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Integration of ICT in transdisciplinary teaching in university education

Integración de TIC en la enseñanza transdisciplinaria en Educación unversitaria

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Abstract

This article examines how Information and Communication Technologies (ICT) are integrated into transdisciplinary teaching in university education. The objective is to analyze the role of ICT in promoting transdisciplinarity. To this end, the researcher conducted a literature review in databases such as Scopus, Redalyc, and Scielo, using terms like "ICT," "transdisciplinary teaching," and "university education." The results reveal that platforms like Zoom and Moodle enable global connectivity and resource sharing, enhancing learning and collaboration across disciplines. The conclusions indicate that ICT serve as mediators in transdisciplinary teaching in university education and as an integrative tool, though evidence of digital gaps persists. Universities continue training their faculty to improve digital competencies.

Keywords: Transdisciplinarity, university education, Information and Communication Technologies, integration.

Resumen

En el presente artículo se plantea como las Tecnologías de la Información y la Comunicación (TIC) se integran en la enseñanza transdisciplinaria en la educación universitaria. En tal sentido el objetivo es analizar el rol de las TIC en la promoción de la transdisciplinariedad. A tal efecto el investigador ha realizado una revisión bibliográfica en bases como *Scopus*, *Redalyc* y *Scielo*, usando términos como "TIC", "enseñanza transdisciplinaria" y "educación universitaria". Los resultados revelan que plataformas como *Zoom* y *Moodle* permiten la conectividad global y el intercambio de recursos, enriqueciendo el aprendizaje y la colaboración entre disciplinas. Entre las conclusiones se tienen que las TIC son mediadores en la enseñanza transdisciplinaria en educación universitaria pero también un medio integrador, aunque todavía hay evidencia de brechas digitales las universidades siguen formando a su profesorado para mejorar sus competencias digitales.

Palabras clave: Transdisciplinariedad, educación universitaria, Tecnologías de la Información y la Comunicación, integración.

Introduction

Universities today face the challenge of engaging with an interconnected, complex world that never stops evolving. One fundamental pathway to achieve this is through ICTs by fostering transdisciplinarity. As Asunción (2018) states:

> University education and transdisciplinarity are undoubtedly intertwined due to their importance in specialist training and discipline design. Moreover, transdisciplinary knowledge isn't automatically acquired as the sole result of scientific and technological progress, but rather requires deliberate, conscious efforts oriented toward this goal. (2.1. Transdisciplinarity in University Education Context, para. 1).

Thus, transdisciplinarity enables integrating diverse disciplines to solve complex problems, as knowledge remains fragmented in disciplinary silos incapable of intercommunication, let alone holistic problem-solving. This is where ICTs facilitate a paradigm shift, since as Morin (2011) argues: "Hyperspecialization fragments reality's complex fabric, while quantification's dominance obscures human affective dimensions" (p. 141). Transdisciplinarity confronts these knowledge partitions, dethroning them from their modernist pedestal.

Martínez (2013) asserts that transdisciplinarity "overcomes disciplinary boundaries to generate more complete, integrated - and thus truer - representations of reality" (p. 86). This transdisciplinary worldview offers alternative lenses for examining realities beyond disciplinary reach, centering on humanity through integrative vision. However, achieving transdisciplinary attitudes requires, per Nicolescu (1996): rigorous argumentative language, openness to the unknown, and tolerance for contradictory truths. Artidiello et al. (2017) attribute these characteristics to transdisciplinary teaching: transgressive, knowledge-integrating, inclusive, critical, comprehensive, and ethical.

Notably, transdisciplinary education transcends individual disciplinary frameworks. Conversely, it transgresses disciplines (transversally) by blending concepts, approaches, and notions to construct new, specific knowledge complementing, enriching, integrating, and transcending source disciplines while surpassing expert domains. It embraces diverse wisdom forms, fostering sensitivity to multiple cultural, social, and scientific perspectives through holistic, interconnected understanding.

