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PROPOSAL FOR A CONCEPTUAL DEFINITION OF TECHNOLOGICAL LEARNING BASED ON DIFFERENT TYPES OF TECHNOLOGY-MEDIATED LEARNING

PROPOSIÇÃO DE UMA DEFINIÇÃO CONCEITUAL PARA A APRENDIZAGEM TECNOLÓGICA COM BASE EM DIFERENTES TIPOS DE APRENDIZAGENS MEDIADAS POR TECNOLOGIAS

PROPUESTA DE DEFINICIÓN CONCEPTUAL DEL APRENDIZAJE TECNOLÓGICO BASADA EN DIFERENTES TIPOS DE APRENDIZAJE MEDIADO POR TECNOLOGÍA

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Abstract

This study aimed to propose a conceptual definition of technological learning from the perspective of the human being who learns through various technology-mediated learning experiences. The method used was conceptual bibliographic research in its four stages: formulation of research questions, data collection from publications available on Google Scholar, Scopus, and Web of Science carried out between 2022 and 2026, organization and analysis using content and semantic analysis techniques, and generation of empirical responses compared with the theoretical framework. The results showed that a) online learning can be understood as an educational process in which teaching and learning experiences are designed to occur mainly through digital technologies and the internet; e-learning: educational modality mediated by digital technologies and electronic communication systems that provides delivery, interaction, and management of the learning process; Technology-enhanced learning (TEL): field of research and educational practice in the intentional use of digital technologies to improve, support, and transform teaching and learning processes; Digital learning: educational process in which digital information and communication technologies are integrated into the teaching and learning environment; b) the similarities are: they all involve digital technology in the learning process, seek greater flexibility, accessibility, and global reach, promote

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synchronous and asynchronous learning, and aim for personalization and learner autonomy; and c) The differences are: online learning focuses specifically on learning via the internet, b) e-learning is structured in digital environments, TEL is a broader concept that does not depend solely on online environments, and digital learning is the broadest term of all, including everything from online activities to the use of digital devices and tools. The conclusion shows that technological learning can be understood as a process in which students mobilize cognitive, digital, and socio-emotional skills to learn in technology-mediated environments.

Keywords: Technological learning; Digital learning; Online learning; e-learning; Technology-enhanced learning.

Resumo

Este estudo teve como objetivo propor uma definição conceitual de aprendizagem tecnológica a partir da perspectiva do ser humano que aprende por meio de diversas experiências de aprendizagem mediadas pela tecnologia. O método utilizado foi a pesquisa bibliográfica conceitual em quatro etapas: formulação das questões de pesquisa, coleta de dados de publicações disponíveis no Google Scholar, Scopus e Web of Science, realizadas entre 2022 e 2026; organização e análise, utilizando técnicas de análise de conteúdo e semântica; e geração de respostas empíricas comparadas ao referencial teórico. Os resultados mostraram que: a) a aprendizagem online pode ser entendida como um processo educacional no qual as experiências de ensino e aprendizagem são planejadas para ocorrer principalmente por meio de tecnologias digitais e da internet; e-learning: modalidade educacional mediada por tecnologias digitais e sistemas de comunicação eletrônica que proporciona a entrega, a interação e a gestão do processo de aprendizagem; Aprendizagem aprimorada por tecnologia (TEL): campo de pesquisa e prática educacional no uso intencional de tecnologias digitais para aprimorar, apoiar e transformar os processos de ensino e aprendizagem; Aprendizagem digital: processo educacional no qual as tecnologias digitais de informação e comunicação são integradas ao ambiente de ensino e aprendizagem. b) As semelhanças são: todas envolvem tecnologia digital no processo de aprendizagem, buscam maior flexibilidade, acessibilidade e alcance global, promovem a aprendizagem síncrona e assíncrona e visam à personalização e à autonomia do aluno; e c) As diferenças são: a aprendizagem online concentra-se especificamente na aprendizagem via internet, o e-learning é estruturado em ambientes digitais, a TEL é um conceito mais amplo que não depende exclusivamente de ambientes online, e a aprendizagem digital é o termo mais abrangente de todos, incluindo tudo, desde atividades online ao uso de dispositivos e ferramentas digitais. A conclusão mostra que a aprendizagem tecnológica pode ser entendida como um processo em que os alunos mobilizam habilidades cognitivas, digitais e socioemocionais para aprender em ambientes mediados por tecnologia.
Palavras-chave: Aprendizagem tecnológica; Aprendizagem digital; Aprendizagem online; e-learning; Aprendizagem aprimorada por tecnologia.

