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Digital Competency Among Teachers in the 21st Century Classroom

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Abstract:

Contemporary education demands that teachers acquire digital competencies essential for 21st-century classrooms. These competencies include the knowledge and skills necessary to integrate technology with pedagogy, ethics, and policy to enhance learning outcomes for diverse learner populations. Research highlights the varied learning preferences of these populations, impacting motivation and engagement. Future career trends suggest a growing need for data analysis, creativity, and digital tech skills. Teachers are vital in fostering digital competence in students, making it crucial for them to have a strong understanding and abilities in this area. Choosing educational technology to improve learning and engagement requires a thorough grasp of teacher digital competence. Various theoretical frameworks examine this concept, showing that teacher digital competence involves understanding digital technology's application in pedagogy and ethical standards to improve learning experiences, monitor progress, maintain engagement, and boost motivation. A theoretical foundation has been chosen to align with teacher digital competence, outlining its characteristics, how contextual factors affect its development, specific assessment indicators, and interventions to enhance its acquisition and implementation in classrooms. (Napal Fraile et al., 2018)

Keywords: *Contemporary education, digital competencies, 21st-century classrooms.*

1. Introduction

Today's teachers face unprecedented challenges in creating equitable and effective learning environments, as inequalities increase and the capacity of traditional approaches is strained (Németh & Csongor, 2019). Effective integration of information and communications technology (ICT) has become critical to preparing young people for a volatile future. Accordingly, improving educators' digital competence through the appropriate use of technology to enhance pedagogy, engage learners, and support 21st-century skill acquisition is a pressing challenge for education systems worldwide. Digital competence is defined as the ability to use digital technologies, communication tools and networks to access, manage, integrate, evaluate and analyse information; construct new knowledge; produce digital media; and communicate and collaborate with others. It encompasses five core dimensions: technological knowledge and proficiency (understanding of hardware, software, and digital practices; operational skills; and the use of devices and platforms); pedagogical integration and design (consideration of pedagogical implications of technology in planning and the development of scalable instructional designs); digital communication and collaboration (engagement of students in meaningful online interactions and collaboration; use of OneDrive, Google Drive, and social media to share work; and coordinated interaction with families); and digital citizenship and ethics (modeling the responsible and ethical application of technology; attention to privacy, equity, and safety; and recognition of digital footprint) (Napal Fraile et al., 2018).

2. Conceptual Framework

Teachers' digital competence significantly impacts student learning, making their development crucial. However, comprehensive descriptions and effective applications of this competence are limited. Current research reveals unclear definitions and a lack of insights into how teachers blend technology, pedagogy, and ethics to improve learning outcomes. Digital competence includes four interconnected dimensions: Technological Knowledge focuses on understanding technology's workings; Pedagogical Integration involves planning lessons that integrate technology with curricula; Digital Communication covers online interactions and collaboration; and Digital Citizenship emphasizes responsible behavior and ethical standards. Three main factors affect teachers' ability to cultivate and utilize their digital competence: infrastructure (device accessibility), professional development (quality of training), and governance (leadership standards and incentives). (A. Velandia Rodriguez et al., 2022)(Garzón-Artacho et al., 2021)

2.1. Digital Competence and Pedagogical Practice

Digital competence, defined as the ability to use digital technologies for communication, collaboration, and information management, is a fundamental priority for education systems around the world. This importance relates not only to technological advances, but also to challenges in privacy and digital citizenship (Napal Fraile et al., 2018). Teacher digital competence is particularly essential, given educators' crucial role in guiding the learning process. The increasing prevalence of technology integration into formal education heightens the need to examine teacher digital competency and its relationship to pedagogy, learning design, ethics, and policy. Classroom observation and analysis forms the empirical basis for assessing the interaction between technology and pedagogy in diverse educational contexts (Stefanía Rossi Cordero & Barajas Frutos, 2017).

2.2. Theoretical Models of Teacher Digital Competence

Teacher digital competence remains a crucial issue in many countries, as indicated by teacher digital competence frameworks published by the Organisation for Economic Co-operation and Development (OECD) and the European Commission, as well as studies conducted under the auspices of the OECD Teaching and Learning International Survey (TALIS) (L et al., 2018). Teacher competence can be framed in terms of digital competence and the pedagogical integration of digital technologies. Digital competence is defined as the ability to use digital technologies in a critical, responsible, and creative manner, and to find, evaluate, and produce information and content by means of digital technologies. Teacher digital competence maintains a reciprocal relationship with student digital competence; the degree of digital competence at the teacher level influences the degree of student digital competence attained and the associated benefits. The study of teacher digital competence continues to be relevant; recent TALIS study data show that, across 29 OECD countries, only 46% of teachers reported feeling sufficiently equipped to integrate new digital technologies into teaching practices.