Zarzuelo et al. (2024) posit that in transdisciplinarity, "diverse stakeholders (students and interested parties) collaborate by contributing methods transcending individual disciplinary perspectives. Similarly, they exchange experiences, knowledge, ideas, values, and expectations. Academics, professionals, and researchers develop shared frameworks when addressing problems through this approach."

According to Wall & Shankar (2008), transdisciplinary collaboration is being promoted in academic and professional spheres as a key strategy for exploring new research approaches and generating knowledge directly applicable to solving real-world problems. Martin (2017) notes that transdisciplinarity is grounded in the principle that reality is too complex, interconnected, and multidimensional to be analyzed without multiple disciplines - though specific problems can be solved (in collaboration with affected non-academic stakeholders).

Nicolescu (2010) views transdisciplinarity as an approach integrating knowledge, methodologies, and perspectives from diverse disciplines to address problems unsolvable within single knowledge domains. However, as Nicolescu (2014) asserts, integrating diverse knowledge systems to solve contemporary complex problems requires "the unity of knowledge" (p. 201) rather than reliance on singular knowledge sources.

This integrative approach enables students to develop skills for tackling complex, multidimen-

sional problems. Thus, transdisciplinarity not only enriches learning but also cultivates teamwork and adaptability in dynamic environments. Nevertheless, implementing transdisciplinary teaching in higher education faces challenges including resistance to change, insufficient teacher training, and difficulties integrating cross-disciplinary knowledge.

Notably, as Kubisch et al. (2021) emphasize, transdisciplinarity acknowledges the responsibility to address socially relevant problems and the crucial role of those affected (or potentially affected) by these challenges. This raises the pivotal question of resource roles - particularly ICTs as integration mechanisms in this article's context. The study therefore investigates: How are ICTs integrated into transdisciplinary teaching in university education?

Methodology

This study includes a review of Scopus, Redalyc, and Scielo databases, with searches conducted in English and Spanish. Studies not addressing the research topic were excluded. The exploration employed meta-search engines (Google, Google Scholar, Ask, Bing), books, and Venezuelan university repositories. The canonical search equation was: ("ICT" OR "information and communication technologies") AND ("transdisciplinary teaching" OR "transdisciplinary education") AND ("university education" OR "higher education") AND ("integration" OR "implementation")

Results

ICTs and the promotion of transdisciplinarity

Virtual platforms are digital applications or environments that enable interaction among participants while facilitating learning processes, collaboration, and resource management via the internet. These platforms depend directly on ICTs for their development and operation.

In the digital era, virtual platforms have become essential tools for communication, learning, and collaboration. Their potential to foster interdisciplinary interaction is particularly relevant in a world where complex problems require cross-disciplinary solutions. Virtual platforms facilitate interdisciplinarity by overcoming geographical barriers, promoting cognitive diversity, and optimizing knowledge exchange - all contributing to innovation and comprehensive solution development.

Various tools enable such collaboration. As Tomalá De la Cruz et al. (2020) note: "WikiSpaces, Moodle, and Edmodo represent excellent options for diverse educational purposes" (p. 202). However, other technological resources like email, forums, and chats also promote collaborative learning. Thus, ICTs allow professionals, academics, and multidisciplinary experts to connect and collaborate regardless of geographical location.

Within this framework, ICTs play a fundamental role in promoting transdisciplinarity through virtual platforms. As previously discussed, transdisciplinarity enables knowledge integration

across disciplines, providing comprehensive problem analysis through multiple lenses. Global connectivity and access constitute key enablers of this process.

Connectivity and global access

Platforms like Zoom, Microsoft Teams, and Google Meet allow professionals and experts from diverse disciplines to connect and collaborate irrespective of geographical location - a prerequisite for transdisciplinarity. For instance, a botanist in Congo, physicist in Australia, biologist in Canada, and mathematician in London can collaboratively work on renewable energy projects with university students worldwide.

As Zuña et al. (2020) maintain, these platforms "increase student motivation, create knowledge, manage and share resources, and foster teamwork" (p. 352). Furthermore, Irigoyen et al. (2018) highlight ICTs' role in enhancing engagement, comprehension, creativity, communication, critical thinking, and multicultural awareness. Sagenmüller (2016) identifies how ICTs optimize time, reduce costs, improve student communication, enrich data, enable exploration, and provide learning flexibility - all vital for transdisciplinary education.