Resumen

Este estudio tuvo como objetivo proponer una definición conceptual del aprendizaje tecnológico desde la perspectiva del ser humano que aprende a través de diversas experiencias de aprendizaje mediadas por la tecnología. El método utilizado fue la investigación bibliográfica conceptual en sus cuatro etapas: formulación de preguntas de investigación, recopilación de datos de publicaciones disponibles en Google Scholar, Scopus y Web of Science realizadas entre 2022 y 2026, organización y análisis mediante técnicas de análisis de contenido y semántico, y generación de respuestas empíricas comparadas con el marco teórico. Los resultados mostraron que a) el aprendizaje en línea puede entenderse como un proceso educativo en el que las experiencias de enseñanza y aprendizaje están diseñadas para ocurrir principalmente a través de tecnologías digitales e internet; e-learning: modalidad educativa mediada por tecnologías digitales y sistemas de

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comunicación electrónica que proporciona entrega, interacción y gestión del proceso de aprendizaje; Aprendizaje mejorado por tecnología (TEL): campo de investigación y práctica educativa en el uso intencional de tecnologías digitales para mejorar, apoyar y transformar los procesos de enseñanza y aprendizaje; Aprendizaje digital: proceso educativo en el que las tecnologías digitales de la información y la comunicación se integran en el entorno de enseñanza y aprendizaje; b) Las similitudes son: todos involucran la tecnología digital en el proceso de aprendizaje, buscan mayor flexibilidad, accesibilidad y alcance global, promueven el aprendizaje sincrónico y asincrónico, y apuntan a la personalización y la autonomía del estudiante; y c) Las diferencias son: el aprendizaje en línea se centra específicamente en el aprendizaje a través de internet, c) el e-learning se estructura en entornos digitales, TEL es un concepto más amplio que no depende únicamente de entornos en línea, y el aprendizaje digital es el término más amplio de todos, incluyendo desde actividades en línea hasta el uso de dispositivos y herramientas digitales. La conclusión muestra que el aprendizaje tecnológico puede entenderse como un proceso en el que los estudiantes movilizan habilidades cognitivas, digitales y socioemocionales para aprender en entornos mediados por la tecnología.
Palabras clave: Aprendizaje tecnológico; Aprendizaje digital; Aprendizaje en línea; Aprendizaje electrónico; Aprendizaje potenciado por la tecnología.

1. Introduction

Human education has been considered, from a scientific perspective, as a phenomenon composed of teaching and learning (Wagner; Pishtari; Ley, 2026; Zaldi, 2026). Teaching and learning are its component elements, executed according to a specific logical sequence, whose intended result is the acquisition of specific learning. It is for this reason, for example, that education is said to be a process composed of teaching and learning. Taking the equation education = teaching + learning, one would expect that any derivation of this first equation would produce an equivalent result. For example, in the case of technological education as a derivative, its components should be technological teaching + technological learning. However, any literature search for conceptual definitions of technological learning will yield results that focus on organizations rather than on human beings. Even when considered to originate in the individual, all available approaches to technological learning aim to convert human learning into organizational learning, as seen in the study by Peerally and Fuentes (2020). Organizational technological learning is conceived as a process (Nozari, Radfar; Ghazinoori, 2023; Peerally; Fuentes, 2020; Mokhtarzadeh; Faghei, 2019; Adelowo et al., 2015) that guides the company's technological development and strengthens its technological capabilities, with the potential for replication and process improvement. Its purpose is to create, renew, and enhance capabilities,

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simplifying and improving processes so that the organization can develop and manage its own technologies. Two other approaches found in the literature were technological learning as a form of capability development, in the study by Ghazinoori et al. (2017), and as a condition for the development of efficient technologies (Tongsopit, 2015), the first as a response to market incentives and the second as a response to environmental changes.

