teaching practice: Critical analysis of the literature on the roles and competencies of online teachers. *Distance Education*, 32(3), 421-439.

Barrett, H. C. (2007). Researching electronic portfolios and learner engagement: The REFLECT Initiative. *Journal of Adolescent & Adult Literacy*, 50(6), 436-449.

Bates, A. W. (2022). *Teaching in a Digital Age: Guidelines for Designing Teaching and Learning* (3a ed.). Vancouver, BC: Tony Bates Associates Ltd. Retrieve from: https://pressbooks.bccampus.ca/teachinginadigitalagev3m/

Bellini, C., De Santis, A., Sannicandro, K., & Minerva, T. (2019). Data management in Learning Analytics: terms and perspectives. *Journal of E-Learning and Knowledge Society*, *15*(3), 135-144. https://doi.org/10.20368/1971-8829/1135021

Beke, E., Horvath, R., & Takacsne, G.K. (2020). Industry 4.0 and Current Competencies. *Naše gospo- darstvo/Our Economy*, *66*(4), 63-70.

Biggs, J., & Tang, C. (2011). *Teaching for Quality Learning at University* (4th ed.). Maidenhead: Open University Press.

Billinghurst, M., Clark, A., & Lee, G. (2015). A survey of augmented reality. Foundations and Trends® in Human–Computer Interaction, 8(2-3), 73-272.

Bonk, C. J., & Graham, C. R. (Eds.). (2012). *The Handbook of Blended Learning: Global Perspectives, Local Designs*. San Francisco, CA: Pfeiffer Publishing.

Borup, J., Graham, C. R., Short, C., & Shin, J. K. (2022). Designing the new normal: Enable, engage, elevate, and extend student learning. *EDUCAUSE*

Review. https://er.educause.edu/articles/2022/1/designing-the-new-normal-enable-engage-elevate-and-extend-student-learning

Bower, M., Dalgarno, B., Kennedy, G.E., Lee, M.J.W., & Kenney, J. (2015). Design and implementation factors in blended synchronous learning environments: Outcomes from a cross-case analysis. *Computers & Education*, *86*, 1-17.

Brame, C. J. (2016). Effective educational videos: Principles and guidelines for maximizing student learning from video content. *CBE-Life Sciences Education*, 15(4), es6.

Carey, K., & Stefaniak, J. (2018). An exploration of the utility of digital badging in higher education settings. *Educational Technology Research and Development*, 66(5), 1211-1229.

Cedefop (2023). *Microcredentials for labour market education and training: microcredentials and evolving qualifications systems*. Luxembourg: Publications Office.

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, 8, 75264-75278.

Chen, P.S.D., Lambert, A.D., & Guidry, K.R. (2010). Engaging online learners: The impact of Web-based learning technology on college student engagement. *Computers & Education*, *54*(4), 1222-1232.

Clements, K., West, R. E., & Hunsaker, E. (2020). Getting started with open badges and open microcredentials. *International Review of Research in Open and Distributed Learning*, *21*(1), 154-172.

De Santis, A., Bellini, C., Jana, M., Righetti, L., Sannicandro, K., Talha, M., & Minerva, T. (2024). Dashboards for admins, teachers, and students: tools for monitoring and learning. *EDULEARN24 Proceedings* (pp. 4666-4672). IATED.

De Santis, A., Sannicandro, K., Bellini, C., & Minerva, T. (2023). Analysis of MOOC Features in a Regional Platform: Design and Delivery of Courses. In *International Workshop on Higher Education Learning Methodologies and Technologies Online* (pp. 30-43). Cham: Springer Nature Switzerland.

Drachsler, H., & Greller, W. (2016). Privacy and analytics: It's a DELICATE issue-a checklist for trusted learning analytics. In *Proceedings of the Sixth International Conference on Learning Analytics & Knowledge* (pp. 89-98).

Ehlers, U.-D., & Kellermann, S. A. (2019). Future Skills-The Future of Learning and Higher Education. *Results of the International Future Skills Delphi Survey*. Karlsruhe: Karlsruhe University of Applied Sciences.

Ferguson, R., Hoel, T., Scheffel, M., & Drachsler, H. (2016). Guest editorial: Ethics and privacy in learning analytics. *Journal of Learning Analytics*, 3(1), 5-15.

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education*, 7(2), 95-105.

Garrison, D. R., & Vaughan, N. D. (2008). Blended Learning in Higher Education: Framework, Principles, and Guidelines. San Francisco, CA: Jossey-Bass.

Gish-Lieberman, J. J., Tawfik, A., & Gatewood, J. (2021). Micro-credentials and badges in education: A historical overview. *TechTrends*, 65, 5-7.

Graham, C. R. (2013). Emerging practice and research in blended learning. In *Handbook of Distance Education* (3rd ed., pp. 333-350). New York, NY: Routledge.

Graham, C. R., & Draper, D. E. (n.d.). Blended Teaching. *The Open Encyclopedia of Educational Technology*. Retrieved from https://edtechbooks.org/encyclopedia/blended_teaching

Guo, P. J., Kim, J., & Rubin, R. (2014). How video production affects student engagement: An empirical study of MOOC videos. In *Proceedings of the first ACM conference on Learning@ scale conference* (pp. 41-50).

Guo, P., Saab, N., Post, L.S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. *International journal of educational research*, *102*, 101586.

Halupa, C. (2019). Differentiation of Roles: Instructional Designers and Faculty in the Creation of Online Courses. *International Journal of Higher Education*, 8 (1), 55-68.

Han, X., Cui, Y., Wang, W., Wang, S., & Feng, X. (2023). Implementation of Blended Learning at the Course Level. In *Handbook of Educational Reform Through Blended Learning* (pp. 45-123). Singapore: Springer Nature Singapore.

Helleken, T., Langesee, L.M., & Jantos, A. (2024). Bridging the gap: a guide for competence improvement methods for e-tutors in higher education. In *EDULEARN24 Proceedings* (pp. 304-313). IATED.

Henrie, C.R., Halverson, L.R., & Graham, C.R. (2015). Measuring student engagement in technology-mediated learning: A review. *Computers & Education*, *90*, 36-53.

HolonIQ (2023). *Micro-credentials Survey. 2023 Trends and Insights*. Retrieved from https://www.holoniq.com/notes/micro-credentials-survey-2023-insights

Hrastinski, S. (2019). What do we mean by blended learning? *TechTrends*, 63(5), 564-569.

Ifenthaler, D., & Yau, J. Y.-K. (2020). Utilising learning analytics to support study success in higher education: A systematic review. *Educational Technology Research and Development*, 68(4), 1961-1990.

Ilieva, G., Yankova, T., Klisarova-Belcheva, S., Dimitrov, A., Bratkov, M., & Angelov, D. (2023). Effects of generative chatbots in higher education. *Information*, *14*(9), 492.

Iniesto, F., Ferguson, R., Weller, M., Farrow, R., & Pitt, R. (2022). Introducing a reflective framework for the assessment and recognition of microcredentials. *The Open/Technology in Education, Society, and Scholarship Association Journal*, *2*(2), 1-2 4.

Jensen, L., Konradsen, F., & Nielsen, C. (2019). A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies*, 24(1), 151-158.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (2014). Cooperative learning: Improving university instruction by basing practice on validated theory. *Journal on Excellence in College Teaching*, 25(3&4), 85-118.

Kahu, E. R. (2013). Framing student engagement in higher education. *Studies in Higher Education*, 38(5), 758-773.

Knight, S., Shum, S. B., & Littleton, K. (2014). Epistemology, assessment, pedagogy: Where learning meets analytics in the middle space. *Journal of Learning Analytics*, 1(2), 23-47.

Kossen, C., & Ooi, C.Y. (2021). Trialling micro-learning design to increase engagement in online courses. *Asian Association of Open Universities Journal*, *16*(3), 299-310.

Koszalka, T.A., RussEft, D.F., & Reiser, R. (2013). *Instructional designer competencies: The standards*. IAP.

Labadze, L., Grigolia, M., & Machaidze, L. (2023). Role of AI chatbots in education: systematic literature review. *International Journal of Educational Technology in Higher Education*, *20*(1), 56.

Laferrière, T., Lamon, M., & Chan, C. K. K. (2006). Emerging e-trends and models in teacher education and professional development. *Teaching Education*, 17(1), 75-90.

Lang, C., Siemens, G., Wise, A.F., Gašević, D., & Merceron, A. (2022) (Eds.). *Handbook of Learning Analytics* (2nd. ed.). Vancouver: SoLAR.

Langesee, L.M. (2023). From qualification to competencies: defining a task-based competency profile for e-tutors in higher education. *International Journal of Management in Education*, *17*(2), 109-129.

Li, S., Zhang, J., Yu, C., & Chen, L. (2017). Rethinking distance tutoring in e-learning environments: A study of the priority of roles and competencies of Open University Tutors in China. *International Review of Research in Open and Distributed Learning*, *18*(2), 189-212.

Liasidou, A. (2014). Critical disability studies and socially just change in higher education. *British Journal of Special Education*, 41(2), 120-135.

Liu, Q., Chen, L., Feng, X., Bai, X., & Ma, Z. (2024). Supporting students and instructors in blended learning. *Handbook of Educational Reform Through Blended Learning*, 199-230.

López-Gómez, E., Leví-Orta, G., Medina Rivilla, A., & Ramos-Méndez, E. (2020). Dimensions of university tutoring: a psychometric study. *Journal of Further and Higher Education*, *44*(5), 609-627.

MacDonald, J. (2008). *Blended learning and online tutoring: Planning learner support and activity design*. Gower Publishing, Ltd.

Magruder, O., Arnold, D. A., Moore, S., & Edwards, M. (2019). What Is an ID? A Survey Study. *Online Learning*, *23*(3), 137-160.

Masiello, I., Mohseni, Z., Palma, F., Nordmark, S., Augustsson, H., & Rundquist, R. (2024). A Current Overview of the Use of Learning Analytics Dashboards. *Education Sciences*, *14*(1), 82.

Massuga, F., Soares, S., & Luis Dias Doliveria, S. (2021). El papel del tutor en la enseñanza de la educación a distancia: una revisión sistemática sobre el enfoque de competencias. *Revista de Educación a Distancia* (RED), *21*(66).

McGill, T. J., Klobas, J. E., & Renzi, S. (2014). Critical success factors for the continuation of e-learning initiatives. *The Internet and Higher Education*, 22, 24-36.

Means, B., Toyama, Y., Murphy, R., & Bakia, M. (2013). The effectiveness of online and blended learning: A meta-analysis of the empirical literature. Teachers College Record, 115(3), 1-47.

Minerva, T., Jana, M., Bellini, C., De Santis, A., & Sannicandro, K. (2022). Openess in education: A technological and conceptual framework. In *EDULEARN22 Proceedings* (pp. 4521-4526). IATED.

Popenici, S. A. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning*, 12(1), 22.

Prince, M. (2004). Does active learning work? A review of the research. *Journal of engineering education*, 93(3), 223-231.

Qureshi, M. A., Khaskheli, A., Qureshi, J. A., Raza, S. A., & Yousufi, S. Q. (2023). Factors affecting students' learning performance through collaborative learning and engagement. *Interactive Learning Environments*, *31*(4), 2371-2391.

Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education*, 147, 103778.

Ramaswami, G., Susnjak, T., & Mathrani, A. (2023). Effectiveness of a Learning Analytics Dashboard for Increasing Student Engagement Levels. *Journal of Learning Analytics*, *10* (3), 115-134.

Reiser, R. A., & Dempsey, J. V. (Eds.). (2017). *Trends and Issues in Instructional Design and Technology* (4th ed.). Boston, MA: Pearson.

Salmon, G. (2013). *E-tivities: The Key to Active Online Learning* (2nd ed.). New York, NY: Routledge.

Sannicandro, K., De Santis, A., Bellini, C., & Minerva, T. (2019). Analysis of completion and dropout rates in EduOpen MOOCs. *Italian Journal of Educational Research*, 27-42.