3. Dimensions of Digital Competency

Digital competence is essential for lifelong learning, facilitating self-fulfillment, active citizenship, and ongoing education. It is particularly significant in teacher training and professional development. Research indicates that teachers excel in information management, safety, and communication, but struggle with content creation and problem-solving. Digital competence involves more than operational skills; it encompasses the ability to evaluate and manage information, communicate effectively, edit content, protect personal data, and resolve technical issues. The TPACK model highlights planning as crucial for achieving digital competence. Key teacher activities involve setting educational goals, selecting resources, organizing lessons, and assessing outcomes. Digital competence closely relates to curriculum standards and the use of ICT in education, influencing

instructional design. It comprises two components: pedagogical integration and design. Although progress is reported in ICT usage, enhancing teachers' digital competence remains challenging and requires ongoing educational efforts. (Napal Fraile et al., 2018)(Rojo-Ramos et al., 2020)

3.1. Technological Knowledge and Proficiency

Contemporary classrooms have been transformed by digital technology, which enables instructional practices that promote meaningful learning. However, evidence shows limited effective adoption; many practices remain traditional methods mediated by tech. Teachers' digital competence—integrating technology with pedagogy and policy for better outcomes—is critical for educational reform. TPACK (Technological Pedagogical Content Knowledge) helps understand this construct, with models showing that access alone doesn't ensure meaningful application; specific knowledge and skills are needed. Teachers not engaged with technology in their lives are unlikely to support its integration in schools, necessitating effective approaches. Digital competence is crucial for 21st-century pedagogy and aligns with education's dual roles of knowledge transfer and future preparation. Teachers must adapt digital tools based on their access and needs. Diverse pedagogical approaches, educational contexts, and technological changes affect technology adoption. The focus may shift from knowledge diffusion to knowledge generation using technology. (Napal Fraile et al., 2018)(Choon Meng, 2017)

3.2. Pedagogical Integration and Design

Digital technologies are now commonplace and culturally indispensable in our daily lives, in business, and among young people. Nevertheless, many teachers have not incorporated digital technologies into their pedagogy. Various barriers, including equipment, lack of support, limited knowledge and skills, disconnection from daily practice, and attitudinal factors inhibit integration of contextual digital technologies in their curriculum design and resource development (Xerez Sabado, 2018). Teacher digital competence remains crucial for enhancing student learning in the 21st century and fostering digital citizenship. The challenge will not be determining the need for teacher digital competence but ensuring that it can actually happen in practice. Avoiding digital integration, digital-native students run the risk of becoming over-reliant on digital technologies while lacking the competencies to make appropriate choices. Digital-collage tasks promote learning-by-doing approaches while developing a sound understanding of pedagogy underpinning subject content. Disregarding pedagogical principles can lead to haphazard methods that lack coherence. An ambitious approach to digital pedagogy encourages students to apply pedagogical principles and approaches in their digital-collage tasks. Subject-specialist pre-service teachers can adopt a

practitioner-researcher position while accumulating pedagogical approaches essential for developing learning designs (Garzón-Artacho et al., 2021).

3.3. Digital Communication and Collaboration

Digital Communication and Collaboration refers to using digital technologies to communicate and collaborate with students and other stakeholders, such as parents and colleagues (Dai, 2023). Teacher engagement in online dialogues with students, for example through emails, discussion boards, text messages, blogs, or social media, can contribute to positive student outcomes (Németh & Csongor, 2019). Collaborative platforms like Google Docs and Microsoft 365 allow teachers and students to work simultaneously on documents. Sharing resources such as lesson plans, teaching materials, or educational links on social media enables broader collaboration among colleagues. Teachers can involve parents in their children's education through digital tools and by encouraging students to share their work with a wider audience. Such sharing improves student motivation and helps them develop a digital portfolio.