The study by Gadelha and Silva (2025) proposed a conceptual definition of technological teaching aligned with the conceptual scope of technological education, based on the few, scattered definitions found in the scientific literature. In the case of human technological learning, no conceptual definition was found. What is abundantly found is a wide variety of concepts, many with substantial definitions, which somehow involve and structure a possible conceptual definition of human technological learning (to differentiate it from organizational technological learning), such as digital learning, online learning, and e-learning, among others. The problem is that these definitions are markedly technological, disregarding the ontological, axiological, and methodological foundations of the substantive phenomenon of learning as a logical sequence of steps that culminates in the acquisition of the desired learning. Learning is a process; learning is a product, a result.

In this regard, this study aimed to propose a conceptual definition of human technological learning based on diverse technology-mediated learning experiences. To this end, the study first reviewed the literature on approaches and attributes of learning, digital learning, online learning, e-learning, and technology-enhanced learning; then compared the conceptual similarities and differences among these types of learning; and concluded with a conceptual proposal. The conceptual bibliographic method was used to conduct the study, with data collected from the Scopus, Web of Science, and Google Scholar databases, processed using content and semantic analysis techniques, organized into summarizing tables, and the results interpreted by comparing them with the previously developed theoretical framework.

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2. Theoretical Architecture

Education is a phenomenon that is scientifically explained through various approaches, such as process (Amando; Owan, 2025; Pandiangan; Uma, 2025), set (Yadav, 2025; van Rijn et al., 2024), and effort (Refjuandani; Arita, 2025; Zuliansyah et al., 2024). The purpose of all educational effort is to achieve learning, which generally represents the behavior that the individual intends to obtain or modify, so that learning is always a behavior change. This is why, for example, it is said that education is a process (Amando; Owan, 2025; Pandiangan; Uma, 2025). In fact, the overall macro-process of education is divided into two processes: the teaching process and the learning process. The teaching process is an effort to plan, organize, direct, and control the learning to be achieved and the resources necessary for it, in such a way that it involves professionals specialized in education, both in the conception of the teaching system and in the execution of teaching activities. That is why it is said that the teaching process is the responsibility of the teacher, understood in its broadest sense as an educator. The learning process, in turn, is intrinsically individual and takes place within the human being, manifesting itself through changes in behavior or alterations of previous behaviors. It is said that the learning process is the responsibility of the individual or student because only they can change their behavior through the acquisition of knowledge, skills, attitudes, and values. The fundamental equation of education can be rewritten as education = teaching (teacher) + learning (student).

Technological learning, from a linguistic point of view, can be considered a form of derivation of learning, just as technological education can be taken as a derivation of education. Scientific literature has consistently shown this derivational relationship between education and technological education, also called EdTech (Gadelha; Nascimento-e-Silva, 2025b). The consequent and differentiating derivation is that education, in its broad, integral sense, is not largely based on technologies and digital media, as is technological education; education often continues to rely on analog systems management, as well as in teaching and learning procedures. The study by Gadelha and Nascimento-e-Silva

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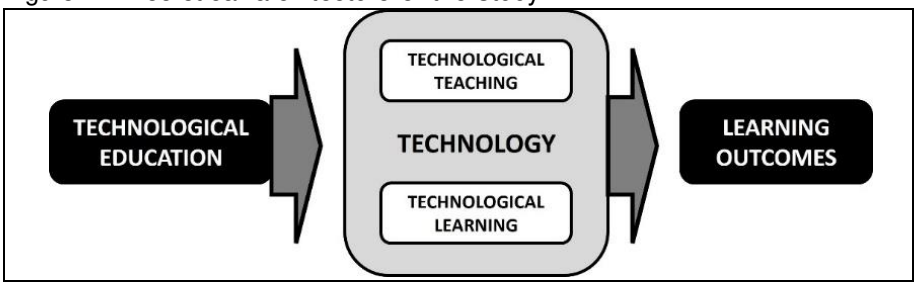
(2025a) showed that the scientific literature on technological education was not aligned with the conceptual scope of traditional education, thereby requiring updating to ensure consistency in the derivation of the fundamental equation of education. The same occurrence was verified in the context of technological learning. Virtually all that the literature presents as technological learning is focused exclusively on the organizational universe (Peerally; Fuentes, 2020; Nozari; Radfar; Ghazinoori, 2023; Peerally; Fuentes, 2020; Mokhtarzadeh; Faghei, 2019; Adelowo et al., 2015; Ghazinoori et al., 2017; Tongsopit, 2015). The prevailing idea is that the organization learns, and therefore, there is organizational learning.