Schwendimann, B.A., Rodriguez-Triana, M.J., Vozniuk, A., Prieto, L.P., Boroujeni, M.S., Holzer, A., Gillet, D., & Dillenbourg, P. (2017). Perceiving Learning at a Glance: A Systematic Literature Review of Learning Dashboard Research. I*EEE Transactions on Learning Technologies*, *10*(1), 30-41.

Selwyn, N. (2014). *Digital Technology and the Contemporary University: Degrees of Digitization*. New York, NY: Routledge.

Slade, S., & Prinsloo, P. (2013). Learning analytics: Ethical issues and dilemmas. *American Behavioral Scientist*, 57(10), 1510-1529.

Staring, F., Brown, M., Bacsich, P., & Ifenthaler, D. (2022). Digital higher education: Emerging quality standards, practices and supports. *OECD Education Working Papers*, No. 281, OECD Publishing, Paris.

Stephany, F., & Teutloff, O. (2024). What is the price of a skill? The value of complementarity. *Research Policy*, *53*(1), 104898.

Stensaker, B. (2018). Academic development as cultural work: Responding to the organizational complexity of modern higher education institutions. *International Journal for Academic Development*, 23(4), 274-285.

Suhasini, B., & Santhosh Kumar, N. (2019). Emerging trends and future perspective of human resource reskilling in higher education. *International Journal of Recent Technology and Engineering*, *8*(2), 351-353.

Tomlinson, M. (2017). Forms of graduate capital and their relationship to graduate employability. *Education + Training*, 59(4), 338-352.

Vegliante, R., & Sannicandro, K. (2020). The role of the tutor in the university context and in distance learning: an exploratory research. *Journal of E-Learning and Knowledge Society*, *16*(3), 76-85. https://doi.org/10.20368/1971-8829/1135274

Verbert, K., Duval, E., Klerkx, J., Govaerts, S., & Santos, J.L. (2013). Learning analytics dashboard applications. *American Behavioral Scientist*, *57*(10), 1500-1509.

Vlachopoulos, D., & Makri, A. (2017). The effect of games and simulations on higher education: a systematic literature review. *International Journal of Educational Technology in Higher Education*, *14*, 1-33.

Wiggins, G., & McTighe, J. (2005). *Understanding by Design* (2nd ed.). Alexandria, VA: ASCD.

Willis, J. E., Slade, S., & Prinsloo, P. (2016). Ethical oversight of student data in learning analytics: A typology derived from a cross-continental, cross-institutional perspective. *Educational Technology Research and Development*, 64(5), 881-901.

Yorke, M. (2006). Employability in higher education: What it is-What it is not. *Learning and Employability Series One*. York: Higher Education Academy.

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice*, 41(2), 64-70.

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 20, No. 3 (2024), pp. 126-137

READY for the future?
New roles and professional practices for 21st century educators

Panagiotis Kampylis[a], Fabio Nascimbeni[b], Jolien van Uden[b,1], Olena Bekh[b]

[a]*University of Piraeus, Department of Digital Systems – Piraeus (Greece)*

[b]*European Training Foundation – Turin (Italy)*

(submitted: 7/7/2024; accepted: 13/10/2024; published: 18/12/2024)

Abstract

The expectations of educators' roles and professional practices have changed considerably due to emerging societal trends and external factors. This paper proposes a structured way to capture and present these changes. We have conducted a literature review of 70 academic and grey publications, an in-depth analysis of 50 existing frameworks, standards and profiles, and a validation workshop with policymakers, researchers and educators. As a result, we have developed a meta-model called READY (**R**eference **M**odel for **E**ducators' **A**ctivities and **D**evelopment in the 21st centur**Y**) that focuses on practices which are relatively new or are receiving increased attention in guiding educators' professional development. READY comprises six-plus-one domains of professional activity, twenty-two professional practices, and seventy-three descriptors of how the practices can be implemented. As a reference model, READY can support educators in identifying development needs and updating their professional practices for responding to the changing needs of society.

KEYWORDS: READY Reference Model; 21st Century Educators; Educators' Professional Practices.

DOI
https://doi.org/10.20368/1971-8829/1135980

CITE AS
Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators. *Journal of e-Learning and Knowledge Society*, *20*(3), 126-137.
https://doi.org/10.20368/1971-8829/1135980

1. Introduction

Global and local socioeconomic changes require fast adaptation of education and training systems. The pivotal function that educators at all levels play in the transition of skills development systems within the knowledge society and the fact that their role - and their corresponding practices - should adapt to accommodate the effects of major societal trends have increasingly been recognised at the policy and the research level (European Training Foundation, 2020; Galvin et al., 2023). In this paper, the term educator has a broad definition, as proposed by the European Training Foundation (ETF, 2022, in the glossary):

"any person involved in the process of teaching or guiding and facilitating learning. In particular, it refers to teachers and instructors at all levels of formal education, ranging from pre-primary, primary and secondary, to further and higher education (e.g., university lecturers), to vocational and adult education, and including initial training and continuous professional development. It may also be used to describe trainers, coaches, and other professionals supporting learning in the workplace and people involved in providing training in non-formal and informal settings, e.g., social workers, library staff, parents providing home schooling, etc."

A literature review by the European Training Foundation (2020) identified four interrelated trends that mainly impact education and training systems and, consequently, educators:

1. the digital transition of education and training systems, including the industry 4.0 developments, urges educators not only to acquire the capacity to implement meaningful technology-enhanced pedagogies across different learning environments

[1] corresponding author - email: jolien.van-uden@etf.europa.eu

but also to have critical knowledge about digitalisation issues such as Artificial Intelligence (AI) or digital privacy (e.g., Wagiran et al., 2019; Subrahmanyam, 2020; Sarva & Puriņa-Biezā, 2023; Wohlfart & Wagner, 2023; Deng, 2024; Maine, 2024).

2. climate change pressures education and training systems to emphasise the development of green skills. Therefore, educators need both knowledge about the required green skills in the labour market and a green attitude in executing their daily work (e.g., Leicht et al., 2018; Sevilla & Dutra, 2018; Pavlova, 2019; Huang et al., 2024).
3. changing demography and migration dynamics are bringing into the core of educators´ professional practices the capacity to support an increasingly diverse and ageing learner population by improving their intercultural communication and linguistic competences (e.g., Marope et al., 2015; Tran & Pasura, 2018; Rissanen et al., 2023).
4. new dynamics in the labour market, such as the circular economy and crowdfunding, put more importance on skill sets (Gonzalez Vazquez et al., 2019). In this context, educators must be able to support learners in developing skill sets and competences, such as entrepreneurship competence (Bacigalupo et al., 2016; Morselli, 2024). Therefore, educators must develop these skill sets themselves (e.g., through adequate training) to have the professional capacity to enable learners to develop them as well (e.g., Avis, 2017; Zhang et al., 2017; Ovcharuk et al., 2023).

On top of these trends, developments in teaching approaches further impact educators' work. For instance, new teaching approaches such as competence-based education require educators to update their teaching strategies to ensure higher integration of theory and practice (e.g., Gulikers et al., 2018; Zyrianova et al., 2018; Phan, 2024). Similarly, collaborative and team-based approaches are gaining ground as essential aspects of educators' professional practices, also in response to the above trends, calling for increased participation in professional networks and open communities (e.g., Roberts & Owen, 2012; Marope et al., 2015; Martinovic & Milner-Bolotin, 2024; Thurlings, 2015; Dickson, 2024).

The European Commission (2012; 2018; 2020) has responded to these developments by emphasising the importance of educators possessing professional, pedagogical, transversal and networking competences to respond to the diverse requirements of contemporary teaching and training processes. Cedefop (2015) states that the role of on-the-job trainers needs to be enriched beyond conveying knowledge and skills with coaching and mentoring activities so that they can stimulate a learning culture in enterprises. The European Training Foundation (2019) recognises that the role of educators is changing with the introduction of new pedagogies such as blended learning and experiential learning. Finally, the European Council (2020, p. 11) puts forward this imperative:

> *"In the context of constant social, demographic, cultural, economic, scientific, environmental and technological changes, the world of education and training is changing, and so is the occupation of teachers and trainers, with increasing demands, responsibilities and expectations put before them. Continuous innovations and challenges have an effect not only on the competences required but also on teachers' and trainers' well-being and the attractiveness of the teaching profession".*

1.1 Educators' new roles

The meta-model presented in this study aims to scope the educators' emerging roles and professional practices that are particularly important to respond to societal trends and to support learners in developing the knowledge, skills and attitudes needed to thrive in a fast-changing world. The global socioeconomic trends and the new insights into how people learn confirm the new demands on educators (e.g., Salamatov et al., 2017; Carlsson & Willermark, 2023). Reviewing the literature, we found agreement on three aspects that are increasingly important for the 21st century educators:

1. They are encouraged to work in new ways, which is reflected in the new terms used to refer to them as professionals. Instead of using teacher and trainer, terms such as facilitators, coaches, supervisors, mentors, and counsellors are increasingly used (e.g., Rivoltella & Rossi, 2012; Oddone et al., 2019; Russon & Wedekind, 2023). Caena and Redecker (2019) refer to teachers and trainers as alchemists who mix strategies, techniques, and resources to create meaningful learning, orchestrators who lead individual and group learning, or welders who connect bits and pieces of knowledge and activities into a meaningful whole. Looking specifically at Vocational Education and Training (VET), the profile of educators has been defined as a mix of pedagogy, social and career development, and socio-emotional skills such as self-regulation, empathy, and emotional intelligence (Marope et al., 2015; European Commission, 2018; Subrahmanyam, 2020).
2. Educators are expected to expand their responsibilities beyond teaching, getting involved in administrative and management tasks, quality assurance processes, school improvement, and curriculum design (Finnish National Board of Education and Cedefop, 2009; European Training Foundation, 2019). Also, educators are increasingly considered agents of change within skills development reform processes (European Training Foundation, 2020). To play these new roles, educators must constantly develop their innovative capacities to keep teaching and learning

experiences up-to-date with recent trends and developments (e.g., Messmann & Mulder, 2011; Gu, 2024).

3. Educators are increasingly called to collaborate with colleagues, experts and external stakeholders to share expertise in their day-to-day work, as one person cannot have all the competences needed to the highest level (Tapani & Salonen, 2019). For instance, collaboration is essential for creating multidisciplinary learning opportunities or for making better use of the strengths of all members of the team of educators to foster well-being and peer support. Team teaching has also proved effective, especially when integrating theory and practice (Sturing et al., 2011; De Weerdt et al., 2024).

The literature recognises that these transitions imply a major paradigm shift in how educators perceive themselves and interact with other key actors in the education systems, such as school leaders and teacher educators (Snoek & Dengerink, 2019; Admiraal & Kittelsen Røberg, 2023). They need to change their ideas on how the teaching and learning processes take place, and in line with that, they need to rethink and reshape the roles they play in these new settings (e.g., Duch & Andreasen, 2015; Kovalchuk et al., 2023). The new requirements on educators' roles highly influence their professional identity, which is linked to what they (should) do and the expectations arising from the labour market as well as from learners, parents, and society at large. Therefore, educators might need to change their personal and professional attitudes to meet these expectations (De Bruijn, 2012). Furthermore, educators should be given sufficient time, resources, and support to adapt to the new requirements and develop innovative teaching practices and training programmes (Ganter de Otero, 2019; Brevik et al., 2023). Finally, educators are also expected to play a crucial role in the structural reforms many transitions and developing countries implement (European Training Foundation, 2018).

Fostering a transition to the required new roles of educators within the education and training systems is a long-term (although urgent) and multifaceted challenge. At the same time, a clear understanding of what these new roles entail in professional practice is often lacking because of the multiplicity of concepts and approaches, as well as difficulty of adapting the many existing international competence and qualification frameworks and standards for educators to the local context (Nascimbeni, 2018). Therefore, this paper aims to contribute to the understanding of the new roles educators should play and the professional practices they should apply for supporting learners to develop adequate knowledge and skill sets for the 21st century, by answering the following research questions:

1. What are the emerging domains of professional activity and related practices that 21st century educators should consider in their everyday work?
2. How can the emerging professional practices be presented in a structured and aggregated way to inspire and engage 21st century educators in playing their new and demanding roles?