3.4. Digital Citizenship and Ethics

The Fourth Industrial Revolution and digital transformation significantly alter how people live, work, and interact, disrupting 21st-century pedagogy. The education sector focuses on training students in technology-rich, student-centered classrooms, guided by pedagogical philosophy, ethics, and policy. Digital competence, defined as the ability to blend technology with content and pedagogical knowledge, enhances student motivation and learning. The analysis examines how teachers employ digital technology to support learning in Korea, where high-stakes English tests are vital for college admissions. This competence extends to students, encompassing global competence—knowledge, skills, attitudes, and values vital for navigating globalization. Education must prepare students with global competence in a tech-rich environment, especially amidst a widening digital divide and advancing artificial intelligence. As technology's role in education surges post-COVID-19, digital competence becomes even more essential for both teachers and students. (Çevik Kansu & Öksüz, 2019)

4. Contextual Influences

Digital competence reflects teachers' ability to incorporate technology effectively into pedagogical practices. Competence hinges not only on technical know-how and familiarity with available tools but also on integration of technology within planned, deliberate approaches that enhance learning outcomes. Digital competence encompasses the tools, skills, and innovative practices adopted to meet agreed-upon frameworks that facilitate the accomplishment of learning objectives. Given the general

consensus around the relationship between teacher digital competence and student learning (Xerez Sabado, 2018) , further understanding of how competence manifests remains critically important.

The basic elements underpinning the notion of digital competence draw on three conceptual strands: understanding, pedagogical integration, and communication. These threads inform pedagogical practice—specifically, lesson design, planning, and implementation; the selection and use of specific technological tools, platforms, and applications; and engagement within formal and informal educational settings. An analysis of contextual constraints on the enactment of digital competence— institutional factors that shape initiatives involving technology, accessibility of digital equipment and infrastructure, professional training and ongoing support, and guidance around relevant frameworks and standards—therefore remains timely and necessary.

4.1. School Infrastructure and Access

The integration of digital technology in education is a complex endeavour involving many contextual factors. Significant yet often overlooked influences on how schools implement and sustain the pedagogical integration of digital competence include the local infrastructural climate, overall student access to digital tools, the existence of both formal and informal support services, and the provision of help desk and repair facilities (Mangino, 2018). Certainly, such infrastructure constitutes but one component of a complex evolving ecosystem driving pedagogical approaches among educators and their digital practices with students. But without functional hardware and operating systems, connectivity, and basic troubleshooting support, no school can provide reliable and expansive access to the range of contemporary and emergent digital tools and platforms that underpin educational transformation for both teachers and learners.

Digital technologies have become an integral element of everyday learning experiences for students outside the school environment. Educational institutions therefore face a continuing challenge to effectively construct digital access and experiences that will engage and sustain the interest of those same students once they arrive at school and enter the formal learning environment. However, to fully understand the wider contextual influences at play in such situations, and their implications for the enactment of the digital competence construct by educators inside the classroom, it is crucial to first clarify what constitutes digital competence.

4.2. Professional Development and Support

Effective teacher professional development is crucial for technology-infused pedagogy. Teacher-researcher collaboration enables the acquisition of knowledge and skills needed to utilize technological resources for improved student learning. A continuous inquiry cycle, informed by

formative and summative assessments, guides adjustments to instructional objectives and strategies. Collaborative evaluations of classroom data help teachers identify factors affecting student learning—such as behaviors and backgrounds—and explore technology integration in the classroom. Literature shows that technology can engage students and promote higher-order thinking skills. Collaboration among teachers and technology staff enhances understanding and adoption of educational technology. Emphasizing three areas can facilitate better technology integration in lesson planning: access to research on student-centered pedagogy, understanding instructional technology roles, and availability of customized, relevant instructional materials. (Blackmon, 2013)(Collins Tyner, 2018)

4.3. Policy and Leadership

The role of policy and leadership in enhancing technology integration in schools is crucial but often inadequately addressed regarding teacher digital competency. District-level leaders acknowledge four key elements for 21st-century classrooms: desired learning outcomes, formative assessments, collaboration opportunities, and creativity. However, their understanding of technology-enhanced learning is often limited, complicating personal development. Leaders must evaluate new tools' instructional potential and enhance cultural awareness through global experiences. Professional development options are frequently restricted to vendor-led sessions, which may not meet critical knowledge needs or provide practical skills. Leadership and policy also affect technology availability for teachers and students, with risk perceptions sometimes restricting tool access, thereby limiting innovation exploration. Teachers are more likely to experiment when colleagues can freely explore new materials. By promoting moderate trial-and-error, school leaders create an innovative climate, improving material selection across classrooms. Staffing decisions and support services shape the environment for professionals. A shortage of full-time teachers disadvantages secondary educators seeking pedagogical assistance for younger students, as supply educators may lack insight into specific practices or student needs, necessitating additional support for professional learning. (Arrington, 2014)

5. Assessment and Measurement

Assessment of teacher digital competence poses significant challenges owing to its multifaceted nature and the difficulties associated with measuring pedagogical practices (Napal Fraile et al., 2018). Moreover, competent teachers employ digital technologies to help students become competent citizens. Therefore, the analysis considers instruments that encompass teacher training, digital technologies, communications, and digital citizenship to assess teaching practices. Available data

sources include teacher-participant completion of TPACK-based self-evaluation questionnaires and the DigCompEdu framework. The absence of published data on the participation of UAE educators in structured training on responsible technological integration, curriculum design, or serious games use within institutions underscores the need for further investigation (Muammar et al., 2022).