On the other hand, the scientific literature seems to fill, or attempt to fill, the conceptual and operational gap in technological learning by constructing several other concepts, such as digital learning, online learning, and e-learning, among many others, whose nomenclature is somewhat vague conceptually and operationally. For educational system operators, it is fundamental that these concepts be delimited in scope and attributes, so that it is possible to identify with relative precision what one is and what another is, as well as to make the fundamental distinctions that yield diverse scientific and practical benefits.

Figure 1. Theoretical architecture of the study.



Source: adapted from Gadelha and Silva (2025).

In this sense, as shown in Figure 1, the theoretical architecture of this study considers technological education, comprising technological teaching and technological learning. Technological education refers to an educational unit or an entire educational macrosystem, such as state and national ones (Gadelha; Nascimento-e-Silva, 2025), formally organized and institutionalized, whose functioning occurs through diverse technologies. Technological teaching is the

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partnership between education professionals and various student bodies to plan, execute, monitor, and evaluate teaching processes. The results achieved are all mediated by technologies (Gadelha and Silva, 2025). Finally, technological learning is the part of the equation that is the responsibility of the student body, with the help of education professionals, and this study intends to define it conceptually.

3. Research Methodology

This study is characterized as a bibliographic survey, constituting a review of the scientific literature, of an eminently qualitative nature, whose data were all nominal. The unit of analysis was conceptual, in which each conceptual definition was divided into its constituent parts of equivalence term (approach) and conceptual characteristics (attributes); the level of analysis was the conceptual field, in which the approaches for each conceptual field studied (the different types of learning) were sought to be understood, representing the extent of the generated explanation. The perspective of analysis was synchronic or transversal, to describe reality statically.

3.1 Guiding Research Questions

This study had the general objective of proposing a conceptual definition for human technological learning based on different types of technology-mediated learning. To this end, the following guiding or ancillary research questions were formulated: 1) What is learning? 2) What is digital learning? 3) What is technology-enhanced learning? 4) What is e-learning? 5) What is online learning? 6) What are the similarities and differences between the different types of technological learning? The methodological design adhered to the guidelines contained in the studies of Nascimento-e-Silva (2020; 2021a; 2021b; 2021c; 2023).

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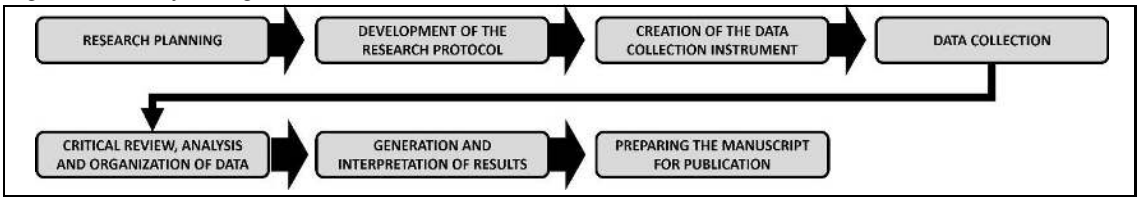
3.2 Study Design

The study design followed the procedures used in the research by Gadelha and Silva (2025). The first stage consisted of formulating the research questions, the survey scope, the inclusion and exclusion criteria, and the tools to be used. The second stage involved developing the research protocol, encompassing the rules for data collection and analysis, data organization, and the generation and interpretation of results. The third stage involved developing the data collection instrument for questions on learning types, as well as an instrument to identify conceptual differences and similarities. The fourth stage involved data collection from the Web of Science, Scopus, and Google Scholar databases.

Figure 2. Study design



Fonte: Gadelha e Silva (2025).

In the fifth stage, the data collected were reviewed to determine whether they met the inclusion and exclusion criteria and contained all the conceptual elements necessary for the analysis. This consisted of separating these elements and organizing the data by approach type, attributes, similarities, and differences. In the sixth stage, results were generated from the summary tables and compared with the theoretical framework to answer the main research question, as stated in the results discussion section. The seventh and final stage was the transformation of the report into a manuscript for submission to publication.