2. Materials and methods

A qualitative research design was applied to study the new roles of 21st century educators and the emerging professional practices they could perform in their everyday work. In this context, we conducted desk research followed by a validation process to answer the study's research questions presented in the Introduction. The emerging roles and professional practices of educators were collected, analysed and mapped through desk research, based on a literature review and on the in-depth analysis of existing models and approaches (frameworks, standards, profiles). This desk research served as a basis for the first draft of the READY (**R**eference **M**odel for **E**ducators' **A**ctivities and **D**evelopment in the 21st centur**Y)** model that was presented and discussed in a validation workshop, where insights and feedback were collected from researchers, practitioners and various education and training stakeholders.

2.1 Desk research – literature review and analysis of existing models

The initial stage of the desk research was an extensive review of academic and grey literature built by the European Training Foundation (2020). The literature review was complemented by an online search covering existing professional standards, profiles and competence frameworks that provide insights into educators' roles and professional practices. Through this two-step approach, we created a pool of 70 existing models (frameworks, profiles and standards used at regional, national or international levels). The following criteria were applied to select the ones of particular interest and relevance for developing the READY reference model:

- to include educators' professional standards, characteristics, practices, skills or competences;
- to be relevant for educators from different educational or training sectors.

Fifty models with a wide geographical coverage (international, national and local) fulfilled these criteria and were analysed in depth. We focused the analysis on three dimensions: (1) the different functions, roles and practices distinguished for educators, (2) the proposed teaching, learning and assessment approaches and (3) the references to specific skills or competences required by the 21st century educators. The analysis aimed (a) to gain insights into the focus, content and structure of the selected models, (b) to identify commonalities and points of divergence across them, and (c) to provide the basis for drafting a reference model that can be adapted and used in various education and training settings.

Given the scope of this study, the analysis was limited to providing an overview of the 50 models in terms of structure and content, and it did not provide a comparative scrutiny of their effectiveness and impact. Appendix 2 summarises the models analysed, including their structure, geographical coverage, target group, and whether they use any progression or proficiency levels.

2.2 Validation workshop

The draft model was presented and discussed during an online validation workshop on 2 December 2021. Overall, 23 international experts and stakeholders with diverse backgrounds (policymakers, researchers, and educators) attended this by-invitation-only workshop, plus four research team members (see Table 1 below).

Table 1 - Workshop participants.

Female	15	Male	8
From EU member states	15	From EU neighbourhood and other countries	8
External participants	17	Staff from the organising agency	6

The draft reference model was shared with the participants one week in advance. The workshop started with introducing the model and answering general questions concerning its purpose, structure and content. After the introduction, the participants were allocated to three predefined heterogeneous focus groups achieving an optimal variety of genders, nationalities and profiles. Each group discussed the draft model in depth and provided feedback structured around four questions:

- What proposals do you have for improving the model's structure?
- What proposals do you have for improving the terminology used for the educators' professional practices and attributes?
- What proposals do you have for changing/adding/removing content for the educators' professional practices and attributes?
- How could the model be used (why, how, when, where, by whom)?

The group discussions were moderated by the first three authors of this paper and supported by Mural canvases for online collaboration and feedback collection. In each group, one participant was assigned the role of rapporteur. At the beginning of the group session, all participants were asked to provide their questions, comments, and recommendations individually by adding virtual post-its to the Mural canvases. Then, based on the collective input on the canvases, the moderators facilitated an open discussion and feedback collection. In the workshop's last session, the rapporteurs presented the collective feedback of their group. Finally, the workshop concluded with a plenary discussion moderated by the last author of this paper.

Overall, the workshop participants, representing different stakeholder organisations and having diverse backgrounds (e.g., educators, teacher trainers, representatives of school networks, and people working on educational reform), confirmed the need for an up-to-date reference model that is adaptable, flexible, and grounded in the literature. Also, they recognised the potential of READY to serve as such reference model for educators, policymakers, researchers and other education and training stakeholders.

As final step READY has been applied by two major educational networks (Ort and Amal) in Israel from July 2022 to September 2023. These networks have engaged Israeli educators and students from ten schools in using the READY model to develop new pedagogical approaches and test new teaching and learning practices that can be implemented in their respective schools. During the feedback loops, the READY domains and practices have been used for identifying educators' professional development needs to support them in implementing these new teaching approaches. The feedback provided by the participating experts and educators confirmed both the structure and the usefulness of the READY model.

2.3 Limitations

The methodology for developing READY has its limitations. First, only publications and models in English were considered in the literature review and desk research, respectively. Future research should consider literature in other languages to provide a more comprehensive overview of relevant models that can offer new insights for an update and further development of the READY model. Second, READY has been constructed based mainly on insights collected through the literature review and analysis of existing models with limited consultations with educators and other education and training stakeholders, mainly through the validation workshop. The feedback collected so far shows support for the model. However, future research should test the READY model by conducting more consultations and field work to validate its relevance and applicability in different education and training settings.

3. Results

Through the methodology described above, we developed the READY reference model comprising six-plus-one domains of professional activity and twenty-two professional practices. READY stands for the Reference Model for Educators' Activities and Development in the 21st CenturY. The complete model is presented in Appendix 1, while the detailed mapping of existing models against READY is presented in Appendix 2.

3.1 Model development

Based on the analysis of the existing literature and models, the first draft of the READY reference model was developed to offer a structured way to identify the professional practices and development needs of 21st century educators. The domains and practices that comprise READY will not be particularly new or surprising to most educators, the novelty of READY being that it combines these key elements in a structured and comprehensive way to provide a shared language and an easy-to-use reference point.

We took a selective approach in designing READY, as we did not aim to capture all possible domains of educators' professional activity. Instead, we decided to select those receiving increased attention in recent literature. Also, we aimed to develop a multi-sectoral model. Although our starting point was VET, we aimed to create a reference model applicable to the lifelong learning perspective that would be relevant for all educators independently of the educational or training sub-sector they are working in. Further, we aimed to develop a model that would be relevant for all educators, regardless of their subject, background, and expertise. In other words, we aimed to develop a model that can be a reference point from which all educators can choose and pick the aspects that are most relevant and useful in their professional practice. Finally, we developed a model that is customisable by design as it includes a context-specific domain that can be further developed, along with related professional practices and descriptors, to be relevant to different education and training contexts.

3.2 Model revision and validation

After the workshop, the authors of this paper organised the feedback and insights collected through the online canvases in one document under five thematic areas (i.e., content, structure, terminology, potential users and use) and performed content analysis. The feedback provided during the validation workshop resulted in significant changes (see an overview in Table 2) in the consolidated version of the READY model presented in this paper. The first change was in the structure of the model and the terminology used. The use of the term attributes in the draft model elicited many concerns as an attribute could be perceived more as a characteristic of an individual than the capacity of a professional like, in our case, an educator. Based on the discussion and suggestions provided by the workshop participants, the authors decided to use the term domain of professional activity instead of attribute. This term reveals that the related professional practices are linked to a domain in which educators might have specific knowledge, skills and attitudes which can develop further throughout their career and not to a characteristic of their personality.

A second change was the reduction in the number of domains and related professional practices. In all three discussion groups, proposals were made to reduce overlapping by merging some domains and then reshuffling related practices. We adopted many of these suggestions by significantly reducing the number of the READY model's domains from ten-plus-one to six-plus-one and practices from 43 to 22, respectively.

On the other hand, the consolidated version includes 73 descriptors instead of the 53 in the draft model, based on suggestions of the workshop participants. These descriptors have been added to provide more examples of how a professional practice can be implemented. For instance, the practice Bridge the worlds of education and work of the Adaptability and initiative domain contains two descriptors: "educators design activities that bring together learners and educators with business and community leaders and other stakeholders to expand opportunities for understanding the worlds of work and education and explore opportunities for synergy" and "educators support learners in exploring and understanding business models and the role they play in the economy and society". The role of the descriptors is to illustrate how the practice could be implemented, but they are not meant to be exhaustive. Most of the descriptors emerged from analysing existing models, while the workshop participants proposed some additional ones. The complete list of 73 descriptors is presented in Appendix 1.

As a final step, after the validation workshop, the 50 models from the desk research in-depth analysis were next mapped against the domains and practices of the consolidated READY model (see last column of Table 2 and Appendix 3). The aim of such mapping was twofold: first, to contribute to fine-tuning READY's descriptors. Second, to check the added value of the READY meta-model by comparing its up-to-date structure and content with those of existing models.

4. Discussion

The READY model was developed to support educators and people working closely with them to inform and update their daily professional practices and identify development needs to respond to the changing needs in society.

As presented earlier in the paper, several trends have a significant impact on education and training systems and, consequently, on educators' work: (1) the digital transition, (2) the green transition, (3) the changing demography and migration dynamics, (4) the new dynamics in the labour market. READY highlights the need for educators to adapt to a fast-changing world and take advantage of emerging teaching paradigms and approaches, including the increased need for collaborative and team-based approaches. While existing models, qualification and education standards and occupational profiles typically correspond to one or more trends and related professional practices, READY offers an up-to-date and holistic approach, presenting in a structured way all the emerging areas of practice that contemporary educators should consider in their work.

The mapping of the 50 existing models shows that some of the 22 professional practices identified in the READY model are well reflected in existing models, while others are less present. When interpreting this, it is crucial to consider the wide variety of models analysed. Most of the analysed models directly target educators.

Table 2 - Changes made to the main structure of the READY model based on the validation workshop.

READY draft model

10+1 attributes	40 professional practices
Learner-driven	1. Fostering meaningful learning
	2. Fostering soft skills development
	3. Facilitating peer and team learning
	4. Using a variety of assessment methods
	5. Coaching learners across learning environments
	6. Developing personalised learning experiences
	7. Fostering learners' agency
	8. Providing career guidance
Entrepreneurial	9. Fostering entrepreneurship competence
	10. Bridging the worlds of education and work
Adaptive	11. Being flexible
	12. Demonstrating resilience
	13. Learning from failure
Environmentalist	14. Adopting environmentally sustainable practices
	15. Fostering environmentally sustainable behaviours among learners
Inclusive	16. Fostering intercultural communication with and among learners
	17. Creating inclusive learning environments
Ethical/empathetic	18. Implementing ethical work practices
	19. Being attentive to personal well-being
	20. Being attentive to learners' well-being
	21. Being attentive to colleagues' well-being
	22. Being empathetic

READY consolidated model

6+1 domains	22 professional practices	Existing models with similar practices
Learner-driven	1. Foster meaningful learning	11
	2. Facilitate peer- and team-learning	06
	3. Apply a variety of assessment methods	22
	4. Coach learners across learning environments	11
	5. Develop personalised learning experiences	12
Adaptability & initiative	6. Foster learners' entrepreneurship	05
	7. Bridge the worlds of education and work	11
	8. Demonstrate resilience and adaptability	10
Sustainability & inclusion	9. Create inclusive learning environments	24
	10. Be attentive to personal well-being and that of others	08
	11. Manage one's own and others' emotions	08
	12. Adopt and promote environmental, social and economic sustainability	10

READY draft model		READY consolidated model		
10+1 attributes	**40 professional practices**	**6+1 domains**	**22 professional practices**	**Existing models with similar practices**
Collaborative	23. Working in team with other educators	**Collaboration & engagement**	13. Collaborate with peers and other stakeholders	21
	24. Learning through peers and professional communities		14. Contribute to professional networks and communities	13
	25. Encouraging co-creation and sharing of knowledge		15. Contribute to organisational development and improvement processes	14
	26. Using a variety of communication strategies			
	27. Opening the learning settings to external stakeholders			
Engaged staff member	28. Engaging in institution-wide activities			
	29. Engaging in curriculum development			
	30. Engaging in quality assurance			
Lifelong learner	31. Proactively engaging in professional development opportunities	**Lifelong learning & reflection**	16. Proactively engaging in professional development opportunities	22
	32. Developing autonomously through their career		17. Reflect on professional practices	23
	33. Reflecting on professional practices		18. Apply evidence-based pedagogies	13
	34. Applying research-based pedagogies			
Digital	35. Using digital technologies for teaching	**Digital technologies**	19. Use digital technologies to enhance teaching	16
	36. Reflecting on data to adjust instructional plans		20. Create digital resources and content	02
	37. Being aware of the impact of digital technologies		21. Be aware of copyright and online privacy	06
	38. Respecting copyright and online privacy		22. Understanding the potential role and impact of digital technologies	02
	39. Encouraging learners to use digital technologies for knowledge production			
	40. Fostering responsible digital citizenship			
[Context specific]		**[context specific]**	[to be defined locally]	

In contrast, others are aimed at citizens in general, such as the EU competence frameworks (e.g., EntreComp, DigComp 2.1) or at teaching and learning without a specific focus on educators, such as the Baltimore City Instructional Framework Rubric (Model 34 in Appendix 2). The focus of the different models differs as well. Some cover many areas an educator should develop or perform, such as the Graduand Teacher Competencies Framework (Model 9 in Appendix 2). Others focus on specific areas, such as Green Skills in Vocational Teacher Education (Model 15 in Appendix 2), or on specific sectors, such as the Core Competency for TVET Educator (Model 30 in Appendix 2) or the Teacher Educator Technology Competencies (Model 30 in Appendix 2) for teacher educators. This variety of models helped us construct and validate READY, as they provided different perspectives on the required individual competencies, units of professional qualifications or professional activities of contemporary educators, who are both professionals in the field of education and role models inspiring their learners.