Specifically, teacher competence is conceptually embedded in two broad ideas: (1) the potential presence of instruction—assisted by pedagogical knowledge and technological resources—that scaffolds classroom discussions on managing learners' participation in educational spaces founded on digital applications and (2) the provision of training programs and administrative guidance aimed at helping educators tackle wider challenges regarding pedagogy. The existence of a substantive body of UAE literature addressing teachers' digital competence further points to the relevance of the proposed study for educational institutions and the Ministry of Education.

6. Implications for Practice

Despite the fact that educational technology has undergone considerable advancements, an increasing number of educators still inadequately develop and implement Integrated STEM (Science, Technology, Engineering, and Mathematics) programs in their classrooms. The phenomenon was examined in a face-to-face research project between 2019 and 2021 in the actual classrooms and schools of seven schools within the Northwest Territory of Canada. Teachers were interviewed about their views regarding four main hindrances: (a) lack of knowledge of the Design Process, (b) lack of knowledge of Indigenous education, (c) the educational curriculum, and (d) the political contextuality of their schools. They emphasized that the most significant barriers preventing the active utilization and incorporation of Integrated STEM into their pedagogies were insufficient knowledge of the Design Process and lack of understanding of Indigenous education

These findings showed that the educators' perception was mainly related to the Knowledge and Awareness framework of the Technological Pedagogical and Content Knowledge (TPACK) theoretical model. A considerable number of teachers possessed no prior knowledge on either of these aspects; hence, they did not conduct any related activities or lessons in their classrooms. These observations revealed that knowledge and awareness on STEM and Indigenous education implementation was a vital form of professional learning that should be immediately provided to teachers in the Northwest Territory, Canada (Napal Fraile et al., 2018).

7. Challenges and Opportunities

Many barriers impede the development of teachers' digital competence (Németh & Csongor, 2019). Lack of institutional commitment to policy prioritization, governance structures, or operational

incentives inhibits promotion of a strategic vision. Insufficient technology infrastructure, insufficient bandwidth, and inadequate technical support and services hinder quality technology implementation. Training packages that do not respond to teachers' contextual situational and pedagogical needs constrain uptake of professional development and lead to disillusionment with provision (M. ASEBIOMO, 2014). Dominance of outdated simplistic digital literacy in curricula and assessment ignores integration with varied technologies that could further deepen digital competence. Teachers report competing demands on their workload and limited time for engagement with ongoing development. Moreover, rapid technological developments challenge currency of input at all levels. Formal systems remain necessary to collaboratively develop blended instructional materials available in open online environments while emphasizing local socio-cultural relevance. Technical support for guidance, infrastructure, tools accessible at home with no educational restrictions, and collaborative professional communities foster either initial uptake or further widening of digital competence. Existing integration warrants greater attention in pre-service training programmes and subsequent continuous professional development. Successful innovation thrives at intersections among traditional and varying approaches, and spaces where curriculum and educational outcomes determined by technological focus coexist with forms retaining a human-centred base. Emphasis on pedagogy alongside technical tools or commercial products becomes increasingly viable as education adapts.

8. Research Gaps and Future Directions

Despite numerous studies conducted since the onset of the pandemic, research gaps pertaining to teacher digital competence remain (Garzón-Artacho et al., 2021). The following questions therefore warrant investigation

- How does teacher digital competence influence student learning outcomes? - What role do leadership, policy, and context play in teacher digital competence? - What pedagogical frameworks inform teacher digital competence? - How do teachers acquire digital competence? - What metrics effectively evaluate teacher digital competence?

Furthermore, methodological perspectives provided rich explanations on the genesis of personal and professional digital competencies. Yet, adoption continues to vex many theorists and practitioners. Emerging eld such as blended learning, flexible learning, and the metaverse therefore require ongoing consideration.

9. Conclusion

Digital competence incorporates the effective and critical use of technology for learning, communication, collaboration, content creation, and problem-solving. Digital technologies are increasingly integrated into 21st-century teaching and learning practices, requiring teachers to be digitally competent. Prioritize training and developing relevant skills among teachers to maximize the effect of infrastructure investments. Explore four core dimensions of teacher digital competence—technological knowledge and proficiency, pedagogical integration and design, digital communication and collaboration, and digital citizenship and ethics—together with implementation determinants (M. ASEBIOMO, 2014) , (Napal Fraile et al., 2018).

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