3.3 Populations and Samples

The methodological design of this research consisted of six surveys, each covering a specific concept, and the data collection period. The population consisted of all conceptual definitions of the study's concepts, namely: learning, digital learning, technology-enhanced learning, e-learning, and online learning. No sampling calculations were used, so the data collection became a census effort.

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Table 1. Period covered, populations, and samples.

Conceptual definitions collected	Period covered	Populations	Samples
Learning	2025 to 2026	26	23
Digital learning	2022 to 2026	17	17
Technology-enhanced learning	2022 to 2026	5	5
E-learning	2025 to 2026	14	13
Online learning	2024 to 2026	14	14

Source: prepared by the authors.

Table 1 shows that the data collected for the concepts "learning" and "e-learning" covered the period from 2025 to 2026; for the concepts "digital learning" and "technology-enhanced learning," the period covered was from 2022 to 2026; and for the concept "online learning," the period covered was from 2024 to 2026. The table also shows the size of the study populations that contained the sought-after conceptual definitions. In only two cases was it not possible to collect and use all available conceptual definitions. The first was about "learning" because the platform required payment for access and because the study did not meet the requirements for a Digital Object Identifier (DOI) link. The second was about "e-learning," because the access link to the document did not complete the access.

3.4 Data: instruments and data collection strategies

Two data collection instruments were used. The first method used to collect conceptual definitions of the types of learning consisted of a double-entry table, in which bibliographic references were listed in the left column and definitions in the right. The second method was used to collect data on similarities and differences among the types of learning, organized into nine analytical aspects: the synthesized definition, delivery mechanism, scope, interaction/humanization, flexibility and accessibility, technology dependence, personalization and adaptability, and limitations/motivators.

The collection of conceptual data was conducted by searching a scientific database using the query pattern "concept x can be defined as". For example, to collect data on conceptual definitions of "learning", the response pattern "learning

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can be defined as" was used. Data to identify differences and similarities was collected using two artificial intelligences: ChatGPT and Gemini. The procedure adopted was to ask each one to list all studies that presented at least two of the nine comparative aspects. The lists of the two studies were compared. Those studies that coincided were separated, while the remaining items on the lists were analyzed individually to certify their suitability for data collection. Most non-coincident studies were discarded, and only two coincident studies were excluded because they lacked a DOI or did not meet the inclusion criteria.

3.5 Data Analysis and Organization

The conceptual data were divided into equivalence terms and attributes, according to Nascimento-e-Silva's (2023) recommendations. The equivalence terms were grouped on the right side of a double-entry table, placing all authors and bibliographic publication dates in the left column. The equivalence terms indicate the approaches used in the studies and demarcate how the phenomenon was addressed, so that their sum represents the conceptual scope already mapped by science. The attributes were also organized in the same way, with the difference that they are more numerous and give meaning to the delimitation that the approach represents.

The data on similarities and differences were also divided into nine analytical aspects and organized in a five-column table: the first column shows the analytical criteria, and the remaining columns show each type of learning. Each aspect was recorded in the table in a way that allows one to perceive both their similarities and their differences. For example, for the aspect "flexibility and accessibility," the records sought to categorize the degree of flexibility as "very flexible," "flexible," and "not very flexible."

3.6 Generation, Presentation, and Interpretation of Results

The results were presented in the first part of the research results section, where the data in each summary table are shown and described (i.e., the empirical evidence). Results were generated by writing the answer to each

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guiding question of the research, which is presented in the discussion section of the results. The interpretation was based on comparing the empirical findings with the study architecture, which explains what the answers mean. This strategy was defined to facilitate understanding of the proposed conceptual definition of technological learning, which constituted the study's general objective.

4. Results and Discussion

To better understand the construction of the conceptual definition for technological learning, in line with the conceptual definition of technological education (Gadelha; Nascimento-e-Silva, 2025b), the research results will be presented in the following order: first, the approaches to different learning modalities will be presented, starting with general human learning and continuing with learning of a technological nature; then a comparison of the most salient similarities and differences of the different technology-supported learning is made; and, in the discussion of the results, the conceptual definition for technological learning is presented.