The READY model's diversity allowed us to understand which areas of practice are covered by the most common approaches and which are less common. Five professional practices are reflected in at least 20 of the 50 analysed models, representing a 'shared common ground'. These are: (1) Apply a variety of assessment methods, (2) Create inclusive learning environments, (3) Collaborate with peers and other stakeholders, (4) Proactively engage in professional development opportunities, and (5) Reflect on professional practices. It is not a surprise that assessment is included in many existing models, as it is an integral part of contemporary teaching and learning, and also because innovative forms of assessment have become critically important in the context of the COVID-19 lockdown. The way the different models view assessment varies, but most models distinguish between formative and summative assessment and emphasise the need for informative and timely feedback. With classrooms becoming more heterogeneous due to migration and other demographic changes, more and more attention is paid to creating inclusive learning environments. This is reflected in the number of existing models that included this aspect, often using terms like diversity, equity, culturally responsive and respect. Collaboration with peers and other stakeholders is also incorporated in many existing models. The shift from subject-oriented to more integrated, cross-curricula approaches requires educators not only to collaborate, but also to make learning more relevant by including real-world problems or authentic learning experiences. This means that educators have to collaborate with various actors.

Interestingly, the two practices most often found in existing models are in the domain of lifelong learning and reflection. This is not surprising: lifelong learning is considered essential in any occupation across various life transitions. Thus, it equally applies (or even more so) to educators. At the same time, it aligns with the concept of an educator as a reflective practitioner embraced by scholars and education stakeholders for a long time.

Five professional practices included in the READY model are supported by six or fewer other models: (1) Facilitate peer- and team-learning, (2) Foster learners' entrepreneurship, (3) Create digital resources and content, (4) Be aware of copyright and online privacy, (5) Understanding the potential role and impact of digital technologies. Remarkably, three of these five professional practices come from the domain of digital technologies, which gets much attention in light of the digital transition of education and training systems. There could be different explanations for this. First, most existing models were developed before 2020 and do not incorporate the recent developments in digital education triggered by the COVID-19 pandemic. Although the use of digital technology in education has been in the spotlight for some decades, it got a real boost with the pandemic resulting in school closures and the online education wave. The OECD report Education at a glance 2022 shows that many countries intend to maintain or further develop digitalisation measures implemented during the school closures (OECD 2022). 'Copyright' and 'online privacy' are also issues that gained more attention in the public debate in recent years, connected to the emerging concept of critical digital literacies (Pangrazio 2016). The last one, Understanding the potential role and impact of digital technology, is more forward-looking. It is about understanding the potential impact of emerging technologies (such as generative artificial intelligence or virtual, augmented and mixed reality) in society and economy and trying to prepare citizens through education and training. This is quite particular and, therefore, not reflected in many other models. Still, two models refer to this aspect, one being the Teacher digital competence framework (Model 26 in Appendix 2), which focuses explicitly on educators.

The mapping of existing models in Appendix 3 shows that all the professional practices identified as important for the 21st century educators have also been included in existing models. On the other hand, most of the existing models only cover a limited number of the professional practices identified within READY. Only three models cover at least half of the professional practices identified by READY: DigCompEdu and ISTE Educator Standard cover 13 practices each, while Educator Competencies for Personalised, Learner-centred Teaching covers 12 practices. The fact that none of the existing models analysed fully covers the scope of the READY model shows that the proposed approach can provide a different and more holistic perspective on the professional activities and areas of professional development of contemporary educators in response to the trends affecting their professional practices.

5. Conclusions and further research

As a reference model, READY represents an original conceptual approach aiming to promote a shared understanding of 21st century educators' domains of professional activity and related practices. However, it is not intended to be prescriptive or to provide solutions for specific education and training settings. To be used in real settings, it must be first adapted and customised by interested parties considering the local context, needs and aspirations.

After the first application by the two educational networks in Israel to test the relevance and applicability, READY has also been applied in Ukraine to inspire the revision of the new Teacher Standard that is currently at the final stage of adoption by the authorities under the New Ukrainian School reform. Further testing in practice will continue to collect feedback, evidence and improvement suggestions by educators, teacher trainers, school leaders and others closely working with educators who will be using the model to inform or shape their work. An online training will be developed to support educators, teacher trainers, school leaders and others in applying READY.

Some more activities are needed to explore other possible applications of READY, such as updating educators' professional development plans, building robust support and professional development practices, or informing national frameworks or profiles for educators. To promote READY's use by education and training policymakers and other stakeholders, it must be widely disseminated and accompanied by tools and guidelines for collecting and analysing data about its usability and effectiveness to different user objectives and contexts. The READY model is, by design, flexible and adaptable, and such implementation in various education and training settings can provide valuable insights into the professional practices of 21st century educators.

References

Admiraal, W., & Kittelsen Røberg, K.-I. (2023). Teachers' job demands, resources and their job satisfaction: Satisfaction with school, career choice and teaching profession of teachers in different career stages. *Teaching and Teacher Education*, 125, 104063. https://doi.org/10.1016/j.tate.2023.104063

Avis, J. (2017). Beyond Competence, Thinking Through the Changes: Economy, Work and Neo-liberalism. In M. Mulder (Ed.), *Competence-based Vocational and Professional Education: Bridging the Worlds of Work and Education* (pp. 183-202). Springer International Publishing. https://doi.org/10.1007/978-3-319-41713-4_9

Bacigalupo, M., Kampylis, P., Punie, Y., & Van den Brande, G. (2016). *EntreComp: The Entrepreneurship Competence Framework*. Publication Office of the European Union. https://doi.org/10.2791/593884

Brevik, B., Kaiser, F. & Hoppe, M. (2023). Challenges and helpful conditions for vocational teachers in Europe. Findings from the "VETteach" project. In V. Tūtlys, L. Vaitkutė & C. Nägele (Eds.), *Vocational Education and Training Transformations for Digital, Sustainable and Socially Fair Future* (pp. 87-92). European Research Network on Vocational Education and Training. https://doi.org/10.5281/zenodo.7808346

Bruijn, E. de. (2012). Teaching in innovative vocational education in the Netherlands. *Teachers and Teaching*, 18(6), 637–653. https://doi.org/10.1080/13540602.2012.746499

Caena, F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu). *European Journal of Education*, 54(3), 356–369. https://doi.org/10.1111/ejed.12345

Carlsson, S., & Willermark, S. (2023). Teaching Here and Now but for the Future: Vocational Teachers' Perspective on Teaching in Flux. *Vocations and Learning*, 16(3), 443–457. https://doi.org/10.1007/s12186-023-09324-z

Cedefop. (2015). *CVET in Europe: The way ahead*. Publications Office of the European Union. https://data.europa.eu/doi/10.2801/034661

De Weerdt, D., Simons, M., Struyf, E., & Tack, H. (2024). Studying the Effectiveness of Team Teaching: A Systematic Review on the Conceptual and Methodological Credibility of Experimental Studies. *Review of Educational Research*, 00346543241262807. https://doi.org/10.3102/00346543241262807

Deng, Y. (2024). The Rise of Hybrid Educators. ECNU *Review of Education*, 7(3), 677-680. https://doi.org/10.1177/20965311231206148

Dickson, E., Lardier, D. T., Verdezoto, C. S., & Hackett, J. M. (2024). Reducing isolation for educators through ECHO virtual communities of practice. *Frontiers in Education*, 9, 1409721. https://doi.org/10.3389/feduc.2024.1409721

Duch, H., & Andreasen, K. E. (2015). Reforming Vocational Didactics by Implementing a New VET Teacher Education in Denmark: Tensions and Challenges Reflected in Interviews with Vocational College Teachers. *International Journal for Research in Vocational Education and Training*, 2(3), 195-213. https://doi.org/10.13152/IJRVET.2.3.5

Escudeiro, P., Gouveia, M. C., & Escudeiro, N. (2024). Revolutionizing Education: The European STEAME Teacher Facilitators Academy Project. In *2024 IEEE Global Engineering Education Conference (EDUCON) Proceedings*, 1-4. https://doi.org/10.1109/EDUCON60312.2024.10578872

European Commission. (2012). *Commission Staff Working Document - Vocational education and training for better skills, growth and jobs*. Retrieved on 10 April 2024, from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52012SC0375

European Commission (2018). *Teachers and Trainers Matter: How to support them in high-performance apprenticeships and work-based learning – 12 policy pointers*. Publications Office of the European Union. https://data.europa.eu/doi/10.2767/129296

European Council (2020). *Council conclusions on European teachers and trainers for the future*. Retrieved on 10 April 2024, from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=uriserv:OJ.C_.2020.193.01.0011.01.ENG

European Training Foundation (2018). *Digital skills and competence, and digital and online learning*. European Training Foundation.

European Training Foundation (2019). *Toolkit: Skills and qualifications: Benefits for people*. European Training Foundation. https://openspace.etf.europa.eu/pages/toolkit-skills-and-qualifications-benefits-people

European Training Foundation (2020). *Teachers and teacher professional development for new learning*. European Training Foundation. https://bit.ly/4dg4wmI

European Training Foundation (2022). *The READY model*. Retrieved on 10 April, from https://view.genial.ly/6243253217ac64001885c67e

Finnish National Board of Education, & Cedefop (2009). *Competence framework for VET professions: Handbook for practitioners*. Finnish National Board of Education.

Galvin, C., Kampylis, P., Craith, D. N., Madalinska-Michalak, J. & Purdy, N. (2023). Mobilising Policy to Reframe Teaching and Teacher Education in Europe - The European Commission's Emerging Role within the Teacher Quality Agenda. In J. Madalinska-Michalak (Ed.), *Quality in Teaching and Teacher Education - International Perspectives from a Changing World*, 304–328. Brill.