This perspective led UNESCO to establish an ICT competency program for educators, as the United Nations Educational, Scientific and Cultural Organization (Unesco, 2015) affirms ICTs can facilitate acquisition of skills needed for contemporary challenges, including: information creation and selection, autonomy and decision-making, problem-solving flexibility, teamwork and communication skills.

ICTs also enhance teachers' roles. Unesco (2008) emphasizes that educators must design learning opportunities and classroom environments facilitating student ICT use for learning and communication. Teachers bear responsibility for utilizing ICTs and designing related activities, recognizing students as the educational focus while serving as facilitators and learning resource managers. This approach helps students develop knowledge-construction skills and competencies for workforce integration - a crucial function of higher education as career preparation.

However, Unesco (2008) stresses that "all teachers must be prepared to provide these opportunities." Makrakis (2005) notes that new technologies demand novel teacher roles, pedagogies, and training approaches. Consequently, Santaella and Ruiz (2023) explain UNESCO advocates transitioning from specialized disciplinary models toward transdisciplinary education enabling students to address an increasingly complex globalized world's challenges.

Knowledge and resource exchange

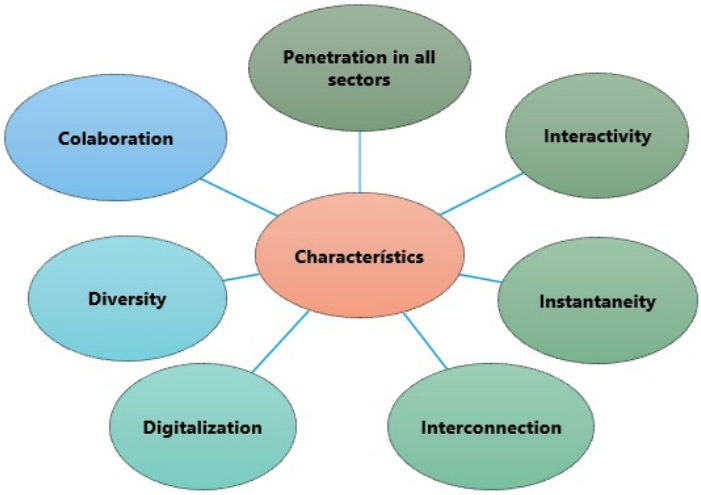
It is worth noting that tools like Google Drive, Dropbox, and Moodle facilitate document sharing, data exchange, research dissemination, and educational material distribution within virtual platforms. From a transdisciplinary perspective, this proves fundamental in higher education as students can access specialized knowledge from other disciplines and integrate it into their own

knowledge construction. For instance, in public health projects, doctors, epidemiologists, and economists can share data and analyses to design comprehensive strategies. Having these resources available on a platform enhances collaboration and ensures all virtual classroom students have equal information access.

In this context, ICTs enable simple and rapid access to information in diverse formats. The most significant ICT characteristics are presented in Figure 1.

Figure 1

Characteristics of ICTs



Note: Author's own elaboration.

Knowledge and resource exchange in higher education

In higher education, knowledge and resource exchange represents a fundamental pillar for fostering transdisciplinarity. ICTs have revolutionized this process by providing virtual platforms that facilitate the sharing, integration, and application of knowledge from multiple disciplines. This approach not only enriches learning but also prepares students to address complex problems requiring comprehensive solutions. Below, we expand on this point with examples and reflections about its impact on higher education.

ICTs in university education

In recent years, universities have undergone changes toward digitalization, interconnected environments, and the development of research and scientific publications related to educational technologies. As Area et al. (2020) state, there is "a clear and focused interest in studying the impacts of digital technologies on alternative teaching modalities beyond face-to-face instruction" (p. 2). This has created a need for changing teaching paradigms, as evidenced by recent

experiences during the COVID-19 pandemic.