4.1 Approaches to Learning

Two approaches to learning predominate in the literature. The first is process (Earnest; Fitchett, 2025; Jumiati, 2025; Supriatna; Arifudin; Kartika, 2026; Tanvir; Zafar; Alimirza, 2025; Tyas et al., 2025; Umarella et al., 2025; Deswita, 2025; Azhura; Lestari; Wahyuni, 2025; Samsudin; Purnawan, 2025). This conception views learning as a sequence of interactive steps, organized and executed by teachers and instructors, that seek to provoke changes in student behavior through the acquisition of new knowledge, skills, and attitudes, as well as modifications to existing knowledge. The stages of this process consist of stimuli and reactions to situations and new experiences and practices (Jumiati, 2025; Supriatna et al., 2026; Azhura et al., 2025), it is continuous and lifelong (Tanvir et al., 2025), it is communicational between students and teachers, of mutual influence and multiple forms (Tyas et al., 2025; Deswita, 2025; Umarella et al.,

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2025), it fosters creative thinking and improves skills and reasoning (Samsudin; Purnawan, 2025), and the lessons to students are based on learning theories and educational principles (Inayati; Pratiwi, 2025) aimed at the acquisition of knowledge (Earnest; Fitchett, 2025). Table 2 summarizes the literature on approaches to learning.

Table 2. Approaches to learning

References	Approaches
Earnest; Fitchett (2025); Jumiati (2025); Supriatna et al. (2026); Tanvir et al. (2025); Tyas et al. (2025); Umarella et al. (2025); Deswita (2025); Azhura et al. (2025); Samsudin; Purnawan (2025)	Process
Nabiilah et al. (2026); Rudolph; Rothermund (2026); Nji (2025); Muzsnay et al. (2025); Esmailnia et al. (2025); Anand et al. (2025); Bakhurin et al. (2025); Karaelmas (2025)	Change
Hidayat et al. (2025); Nafisa et al. (2025)	Effort
Meidina (2025)	Acquisition
Hani'ah; Azani (2026)	Activity
Ridlo et al. (2026)	Interaction
Inayati; Pratiwi (2025)	Transmission

Fonte: dados coletados pelos autores.

The second predominant approach sees learning as change (Nabiilah; Furoidah; Zainuri, 2026; Rudolph; Rothermund, 2026; Nji, 2025; Muzsnay et al., 2025; Esmailnia; Farsani; Khatin-Zadeh, 2025; Anand et al., 2025; Bakhurin et al., 2025; Karaelmas, 2025). The main focus of the change intended by learning is behavior (Rudolph; Rothermund, 2026; Nabiilah et al., 2026; Nji, 2025; Esmailnia et al., 2025; Karaelmas, 2025), as well as knowledge, understanding, and skill (Muzsnay et al., 2025), memory (Anand et al., 2025), and synaptic plasticity (Bakhurin et al., 2025). What triggers the desired changes are environmental interaction (Nabiilah et al., 2026), quick, efficient, and appropriate responses to situations (Rudolph; Rothermund, 2026), reinforced practice (Esmailnia et al., 2025), experience, practice, and instruction (Muzsnay et al., 2025), and practical experiences performed (Nji, 2025). The behavioral change sought results from cognitive and metacognitive processes (Muzsnay et al., 2025) that occur in the long term (Karaelmas, 2025; Anand et al., 2025; Bakhurin et al., 2025).

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Four other less frequent approaches to learning were found: interaction (Ridlo et al., 2026), effort (Nafisa; Utami; Wijaya, 2025; Hidayat et al., 2025), activity (Hani'ah; Azani, 2026), and acquisition (Meidina, 2025). Learning is seen as the acquisition of knowledge achieved through reasoning; activity is considered learning when it produces new knowledge through the execution of new experiences; it is interaction when students and teachers jointly use learning resources in learning environments; And it is effort when the teacher, facilitator, or student consciously works on changing behaviors in the long term, with the help and facilitation of the learning process.