Ganter de Otero, J. (2019). Trends Mapping Innovation in TVET. UNESCO-UNEVOC. https://bit.ly/4gBkfQb

Gonzalez Vazquez, I., Milasi, S., Carretero Gomez, S., Napierala, J., Robledo Bottcher, N., Jonkers, K., Goenaga, X., Arregui Pabollet, E., Bacigalupo, M., Biagi, F., Cabrera Giraldez, M., Caena, F., Castano Munoz, J., Centeno Mediavilla, C., Edwards, J., Fernandez Macias, E., Gomez Gutierrez, E., Gomez Herrera, E., Inamorato Dos Santos, A., … Vuorikari, R. (2019). *The changing nature of work and skills in the digital age*. Publications Office of the European Union. https://doi.org/10.2760/679150

Gu, M. (2024). Empowering Vocational Education through Digital Technology: Innovating the Teaching Landscape. *International Journal of New Developments in Education*, 6(6), 131–136. https://doi.org/10.25236/IJNDE.2024.060621

Gulikers, J. T. M., Runhaar, P., & Mulder, M. (2018). An assessment innovation as flywheel for changing teaching and learning. *Journal of Vocational Education & Training*, 70(2), 212–231. https://doi.org/10.1080/13636820.2017.1394353

Huang, R. X., Pagano, A., & Marengo, A. (2024). Values-Based Education for Sustainable Development (VbESD): Introducing a Pedagogical Framework for Education for Sustainable Development (ESD) Using a Values-Based Education (VbE) Approach. *Sustainability*, 16(9), 3562. https://doi.org/10.3390/su16093562

Kovalchuk, V. I., Maslich, S. V., & Movchan, L. H. (2023). Digitalization of vocational education under crisis conditions. *Educational Technology Quarterly*, 2023(1), 1–17. https://doi.org/10.55056/etq.49

Leicht, A., Heiss, J., & Byun, W.J. (2018). *Issues and trends in education for sustainable development*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000261445

Maine, J. L. (2024). Exploring AI's Impact on Our Post-Pandemic Educational System: In L. A. Tomei & D. D. Carbonara (Eds.), *Advances in Educational Technologies and Instructional Design* (pp. 444–461). IGI Global. https://doi.org/10.4018/979-8-3693-2885-9.ch015

Marope, P. T. M., Chakroun, B., & Holmes, K. P. Martinovic, D., & Milner-Bolotin, M. (2024). Re-imagining professional learning communities in education: Placing teacher leadership in STEM context. *School Science and Mathematics*, ssm.18315. https://doi.org/10.1111/ssm.18315

Messmann, G., & Mulder, R. H. (2011). Innovative Work Behaviour in Vocational Colleges: Understanding How and Why Innovations Are Developed. *Vocations and Learning*, 4(1), 63-84. https://doi.org/10.1007/s12186-010-9049-y

Morselli, D. (2024). To assess or not to assess an entrepreneurship competence in vocational education and training? Results from a case study of Italy. *Education & Training*, 66(10), 29–41. https://doi.org/10.1108/ET-06-2023-0242

Oddone, K., Hughes, H., & Lupton, M. (2019). Teachers as Connected Professionals. *The International Review of Research in Open and Distributed Learning*, 20(3), 102-120. https://doi.org/10.19173/irrodl.v20i4.4082

OECD 2022. *Education at a Glance 2022: OECD Indicators*. OECD Publishing. https://doi.org/10.1787/3197152b-en

Ovcharuk, O. V., Ivaniuk, I. V., Burov, O. Yu., Marienko, M. V., Soroko, N. V., Gritsenchuk, O. O., & Kravchyna, O. Y. (2023). Digital resources for developing key competencies in Ukrainian education: Teachers' experience and challenges. In *CEUR Workshop Proceedings* (pp. 84-104).

Pangrazio, L. (2016). Reconceptualising critical digital literacy. *Discourse: Studies in the Cultural Politics of Education*, 37(2), 163–174. https://doi.org/10.1080/01596306.2014.942836

Pavlova, M. (2019). Facilitating the development of students' generic green skills in TVET: An ESD pedagogical model. *TVET@Asia*. http://tvet-online.asia/issue/12/pavlova-etal

Phan, T. T. H. (2024). Promoting Learner Autonomy in Competence-Based General Education Curriculum in Vietnam: High School Teachers' Beliefs. *International Journal of Learning, Teaching and Educational Research*, 23(1), 258–276. https://doi.org/10.26803/ijlter.23.1.13

Rissanen, I., Kuusisto, E., & McMullen, J. (2023). Identifying core beliefs of an intercultural educator: How polyculturalism and group malleability beliefs shape teachers' pedagogical thinking and practice. *Social Psychology of Education*, 26(5), 1201–1225. https://doi.org/10.1007/s11218-023-09785-z

Rivoltella, P. C., & Rossi, P. G. (2012). *L'agire didattico. Manuale per l'insegnante*. La Scuola.

Roberts, K., & Owen, S. (2012). *Innovative Education: A Review of the Literature*. Retrieved on 10 April, 2024, from https://bit.ly/3zlaZyY

Russon, J., & Wedekind, V. (2023). 6: Vocational Teachers as Mediators in Complex Ecosystems. In *Transitioning Vocational Education and Training in Africa*. Bristol University Press. https://doi.org/10.51952/9781529224658.ch006

Salamatov, A. A., Gnatyshina, E., Uvarina, N., Korneev, D.N., & Korneeva. N. (2017). Developing professionally significant qualities of competitive vocational training teachers: Dynamics of the process. *Revista Espacio*, 38 (40).

Sarva, E., & Puriņa-Biezā, K. E. (2023). Educators' Perspectives on the Main Challenges and Opportunities for Implementing Digital Solutions in Learning and Teaching. *International Journal of Emerging Technologies in Learning*, 18(24), 62–80. https://doi.org/10.3991/ijet.v18i24.44745

Sevilla, P., & Dutra, G. (2018). *Informe: La enseñanza y formación técnico profesional en América Latina y el Caribe. Una perspectiva regional hacia el 2030*. UNESCO. http://otrasvoceseneducacion.org/archivos/269776

Snoek, M., & Dengerink, J. (2019). Reframing the teacher profession as a dynamic multifaceted profession: A wider perspective on teacher quality and teacher competence frameworks. *European Journal of Education*, 54 (3), 413-425. https://doi.org/10.1111/ejed.12350

Sturing, L., Biemans, H.J.A., Mulder, M., & de Bruijn, E. (2011). The Nature of Study Programmes in Vocational Education: Evaluation of the Model for Comprehensive Competence-Based Vocational Education in the Netherlands. *Vocations and Learning*, 4 (3): 191–210. https://doi.org/10.1007/s12186-011-9059-4

Subrahmanyam, G. (2020). *Trend Mapping Report: Future of TVET Teaching. UNESCO-UNEVOC.* https://unevoc.unesco.org/pub/trendsmapping_futureoftvetteaching.pdf

Tapani, A., & Salonen, A.O. (2019). Identifying teachers' competencies in Finnish vocational education. *International Journal for Research in Vocational Education and Training*, 6 (3), 243–260. https://doi.org/10.13152/IJRVET.6.3.3

Thurlings, M. (2015). Toward a Model of Explaining Teachers' Innovative Behavior: A Literature Review. *Review of Educational Research*, 85(3), 430-471. https://doi.org/10.3102/0034654314557949

Tran, L. T., & Pasura, R. (2018). Professional Development for Teachers Working with International Students. *Vocations and Learning*, 11(2), 345-364. https://doi.org/10.1007/s12186-017-9195-6

Wagiran, W., Pardjono, P., Suyanto, W., Sofyan, H., Soenarto, S., & Yudantoko, A. (2019). Competencies of future vocational teachers: perspective of in-service teachers and educational experts. *Cakrawala Pendidikan*, 39 (3), 387-397. https://doi.org/10.21831/CP.V38I2.25393

Wohlfart, O., & Wagner, I. (2023). Teachers' role in digitalizing education: An umbrella review. *Educational Technology Research and Development*, 71(2), 339-365. https://doi.org/10.1007/s11423-022-10166-0

Zhang, X., Z. Kong, and K. Bai. 2017. Training Teachers for Better Innovation and Entrepreneurship Education. *Social Science, Education and Human Science*. https://doi.org/10.12783/dtssehs/mess2016/9610

Zyrianova, N.I., Dorozhkin, E.M., Zaitseva, Y.V., Korotayer, I. S., & Shcherbin, M.D. (2018). Trends in and principles of training vocational teachers. *International Journal of Engineering & Technology*, 7(2.13), 200-204. https://doi.org/10.14419/ijet.v7i2.13.11687

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY - Vol. 20, No. 3 (2024)

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

Appendix 1. The READY model

6+1 domains	22 professional practices	73 Descriptors Educators...
Learner-driven	Foster meaningful learning	1. collect and analyse information about learners' interests to engage them in relevant, real-life learning experiences
		2. design and implement authentic, learner-driven activities that accommodate learners' needs and dispositions
		3. apply questioning and discussion techniques to engage learners in participatory learning through active listening, dialogue, and expression of opinions, ideas and alternative points of view
		4. support learners to develop fundamental skills, such as creativity and critical thinking, needed for personal and professional growth
		5. support learners to develop occupational skills necessary for professional growth
	Facilitate peer- and team-learning	6. cultivate a learning environment that promotes teamwork and peer learning
		7. provide opportunities for learners' structured interaction and dialogue
		8. create a “safe environment” where all learners can participate in the learning process
	Apply a variety of assessment methods	9. design and apply a variety of formative and summative assessments to provide timely and informative feedback to learners, monitor progress and modify instruction
		10. use qualitative and quantitative data to capture more refined insights into learners' performance and identify each learner's strengths, weaknesses, interests, and aspirations and use that information to design and modify personalised learning paths
	Coach learners across learning environments	11. develop learning environments and scenarios that increase learner engagement and active learning
		12. design and coordinate different kinds of synchronous and asynchronous learning in various environments
		13. design and implement activities for career-connected learning exploring how technological, demographic, societal and environmental developments impact the jobs market and career paths
	Develop personalised learning experiences	14. organise teaching and learning time for maximum learning impact considering context and learners needs and interests
		15. plan for differentiated and personalised learning through self-paced activities, project-based assignments, and learner's choice on assignments or topics they want to study further
		16. create opportunities for learners to take responsibility and initiatives for active learning (formal and informal)
Adaptability & initiative	Foster learners’ entrepreneurship	17. provide learners with opportunities to reflect on their entrepreneurial skills and identify their strengths
		18. engage learners in experiential learning applying entrepreneurial skills such as initiative-taking, mobilising resources, planning and management

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

6+1 domains	**22 professional practices**	**73 Descriptors** **Educators...**
		19. design learning scenarios that expose learners to cope with ambiguity and uncertainty and assess possible risks in value creation activities
	Bridge the worlds of education and work	20. design activities that bring together learners and educators with business and community leaders and other stakeholders to expand opportunities for understanding the worlds of work and education and explore opportunities for synergy
		21. support learners to explore and understand business models and the role they play in the economy and society
	Demonstrate resilience and adaptability	22. manage change coping with ambiguity, uncertainty, and unforeseen circumstances, adapting to new settings, making informed choices, and setting new goals and priorities
		23. show initiative by contributing creative ideas to improve professional practice and experiment following a trial-and-error approach
		24. design learning activities that help learners nurture optimism and self-efficacy and adopt new ideas, approaches, tools, and actions in response to changing contexts
Sustainability & inclusion	Create inclusive learning environments	25. develop learning environments that value diversity and embrace all learners regardless of their socio-economic background, ethnic origin, culture, language, ability
		26. design instructional strategies that address issues of diversity and equity in the classroom/workplace
		27. engage learners in activities that require interaction with people of diverse socio-economic and cultural backgrounds
		28. apply work practices that are characterised by integrity, ethical thinking, and professional values
	Be attentive to personal well-being and that of others	29. acknowledge that colleagues and learners have different backgrounds, beliefs, values, opinions, or personal circumstances that affect their teaching and learning practices
		30. understand potential risks for their emotional and physical well-being using reliable information and support services to deal with this
		31. provide learners with emotional support to make them more confident in their skills and ability to participate in class
		32. support learners to adopt a sustainable lifestyle that promotes their well-being and encourage them to ask for social support and use reliable information and services when their well-being is at risk
		33. support colleagues to understand risks to their well-being and signpost them to appropriate guidance and support services
	Manage one's own and others' emotions	34. use ways and means to express and manage emotions and feelings to improve teaching and learning experiences
		35. express compassion and empathy and can appreciate and recognise learners and colleagues' emotions, feelings, and viewpoints
		36. create an atmosphere that enables learners to express their emotions and feelings without fear of failure or judgment