Area and Adel (2021) argue that the pandemic generated "the unexpected boost of digital teaching, the pedagogical and organizational integration of ICTs in schools, and the metamorphosis of teaching materials" (p. 83). Therefore, universities and educational institutions cannot remain indifferent to these developments, as the alert affected both. The call is to reinvent themselves if they wish to respond to the demands of a digital society where information access and global collaboration prevail. ICTs are precisely the protagonists of this paradigm shift and the promotion of educational innovation - whether desired or not, the response to the pandemic experience was possible thanks to technology. Social networks became the engine of change and the central core.

As Area (2017) states, we have now transitioned from analog to digital or online-distributed media - a metamorphosis of teaching materials. Printed books are becoming obsolete, replaced by disruptive technologies, marking a shift from educational culture to digital culture in teaching materials. The author of this article believes the teaching model is becoming exhausted, along with teaching strategies and didactic resources. The possible path is to open up to new perspectives. It is from this point that disciplines become enriched through contributions from professionals and experts in other fields, making transdisciplinary knowledge manifest in more expressive formats, alternative narratives, and cognitive experiences.

However, we must not forget the warning from Castañeda et al. (2018): "the potential of ICTs in education remains to be fully developed and demonstrated" (p. 2). An example of this challenge can be seen at the Universidad Nacional Experimental de los Llanos Occidentales Ezequiel Zamora, which despite having faculty trained for distance education, continues to develop ongoing teaching diplomas for its professors.

Following this line of thought, other universities worldwide have incorporated virtual platforms for their undergraduate and graduate programs. Regarding this, Hidalgo et al. (2023) mention that in Peru, faculty have been trained in digital competencies, implementing virtual platforms as learning environments. Meanwhile, Varela (2024) notes that in Mexico, "teacher training in digital technologies has become a necessity in contemporary education" (p. 1967).

Indeed, ICTs facilitate this training in transdisciplinary skills. Various online learning platforms offer open-access courses and resources spanning different disciplines. Hernández (2023) highlights platforms such as: (a) Coursera, providing quality interactive learning courses (some free, some paid with certification); (b) edX, founded by Harvard University and MIT with optional certification; and (c) Khan Academy, offering courses in mathematics, science, computing, economics, and finance. Additionally, there are collaboration software and digital resources enabling transdisciplinary work.

Based on the above, teachers can acquire knowledge and skills beyond their core disciplines - a key factor for transdisciplinary collaboration. According to experts like Zawacki & Jung (2023),

ICTs are digital media and tools that facilitate teaching-learning processes through communication, interaction, collaboration, assessment, and feedback. With the global COVID-19 pandemic, ICTs have become fundamental components across all educational levels, enabling interdisciplinary collaboration by providing virtual spaces to share knowledge, resources, and experiences.

Another relevant aspect of ICTs in university education is their ability to personalize learning according to each student's needs and pace. As Gómez and Cano (2020) mention, ICTs also offer various options, including access to academic and professional information sources, course materials, databases, reference management tools, and participation in online conferences and congresses.

Conclusions

It is concluded that ICTs serve as important mediators of transdisciplinarity through virtual platforms. These technologies enable connectivity, collaborative tools, as well as access to data and resources. Furthermore, they provide spaces for communication. ICTs act as bridges facilitating effective collaboration among professionals and academics from different disciplines. This enriches research and development processes while allowing comprehensive solutions to complex problems.

The study concludes that virtual platforms not only overcome geographical barriers but also enable cognitive plurality and knowledge exchange. However, universities still need to continue training faculty in digital competencies to ensure ICT and virtual platform usage doesn't become a digital divide, but rather maximizes teaching potential.

Similarly, it is believed necessary for universities to continue adopting ICT integration in transdisciplinary teaching as an essential process within the emerging educational paradigm they are called to join, as revealed by Unesco documents and education ministry plans. Nevertheless, further research promoting transdisciplinarity development through ICT use is deemed necessary.

ICTs drive a transdisciplinary educational model, moving away from disciplinary approaches toward a global knowledge vision. Platforms like edX or Khan Academy democratize access to interdisciplinary courses, preparing students for a complex world. This paradigm shift, empowered by technology, responds to educational innovation needs.

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