4.2 Approaches to Digital Learning

The literature review presented a wide variety of approaches to digital learning. The predominant conception is that digital learning is learning in several aspects, such as technology-supported learning, found in the study by Rashdan et al. (2025), in which technology is only support; facilitated learning (Blake et al., 2025), in which electronic technology enables and mediates learning, worked from training, learning and content development; learning supported by digital technologies (Lilian, 2022; Ivenicki, 2024), which makes the time, place and pace of learning more flexible, carried out from various approaches, both in a hybrid and online way; and online learning and e-learning (Azhar; Javed, 2024), which uses digital technologies and the internet to improve student performance and the learning process.

Digital learning as a process is an approach described in the studies of Utomo et al. (2024) and Azzahra et al. (2024), characterized by the use of digital tools and technologies across its various stages to facilitate and improve the effectiveness of the teaching-learning relationship. Digital learning as a system was also another approach that appeared twice, consistent in the studies of Ramadhan et al. (2025) and Kareti, Rajpoot and Ramar (2024), in which the system inputs are information, digitally processed in various ways, whose intended results are the internalization of so-called traditional knowledge aided by the system (Kareti et al., 2024), materialized from the support for active learning

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and knowledge construction through digital investigation and exploration (Ramadhan et al., 2025). Finally, digital learning is also addressed in the literature as the use of information and communication technologies to support learning at various stages of the process, as seen in Stalmach et al.'s (2025) study. Table 3 shows all the approaches to digital learning found in the literature review.

Table 3. Approaches to digital learning

References	Approaches
Rashdan et al. (2025) ; Blake et al. (2025); Kummer et al. (2022); Devisakti; Muftahu (2023); Lilian (2022); Ivenicki (2024)	Learning
Utomo et al. (2024); Azzahra et al. (2024)	Process
Ramadhan et al. (2025); Kareti et al. (2024)	System
Kareem; Venkatesh (2025)	Attitudes
Ulfatin et al. (2022)	Integration
Nasreen; Afzal (2023)	Methods
Alkhdour et al. (2025)	Platform
Ismail; Ling (2025)	Practice
Stalmach et al. (2025)	Use

Fonte: dados coletados pelos autores.

Six other approaches to digital learning were found, appearing only once in the literature review. Attitudes are considered digital learning because student engagement in online classes allows for success in assessments and exams, ethical compliance, and overcoming the challenges associated with online learning (Kareem; Venkatesh, 2025). “Method” was another approach found to designate the different stages and criteria for achieving the intended learning, where technology serves as support that allows students greater control over the pace, timing, location, and other aspects of learning (Nasreen; Afzal, 2023). The study by Ulfatin et al. (2022) considers digital learning as an integration, in which various digital technologies can cover all aspects of the desired learning. Platform was another approach identified, a technological resource through which students can obtain the desired knowledge and access it via mobile devices (Alkhdour et al., 2025). Educational practice is also an approach to digital learning because it

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incorporates digital tools, platforms, and resources used throughout each stage of the learning process, allowing students to both support and enhance the various planned learning experiences (Ismail; Ling, 2025).

4.3 Approaches to Technology-Enhanced Learning (TEL)

TEL has presented only four conceptual approaches. The most common approach was the "use" of information and communication technologies to facilitate the delivery of educational content, as seen in the study by Habib et al. (2025), and the "use" of computers and other digital technologies to offer courses and training in different modes and formats, such as online courses, offline content, and blended learning modalities, so that students can achieve the intended learning (Alshammari, 2023). The study by Abu Arqub et al. (2024) presents the “application” approach to technology-enhanced learning, which is semantically similar to the ICT and computer use approach. It aims to provide educational content through numerous resources, including computers, mobile devices, virtual reality, virtual learning environments, various software applications, and videos. Table 4 summarizes these findings.

Table 4. Approaches to technology-enhanced learning (TEL)

References	Approaches
Habib et al. (2025); Alshammari (2023)	Use of technologies
Abu Arqub et al. (2024)	Application of technologies
Triarisanti et al. (2022)	Learning approach
Kurent; Avsec (2025)	Ability to understand and apply ICT

Fonte: dados coletados pelos autores.