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

6+1 domains	**22 professional practices**	**73 Descriptors** **Educators...**
	Adopt and promote environmental, social and economic sustainability	37. act as role models in advocating for and adopting environmentally sustainable behaviours and practices
		38. provide learners with opportunities to engage in learning activities that promote sustainable thinking and action and reflect on societal, environmental, and economic challenges
		39. foster systemic thinking skills helping learners to understand that everything is inter-related and interconnected (e.g., climate crisis and economic inequality)
Collaboration & engagement	Collaborate with peers and other stakeholders	40. help foster a culture of collaboration among peers through meetings and workshops, co-planning sessions and shared workspaces, online and/or on-site
		41. actively engage with parents, community members, businesses, youth organisations, experts, and other stakeholders to extend opportunities for learning within and beyond the classroom and/or workplace
		42. liaise with external actors and organisations to ensure teaching and assessment are of relevance and reflect current practices in the workplace
		43. use a variety of communication strategies and tools tailored for the specific context, content, and target audience
	Contribute to professional networks and communities	44. actively participate in professional learning networks face-to-face and/or online for anytime/anywhere learning
		45. ask colleagues and peers for feedback on teaching practices
		46. act as a "critical friend" providing feedback to colleagues and peers when asked
		47. share knowledge, teaching practices, resources, and ideas to improve teaching and learning experiences within and/or outside the organisation, using digital technologies and/or through face-to-face interaction
		48. involve in research of own practices and share findings with colleagues and other interested parties
	Contribute to organisational development and improvement processes	49. actively engage in institutional initiatives, including development and implementation of improvement plans
		50. provide feedback on curriculum implementation and identify opportunities for improvement
		51. participate in internal quality assurance processes and linking own practices to the overall organisational goals of providing quality learning experiences to learners
		52. participate in external quality assurance processes
Lifelong learning & reflection	Proactively engaging in professional development opportunities	53. regularly engage in professional learning, individually and as a group, both inside and outside their organisation
		54. make choices, define priorities, and set goals for their professional development, individually and as part of a group
		55. get the most of professional development opportunities by reflecting, providing feedback, and sharing promising practices
	Reflect on professional practices	56. reflect on their professional practice to improve self-knowledge and career development
		57. reflect on the way actions impact learning processes

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

6+1 domains	**22 professional practices**	**73 Descriptors** **Educators...**
		58. seeking feedback from peers and learners to evaluate their own performance and plan for improvements
	Apply evidence-based pedagogies	59. actively engage in action research, individually or as a member of a research team
		60. are informed on the latest research developments in their field through related events and literature
		61. are ready to review and change professional practices given new evidence from research
Digital technologies	Use digital technologies to enhance teaching	62. use digital tools and technologies where appropriate to support and enhance teaching and assessment
		63. use data generated by digital tools and platforms to gain insights into learners' progress and identify ways to improve teaching and learning practices further
		64. provide learners with opportunities to use simulations and Virtual Reality applications for "real-life" work situations
		65. inspire and guide learners to contribute to and take part, both critically and creatively, in the online and digital world
	Create digital resources and content	66. use, revise, remix or create digital resources, including Open Educational Resources (OER)
		67. enable learners to use digital tools for learning purposes
		68. engage learners in creating digital content
	Be aware of copyright and online privacy	69. act as role models of safe, legal, and ethical use of digital technologies and resources respecting intellectual property and copyright and promoting legal sharing of openly licensed resources
		70. enable learners to understand how to protect their privacy in the digital world
	Understanding the potential role and impact of digital technologies	71. explore new pedagogical approaches to deepen understanding of how digital tools and technologies can potentially facilitate and enhance learning
		72. follow developments and trends and are aware of new and emerging technologies that can support teaching, learning and assessment and discuss these issues with learners
		73. design activities for learners to reflect on the transformative role of digital technologies and the implications, opportunities and risks for society, the economy, and the environment
[context specific]	[to be defined locally]	[to be defined locally]

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators. *Journal of e-Learning and Knowledge Society*, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

Appendix 2 – Overview of existing models analysed

	Title - link	Type	Target group	1st level	2nd level	3rd level	Progression
1	EntreComp	Competence framework	Citizens	3 **competence areas**	15 **competences -** For each there is a **hint** and 2-3 **descriptors**	It also includes a list of 442 **learning outcomes**	8-level **progression model**
2	LifeComp	Competence framework	Citizens	3 intertwined **competence areas**	9 **competences** (3 per area)	Each competence has, in turn, three **descriptors**	-
3	DigComp 2.1	Competence framework	Citizens	5 **competence areas**	21 **competences**	There are also examples of use, on the applicability of each competence to different purposes and knowledge, skills and attitudes applicable to each competence	8 **proficiency levels**
4	GreenComp	Competence framework	Citizens	4 interrelated **competence areas**	12 **competences** (3 per area)	For each competence there is a number of **descriptors** and **examples of knowledge, skills and attitudes**	-
5	DigCompEdu	Competence framework	Educators	6 **competence areas**	22 **elementary competences** are organised in the 6 areas	There are descriptors and examples for each of the 22 competences.	6 **proficiency levels**
6	Analytical Hierarchy Process-based Evaluation Method for Vocational Teachers Competency Standard	Competency Standard	VET teachers	4 **criteria competencies**	21 **sub-criteria competency**	-	-
7	Competencies for Education for Sustainable Development Teachers	Competence framework	ESD teachers	3 overall **competencies**	5 **domains of competencies**	3 different **levels**	-
8	Core competencies of technical trainers	Competence framework	Technical trainers	9 **core competencies**	27 **competency fields/facets**	-	-
9	Graduand Teacher Competencies Framework	Framework	Teachers	3 **performance dimensions**	7 **core competencies**	-	2 **focus levels**

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

	Title - link	Type	Target group	1st level	2nd level	3rd level	Progression
10	**New Values, Skills and Knowledge (V^3SK) Model**	Model	Teachers	3 **values**	10 **skills**	10 **knowledge**	-
11	**GRETA – a competence model for teachers in continuing training**	Model	Educators (Adult learning)	4 **competence aspects**	12 competence **areas**	12 Competence **facets**	-
12	**Hattie 2009**	Model	Educators	7 of the most **effective teaching strategies**[i]		-	-
13	**ISTE Educator Standards**	Standards	Educators	Empowered professional; learning catalyst	Learner; Leader; Citizen; Collaborator; Designer; Facilitator; Analyst	For each "characteristic" there is a number of statements	-
14	**Kolb Educator Role Profile**	Profile	Educators	9 **learning styles**		-	Four **roles** are defined
15	**Green Skills in Vocational Teacher Education – a model of pedagogical competence for a world of sustainable development**	Green skills in vocational teacher education	VTE Vocational Teacher Education	**6 competence domains**	Plus **Educational basic knowledge**	Plus **Additional knowledge / skills**	-
16	**Pedagogical, Ethical, Attitudinal and Technical dimensions of Digital Competence in Teacher Education - The PEAT Model**	Model	Teachers	4 **key dimensions**	-	-	-

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

	Title - link	Type	Target group	1st level	2nd level	3rd level	Progression
17	**PISA 2018 global competence**	Competence framework	Students	4 **target dimensions**	The global competence is articulated in **knowledge**, **cognitive skills**, **social skills and attitudes** and **values** and it is assessed in PISA 2018 (excluding values)	-	-
18	**Professional Digital Competence Framework for Teachers (Norway)**	Competence framework	Teachers	7 **competence areas**	For each area there is a definition and statement for **knowledge**, **skills,** and **competence**	-	-
19	**Profile of a Berkeley County Educator**	Profile	Teachers	6 **areas of world class knowledge**	8 **professional characteristics**	8 **world class skills**	-
20	**QESS Project on Teacher Competency Framework**	Competence framework	Teachers	3 **domains**	16 **competencies**	**Descriptions** of teacher competencies generally will include the following 3 **strands**	3 **phases of competency standards**
21	**San Angelo Independent School District Educator Profile**	Profile	Teachers	15 **attributes**	-	-	-
22	**Teacher continuing professional development and teamworking competences**	Model of Competences	Pre-school teachers	6 **competences**	-	-	-
23	**Teachers' Professional Competencies**	Professional competences	Teachers	9 teachers' professional **competencies**	-	-	-
24	**Texas Educator Excellence Model (TEEM)**	Model	Teachers	8 **strategies**	-	-	-

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

	Title - link	Type	Target group	1st level	2nd level	3rd level	Progression
25	TPACK	Framework	Teachers	3 **primary forms of knowledge**	4 **kinds of knowledge** that lie at the intersections between three primary forms	-	-
26	The teacher digital competence (TDC) framework	Framework	Teachers	2 new sets of **integrated competencies**	7 **competencies**	6 **pillars**	-
27	Innovation and Business Skills Australia (IBSA) VET Practitioner Capability Framework	Framework (capability)	VET educators	4 **domains**	Each domain has 4 **areas of capability**	6 **skill areas**	**3 levels**
28	Charles Darwin University VET Educator Capability Framework	Framework (capability)	VET educators	6 **domains**	22 specific **capabilities**	120 capabilities **indicators**	**4 levels**
29	Adult Education Teacher Competencies	Competence framework	Adult education	4 **domains**	17 **individual, observable competencies**	Each competency has a **set of indicators.** Each performance indicator is accompanied by a **sample illustration**	-
30	Core Competency for TVET Educator	Framework	TVET educators	The **main components** of the TVET Educator competencies are 1) Personal Traits and Professionalism; 2) Teaching, Learning and Training; and 3) Skill, Technical and Innovation	12 **core competencies**	-	-

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

	Title - link	Type	Target group	1st level	2nd level	3rd level	Progression
31	**High Impact Teaching Strategies**	Teaching strategies	Teachers	10 (evidence-based) **high impact teaching strategies**	-	-	-
32	**InTASC model core teaching standards and learning progressions for teachers**	Standards	Teachers	10 **core teaching standards**	Performances, Essential Knowledge, Critical Dispositions[ii]	-	-
33	**Building Capability and Quality in VET Teaching**	Analysis of existing frameworks	VET	7 **items of capability in VET teaching**[iii]	-	-	-
34	**Baltimore City Instructional Framework Rubric**	Framework (for teaching)	Schools	3 **domains**	11 **indicators** (or "key actions")	-	4 **performance levels**
35	**Danielson's Framework for Teaching (adapted for Kentucky Department of Education) 2014**	Framework (for teaching)	Teachers	4 **domains of teaching responsibility**	23 **components**	-	4 **performance levels**
36	**Danielson's Framework for Teaching**	Framework (for teaching)	Schools	4 **domains of teaching responsibility**	22 **components**	76 **elements** and 5 **common themes**	4 **levels**
37	**Griffith University Learning and Teaching Capabilities Framework**	Framework (for teaching)	HEIs	10 educator **capabilities**	For each capability there is a number of **descriptors and statements**	-	The same capabilities are articulated for Educators, Course Convernors and Program directors
38	**Working context of VET teachers**	Competence framework	VET educators	8 **activity areas** of VET professionals	-	-	-

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

	Title - link	Type	Target group	1st level	2nd level	3rd level	Progression
39	**Elements of Globally Competent Teacher Continuum**	Competence framework	Schools	12 **global competence elements**	For each level they provide a **description** along with **readings**; **classroom demo video**; and **lesson plans**	-	5 **levels**
40	**High Impact Professional Learning**	Model	Teachers	5 high impact professional learning **elements**	-	-	-
41	**Australian Professional Standards for Teachers**	Standards	Teachers	3 **domains** of teaching	7 **standards**	Within each Standard **focus areas** provide further illustration of teaching knowledge, practice, and professional engagement. These are then separated into **descriptors** at four professional career stages	4 professional **career stages**
42	**The Adult Educator's Competences and Competence Development.**	Framework (capability)	Educators (Adult learning)	The study is based on the following 11 **competences**	-	-	-
43	**SITE Teacher Educator Technology Competencies**	Framework (capability)	Teacher educators	12 **competencies**	For each competence 41 **related criteria** were identified	-	-
44	**Professional Standards for Teachers and Trainers in Education and Training in England**	Professional standards	Teachers	3 **sections** each of equal importance: each links to and supports the other sections	20 **standards**	-	The developing teacher/trainer; The professional teacher/trainer; The advanced teacehr/trainer
45	**USA Career and Technical Education (VET) Standards for Teachers (ages 11–18)**	Professional standards	Teachers	10 **standards**	-	-	The standards are articulated for accomplished teachers

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

	Title - link	Type	Target group	1st level	2nd level	3rd level	Progression
46	**Educator Competencies for Personalised, Learner-Centered Teaching**	Competence framework	Educators	4 **domains**	23 **competencies**[iv]	4 **cross-cutting themes**	-
47	**High Impact Educational Experiences (HIEE) Taxonomy**	Taxonomy	Educators	8 **educational experiences**	-	-	3 **levels of impact**
48	**Teaching Excellence at Navitas Capability Framework**	Framework (capability)	Educators	7 **domains**	For each domain there are some **modules**	-	-
49	**Dimensions of effective teaching**	Analysis of existing frameworks	Teachers	4 **dimensions** of effective teaching[v]	17 factors	-	-
50	**Glenbard Profile of an Educator Competencies**	Profile	Educators	6 **competencies**	29 **descriptors**	-	-

[i] According to Hattie, J. (2009). Visible Learning A synthesis of over 800 meta-analyses relating to achievement. Routledge.
[ii] These 10 standards maintain the delineation of knowledge, dispositions, and performances as a way to probe the complexity of the teacher's practice. The relationships among the three have been reframed, however, putting **performance** first—as the aspect that can be observed and assessed in teaching practice. The others were renamed. "**Essential knowledge**" signals the role of declarative and procedural knowledge as necessary for effective practice and "**critical dispositions**" indicates that habits of professional action and moral commitments that underlie the performances play a key role in how teachers do, in fact, act in practice.
[iii] Identified by stakeholder groups (see Table 2 on p. 24).
[iv] For each of the 23 competencies there is a number of **descriptors** and how they relate with the cross-cutting themes as well as hyperlinks of key terms that are defined and presented as a **glossary.** Finally, there are "**In the field**" examples on how specific competencies are applied.
[v] Synthesis based on review of models, theories, standards etc (see p. 129).

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

Appendix 3. Mapping of existing models against READY's professional practices

Domain	Professional Practice	Evidence from existing frameworks, models, profiles and standards
Learner-Driven	**1. Foster meaningful learning**	Spotting opportunities; Learning through experience **[1]**, Actively engaging learners **[5]**, Creation of practical learning opportunities **[8]**, *Design authentic learning activities that align with content area standards and use digital tools and resources to maximise active, deep learning; Explore and apply instructional design principles to create innovative digital learning environments that engage and support learning; Use collaborative tools to expand students' authentic, real-world learning experiences by engaging virtually with experts, teams and students, locally and* globally **[13],** Engage students in purposeful and meaningful learning **[20]**, Provide opportunities for students to do work for REAL AUDIENCES and REAL purposes **[21]**, This includes knowing students' current performance levels, cultural and linguistic backgrounds, interests, learning preferences, and other information that can help teachers prepare to teach in ways that support student success and connect to students' lives **[34], Integrate learning experiences for students that promote content-aligned explorations of the world [39]** Anytime/Anywhere and real-world learning, Project based learning **[46]**, **Meaningful interactions, Practical application [47]**, Embedding future workforce skills **[48]**
	2. Facilitate peer- and team-learning	Actively engaging learners **[5]**, instruction for group learning **[8]**, Moderation/management of groups **[11]**, *Foster a culture where students take ownership of their learning goals and outcomes in both independent and group settings* **[13],** *Facilitating peer to peer interaction to promote collaborative learning* **[37],** Collaborative group work **[46]**
	3. Apply a variety of assessment methods	Assessment strategies **[5]**, Assessment technique; ICT for evaluation and assessment **[6]**, *Use technology to design and implement a variety of formative and summative assessments that accommodate learner needs, provide timely feedback to students and inform instruction; Use assessment data to guide progress and communicate with students, parents and education stakeholders to build student self-direction* **[13]**, **Assessment [19],** Assess, record, report student learning outcomes - interpret assessment results to enhance facilitation of student learning **[20], Assessment [27]**, **Learning, Teaching and Assessment [28]**, Assesses learners' prior knowledge, learning needs, and college and career readiness goals; Monitors learning through summative and formative assessment data; Adapts instruction based on formative and summative student assessment data **[29]**, **assessment [32]**, Ability to design assessment tools and materials, conduct assessments (and engage students in assessment) **[33],** During a lesson, teachers monitor progress of student learning through formative assessments and address student misunderstandings **[34],** Designing Student Assessments; Using Assessment in Instruction **[35]**, Designing Student Assessments; Using Assessment in Instruction **[36]**, **Managing assessment for learning [37]**, Assess, provide feedback and report on student learning **[41]**, **will use appropriate technology tools for assessment [43]**, Apply appropriate and fair methods of assessment, and provide constructive and timely feedback to support progression and achievement **[44]**, **Assessment [45]**, Assessment and data tools **[46]**, **Quality feedback [47]**, **Enhancing Assessment and Feedback [48]**, Moderating and validating assessments; Engaging students in the assessment process; Assessing learners; Designing rubrics; Providing effective feedback **[48]**, Evaluation, assessment, and feedback **[49]**

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

Domain	Professional Practice	Evidence from existing frameworks, models, profiles and standards
	4. Coach learners across learning environments	Guidance **[5]**, Guiding and mentoring of student activity; Facilitating of student's development continually **[6]**, Building apprenticeship and mentorship **[10]**, Facilitate learning; Learning guidance **[11]**, Are clear about what they want their students to learn **[12]**, *Manage the use of technology and student learning strategies in digital platforms, virtual environments, hands-on makerspaces or in the field* **[13]**, *coach* **[14]**, **Effectively communicates to motivate and engage learners [29]**, Sets learning goals and a course of study; Designs learner-centered instruction and classroom environments; Communicates high expectations of learners and motivates them to persist to meet their goals **[29]**, Promote student agency **[46]**, Designing active learning; facilitating self-regulated learning in students **[48]**, Cultivates a sense of voice, ownership, and agency for each student **[50]**
	5. Develop personalised learning experiences	Self-regulated learning; Differentiation and personalisation **[5]**, Understanding the needs of the participants; Tailoring the training to these needs **[8]**, *Use technology to create, adapt and personalise learning experiences that foster independent learning and accommodate learner differences and needs* **[13]**, Honor STUDENT VOICE & agency; SUPPORT A DYNAMIC LEARNING ENVIRONMENT THAT IS SAFE, RESPONSIVE AND ADAPTABLE; Prioritise based on the LEARNING NEEDS of STUDENTS **[21]**, **Differentiated teaching [31]**, **Understanding individual student needs [33]**, *Meeting the Needs of All Learners* **[36]**, *Differentiate teaching to meet the specific learning needs of students across the full range of abilities* ***[41]***, **will use technology to differentiate instruction to meet diverse learning needs [43]**, Vision for teaching and learning, Customise learning experiences **[46]**, Understanding the student lifestyle **[48]**, Guides students to identify barriers, develop plans, and take action; Helps students to access resources and strategies; values the experiences and differences of each individual **[50]**
Adaptability & Initiative	**6. Foster learners' entrepreneurship**	Taking the initiative **[1]**, Entrepreneurship **[6]**, Innovation and Entrepreneurship skills **[10]**, **Entrepreneurship and Innovation [28]**, Entrepreneurial and Soft Skills **[30]**
	7. Bridge the worlds of education and work	Mobilising resources **[1]**, Managing transitions in personal life, social participation, work and learning pathways, while making conscious choices and setting goals **[2]**, Industry Collaboration on curriculum; Vocational knowledge and skills **[6]**, **Competence of linking real work processes with professional learning processes [15]**, **Industry & Community Collaboration [27]**, **Provide opportunities for students to do work for real audiences and real purposes [21] Industry and Community Engagement [28]**, Linking training to practice **[38]**, Maintain and update teaching and training expertise and technical skills through collaboration with employers **[44]**
	8. Demonstrate resilience and adaptability	Coping with uncertainty, ambiguity and risk; Self-awareness and self-efficacy **[1]**, **Flexibility [2]**, adaptability **[4]**, Nurturing optimism, hope, resilience, self-efficacy, and a sense of purpose to support learning and action **[2]**, Dealing with disruption and frustration **[8]**, Adaptive and resilient **[10]**, **Perseverance [19]**, Demonstrate RESILIENCY **[21]**, Demonstrating Flexibility and Responsiveness **[35]**, Demonstrating Flexibility and Responsiveness **[36]**, Demonstrates flexibility in various roles and situations; Is positive and receptive when introduced to a new situation **[50]**

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

Domain	Professional Practice	Evidence from existing frameworks, models, profiles and standards
Sustainability & Inclusion	**9. Create inclusive learning environments**	Accessibility and inclusion **[5]**, Creating a positive learning atmosphere **[8]**, Valuing of diversity; Multicultural literacy **[10]**, Diversity management; **[11]**, *Demonstrate cultural competency when communicating with students, parents and colleagues and interact with them as co-collaborators in student learning; Advocate for equitable access to educational technology, digital content and learning opportunities to meet the diverse needs of all students* **[13]**, **Diversity [19]**, Understand and CELEBRATE differences **[21]**, Models an understanding of diversity **[29]**, **Knowledge of cultural diversity and social inclusion [33]**, Creating an Environment of Respect and Rapport **[35]**, **A Safe, Respectful, Supportive, and Challenging Learning Environment [36]**, **Cultivate a supportive learning community [34],** Creating an Environment of Respect and Rapport **[36]**, *Equity* **[36]**, *Developing processes for inclusive and respectful communication that supports the development of a positive learning community* **[37]**. **Empathy and valuing multiple perspectives; Experiential understanding of multiple cultures; Understanding of intercultural communication; Create a classroom environment that values diversity and global engagement [39]**, Create and maintain supportive and safe learning environments **[41]**, **Being able to work in intercultural contexts [42]**, Value and promote social and cultural diversity, equality of opportunity and inclusion; Build positive and collaborative relationships with colleagues and learners; Plan and deliver effective learning programmes for diverse groups or individuals in a safe and inclusive environment **[44]**, **Responding to diversity [45]**, Dedication to all learners, Culturally responsive teaching **[46]**, *equity and inclusion* **[46]**, **Diverse & Inclusive Experiences [47]** Designing for diversity and inclusion **[48]**, Cultural competency **[49]**, **Embraces Diversity [50]**, Values mutual respect, inclusion, and openness to differing perspectives; Models and nurtures equality, access, and respect for differences; Seeks and applies differing viewpoints **[50]**
	Be attentive to personal well-being and that of others	**Well-being** (personal area) **[2]**, *Awareness that individual behaviour, personal characteristics and social and environmental factors influence health and well-being; Understanding potential risks for well-being, and using reliable information and services for health and social protection; Adoption of a sustainable lifestyle that respects the environment, and the physical and mental well-being of self and others, while seeking and offering social support* **[2]**, Protecting health and well-being **[3], The capacity and disposition to take constructive action toward sustainable development and collective well-being [17]**, **Teachers' well-being [20]**, Physical well-being; Emotional well-being; Social well-being; Spiritual well-being; Professional well-being **[20]**, *Managing personal presence, safety and well-being* **[26]**, Practice self-care **[46]**, Building student resilience through well-being strategies **[48]**, Engages in dialogue to promote a healthy learning environment and positive school culture **[50]**
	Manage one's own and others' emotions	Empathy **[2]**, *Awareness and expression of personal emotions, thoughts, values, and behaviour; Understanding and regulating personal emotions, thoughts, and behaviour, including stress responses; Awareness of another person's emotions, experiences and values; Understanding another person's emotions and experiences, and the ability to proactively take their perspective; Responsiveness to another person's emotions and experiences, being conscious that group belonging influences one's attitude* **[2]**, Emotions **[7]**, Empathy **[8]**, Empathy; Social and emotional intelligence **[10]**, **Emotional Competencies [23]**, *social and emotional learning* **[46]**, Seeks to understand others' feelings, opinions, experiences, and culture **[50], Exhibit compassion [22]**
	Adopt and promote environmental, social and economic sustainability	Ethical and sustainable thinking **[1]**, Protecting the environment **[3], Embodying sustainability values; embracing complexity in sustainability; envisioning sustainable futures; acting for sustainability [4]**, valuing sustainability **[4]**, *Environmental awareness* **[10]**, **Ethical [16], The capacity and disposition to take constructive action toward sustainable development and collective well-being [17], Global thinking [19], Environmental Competencies [23]**

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators. *Journal of e-Learning and Knowledge Society*, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

Domain	**Professional Practice**	**Evidence from existing frameworks, models, profiles and standards**
Collaboration & Engagement	**Collaborate with peers and other stakeholders**	Working with others; Mobilising others **[1]**, **Communication; Collaboration** (Social Area) **[2]**, *Fair sharing of tasks, resources and responsibility within a group taking into account its specific aim* **[2]**, **Communication and collaboration [3]**, Collaborating through digital technologies; Interacting through digital technologies; Sharing through digital technologies **[3]**, Professional collaboration; Digital communication and collaboration; Collaborative learning; **[5]**, ICT for communication **[6]**, Working with others **[9]**, Collaborative learning and practice **[10]**, building apprenticeship and mentorship; social responsibility and engagement; Communication skills **[10]**, *Dedicate planning time to collaborate with colleagues to create authentic learning experiences that leverage technology; Create experiences for learners to make positive, socially responsible contributions and exhibit empathetic behaviour online that build relationships and community* **[13]**, **The ability to establish positive interactions with people of different national, ethnic, religious, social or cultural backgrounds or gender [17]**, **Interaction and communication [18]**, Interpersonal skills **[19]**, *Collaborating; communicating* **[19]**, Image building for the institute amongst stakeholders **[20]**, Uphold a COLLABORATIVE CULTURE among students, educators and the community; Build RELATIONSHIPS **[21]**, Team working process (at School/Group level) **[22]**, **Communication Competencies [23]**, **Family, Community, and Educator Involvement [24],** *Teamwork and Communication* **[27]**, **Develop local, national, or international partnerships [39]**, Engage professionally with colleagues, parents/carers and the community **[41]**, **Partnerships and collaborations [45]**, Build strong relationships**[46]**, **Collaborates [50]**, Collaborates with stakeholders to promote educational policies and strategies for the benefit of all students; Contributes to an open exchange of ideas by listening actively and welcoming a range of perspectives; Is flexible and has the ability to work with a variety of people; Seeks out and responds to feedback in order to build consensus and achieve a collective outcome **[50]**
	Contribute to professional networks and communities	Networking and Collaboration **[6]**, **Networking [7]**, **Peer collaboration/ networking [8]**, **Service to the profession and community**; social responsibility and engagement **[10]**, Team work and networking **[11]**, *Shape, advance and accelerate a shared vision for empowered learning with technology by engaging with education stakeholders; Pursue professional interests by creating and actively participating in local and global learning networks* **[13]**, Large-scale teamworking process (at Institutional level); Networking (School networks) **[22]**, *Strategic, productive engagement in professional networks* **[26]**, **Industry & Community Collaboration [27]**, Networks **[27]**, Participates in professional development networks and learning communities **[29]**, Participating in a Professional Community **[35]**, Participating in a Professional Community **[36]**, **Contributing to teams, communities and networks for learning [37]**, **will engage in ongoing professional development and networking activities to improve the integration of technology in teaching [43]**
	Contribute to organisational development and improvement processes	*Intention to contribute to the common good and awareness that others may have different cultural affiliations, backgrounds, beliefs, values, opinions or personal circumstances* **[2]**, Organisational communication **[5]**, Administrative and management skills **[10]**, **Institutional development [20]**, Leadership **[27]**, **Demonstrates educational leadership in a variety of contexts [28],** Participates in and contributes to program improvement efforts **[29]**, **Leadership and management [30], leader ship and collaboration [32], involvement in higher-level corporate responsibilities [33]**, **Organisational change 38]**, Contribute to organisational development and quality improvement through collaboration with others **[44], Leadership in the profession [45]** Teachers as leaders **[49]** Envisions viable solutions to challenges in the school and community **[50]**

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

Domain	Professional Practice	Evidence from existing frameworks, models, profiles and standards
Lifelong learning & Reflection	**Proactively engaging in professional development opportunities**	**Growth mindset; Managing learning** (Learning to Learn Area) **[2]**, *Awareness of and confidence in one's own and others' abilities to learn, improve and achieve with work and dedication; Understanding that learning is a lifelong process that requires openness, curiosity and determination; Awareness of one's own learning interests, processes and preferred strategies, including learning needs and required support; Planning and implementing learning goals, strategies, resources and processes* **[2]**, Digital Continuous Professional Development **[5]**, Continuous self-development; ICT for continuous development **[6]**, **Personal development [8]**, Further training **[8]**, Strives to improve **[10]**, Professional development **[11]**, Actively seek to improve their own teaching **[12]**, *Set professional learning goals to explore and apply pedagogical approaches made possible by technology and reflect on their effectiveness* **[13]**, *Lifelong learning* **[19]**, Professional development for staff **[20]**, DESIRE to learn more **[21]**, **Lifelong Learning Competencies [23]**, **High-quality, Job-embedded Professional Development [24]**, *Committed to continuous professional learning* **[26]**, **CPD and lifelong learning [28]**, **Pursues professionalism and continually builds knowledge and skills [29]**, professional learning and ethical practice **[32]**, Growing and Developing Professionally **[35]**, Growing and Developing Professionally **[36]**, **Professional learning is driven by identified student needs; Collaborative and applied professional learning strengthens teaching practice; Professional learning is continuous and coherent; Teachers and school leaders are responsible for the impact of professional learning on student progress and achievement [40]**, Engage in professional learning **[41]**, Lifelong learning and Growth **[46]**, **Continuous learning [49]**, Career progression **[49]**, Is open to change in order to learn, unlearn, and relearn to meet the needs of students; Seeks opportunities for professional growth; Listens and responds to feedback in order to improve **[50]**
	Reflect on professional practices	Self-awareness and self-efficacy **[1]**, *Reflecting on other people's feedback as well as on successful and unsuccessful experiences to continue developing one's potential; Reflecting on and assessing purposes, processes and outcomes of learning and knowledge construction, establishing relationships across domains* **[2]**, Reflective practice **[5]**, Reflective actions **[6]**, **Reflecting & visioning [7]**, Reflection of own actions **[8]**, Knowing self and others **[9]**, Reflective skills and thinking dispositions **[10]**, Reflection of teaching activity; dealing with feedback and criticism **[11]**, Monitor their impact on students' learning and adjust their approaches accordingly **[12]**, **Reflecting [14]**, Competence of self-reflection and improving the qualifications **[15]**, Reflective **[19]**, **Quality assurance and continuous improvement [28]**, Refines instructional practices through reflection on experience, evidence, and data **[29]**, **Reflect and Adjust [34]**, Reflect on teaching practice; **[34]**, Reflecting on Teaching **[35]**, Reflecting on Teaching **[36]**, **Practising reflection, evaluation and scholarly inquiry [37]**, *Evaluate and improve teaching programs* **[41]**, Reflect on what works best in your teaching and learning to meet the diverse needs of learners; Evaluate and challenge your practice, values and beliefs **[44]**, **Reflective practice [45]**, **Reflecting on Teaching Practice [48]**, Reflecting on Technology-enhanced learning practices; Reflecting on teaching practice **[48]**
	Apply evidence-based pedagogies	*Readiness to review opinions and courses of action in the face of new evidence* **[2]**, Analysing evidence; feedback and planning **[5]**, Adopt evidence-based teaching strategies **[12]**, Analyst **[13]**, *Stay current with research that supports improved student learning outcomes, including findings from the learning sciences* **[13]**, **Research Competencies [23]**, **Data Driven Instruction Instructional Support [24]**, Informed decision-making about digital technology selection and use in teaching **[26]**, *Evidence Based Practice and Research* **[27]**, **Monitors and manages student learning and performance through data [29]**, **Plans and delivers high-quality, evidence-based instruction [29]**, evidence-based strategies, Reflect on data to adjust instructional plans **[34]**, Maintain and update your knowledge of educational research to develop evidence-based practice; Apply theoretical understanding of effective practice in teaching, learning and assessment drawing on research and other evidence **[44]**, Stay current on practices (evidence-based) **[46]**, Leveraging Learner analytics to improve student learning; Gathering evidence to showcase teaching practices **[48]**

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY - Vol. 20, No. 3 (2024)

Kampylis, P., Nascimbeni, F., van Uden, J., & Bekh, O. (2024). READY for the future? New roles and professional practices for 21st century educators.
Journal of e-Learning and Knowledge Society, *20*(3), pp. 126-137.
https://doi.org/10.20368/1971-8829/1135980

Domain	Professional Practice	Evidence from existing frameworks, models, profiles and standards
Digital technologies	**Use digital technologies to enhance teaching**	Teaching **[5]**, ICT for learning instruction **[6]**, Technological skills **[10]**, *Provide alternative ways for students to demonstrate competency and reflect on their learning using technology* **[13]**, model for colleagues the identification, exploration, evaluation, curation and adoption of new digital resources and tools for learning **[13]**, **Information and Communication Technologies (ICT) Competencies [23]**, Technological Pedagogical Knowledge; Technological Pedagogical Content Knowledge **[25]**, Effective and beneficial teaching about, with and through technology **[26]**, Designs instruction to build learners' technology and digital media literacy skills **[29]**, **knowledge and application of basic and/or advanced digital skills and technologies [33]**, **Optimising digital technologies for learning [37]**, Using Digital Technologies Ethically and Responsibly*: Incorporating processes and procedures to ensure safe, ethical and responsible use of digital technologies in your teaching sessions* **[37]**, **Being able to use information and communication technology [42]**, **Teacher educators will design instruction that utilises content-specific technologies to enhance teaching and learning; will use online tools to enhance teaching and learning; will use effective strategies for teaching online and/or blended/hybrid learning environments [43]**, Promote the benefits of technology and support learners in its use **[44]**, Technology in service of learning **[46]**, *remote learning* **[46]**, **Optimising Digital Technologies [48]**, Designing blended learning; Learning and teaching online; Promoting digital literacies in Students; Optimising technology-enhanced learning **[48]**, Implements various mediums of technology **[50]**
	Create digital resources and content	**Digital content creation [3]**, Developing digital content; Integrating and re-elaborating digital content; Creatively using digital technologies **[3]**, **Digital resources [5]**, Selecting digital resources; Creating and modifying digital resources; Managing, protecting and sharing digital resources; Digital content creation **[5]**
	Be aware of copyright and online privacy	**Safety [3]**, Copyright and licences; Protecting personal data and privacy **[3]**, Responsible use **[5]**, *Mentor students in safe, legal and ethical practices with digital tools and the protection of intellectual rights and property; Model and promote management of personal data and digital identity and protect student data privacy* **[13]**, *Use ICT safely, responsibly and ethically* **[41], will address the legal, ethical, and socially-responsible use of technology in education [43],** Fostering safe, responsible and ethical digital practices **[48]**
	Understanding the potential role and impact of digital technologies	*Establish a learning culture that promotes curiosity and critical examination of online resources and fosters digital literacy and media fluency* **[13]**, *Considering the impact of digital technologies on people, society and the environment* **[26]**

Note. The number in the column 'Evidence from existing frameworks, models, standards and profiles' refer to the framework/standard/profile reviewed. The list is available in Appendix 2. The analysed frameworks, models, standards, and profiles are often structured in several levels. Text in bold means that the topic is mentioned as first level item, normal font is used for the second level and italics for the third level. Spelling follows the original text.

JOURNAL OF e-LEARNING AND KNOWLEDGE SOCIETY

www.je-lks.org

VOLUME 20 | ISSUE NO. 3 | DECEMBER 2024

AN INTERNATIONAL AND OPEN ACCESS JOURNAL BY THE ITALIAN E-LEARNING ASSOCIATION (SIE-L)

www.sie-l.it

ISSN (online) 1971 - 8829 | ISSN (paper) 1826 - 6223