Two other studies differ from the approaches to applying and using technology-enhanced learning: the one by Triarisanti, Lubis, and Ansas (2022) considers TEL simply as an enhanced instructional approach because it represents the use of various digital technologies aimed at improving teaching and learning, while the one by Kurent and Avsec (2025) understands this learning as

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the ability to understand and apply technological principles to develop solutions and communication.

4.4 Approaches to e-learning

There is a wide variety of approaches to e-learning in the scientific literature. The most common is seen simply as an approach, whether it is about learning (Hadi, 2025), the teaching-learning relationship it constitutes (Ahmed et al., 2025), or the innovative form it takes (Fariza et al., 2025). E-learning as learning is characterized by the use of digital media (Hadi, 2025); The teaching-learning relationship perceives e-learning as the facilitation that new ways of understanding and developing learning provide, which has improved access to training, communication and interaction around the world (Ahmed et al. (2025); and the vision of innovation stems from the wide variety of possibilities for distributing instruction to diverse audiences, in a well-developed, interactive and student-centered way.

The second most frequent approach sees e-learning as the use of either the internet (Handayani et al., 2025) or various technologies (Mostefai et al., 2025; Rohlupuia et al., 2025). The available web-based technologies and the internet have provided fundamental support to the learning process (Handayani et al., 2025), providing the learning resources found in the various programs and projects of the most diverse types of courses and educational levels (Mostefai et al., 2025), so that the use of technologies and digital media has made e-learning a systematic teaching, learning, and assessment capable of enhancing and improving any educational system.

The third most frequent approach found was the learning method. There is the e-learning approach as a collaborative form of learning, with the use of technology in remote, virtual learning or in information innovations, whose purpose is to improve learning (Nair; Nair; Chellasamy, 2025), as well as a new form of learning, which uses digital devices and various electronic means as vehicles and supports for the teaching-learning process, which is independent of whether the classes will be remote or face-to-face (Gil-Alana; Alvarez-Santas,

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2025). This approach is interesting because it places e-learning on the same level as any other learning modality, so that the use of electronic and digital resources is just another way, with its strengths and weaknesses, to carry out learning. Table 5 shows the different approaches to e-learning found in the literature review.

Table 5. Approaches to e-learning

References	Approaches
Hadi (2025); Ahmed et al. (2025); Fariza et al. (2025)	Learning approach
Handayani et al. (2025); Mostefai et al. (2025); Rohlupuia et al. (2025)	Use of technologies
Gil-Alana; Álvarez-Santas (2025); Nair et al. (2025)	Learning method
Juidette; Zraiouil (2025)	Learning
Shaarani et al. (2025)	Learning process
Amin; Rattanawiboonsom (2025)	Knowledge acquisition
Oulamine et al. (2025)	Provision of materials
Janković et al. (2025)	Inclusion of teaching methods
Angrayni; Panjaitan (2025)	Educational method
Magwa et al. (2025)	Learning offer

Fonte: dados coletados pelos autores.

The fourth approach conceives of e-learning as both learning and acquisition. The conception of learning views it as any other type of learning, with the difference residing in the heavy reliance on technological devices (Juidette; Zraiouil, 2025), whereas the other types are less intensive in this regard. The e-learning acquisition approach holds that information and communication technologies facilitate learning acquisition (Shaarani et al., 2025). Both acquisition (the product of learning) and acquisition (the set of activities and steps) are facilitated by the use of technologies, according to these two approaches, which is very similar to the acquisition approach, which sees e-learning as a means from which knowledge and skills can be acquired, consisting of information and instruction pathways mediated by education professionals, with the internet often replacing traditional teaching and complementing it (Amin; Rattanawiboonsom, 2025). Four other approaches were also found with only one frequency. The first

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view understands e-learning as the provision of materials through different media, such as the internet, intranet, extranet, satellite transmission, and audio and video systems, among others (Oulamine et al., 2025). The second view considers it as the "inclusion" of all forms of teaching and learning carried out through the internet, using a personal computer or smartphone (Janković et al., 2025). The third view sees e-learning as an educational method based on technologies, both for the transmission of knowledge and for facilitating the learning process and, essentially, for improving the performance of students and teachers (Angrayni; Panjaitan, 2025). The fourth and final interpretation of e-learning is the delivery of learning through training or a formal education system, with the fundamental difference that it is carried out via electronic means, applications, and digital platforms.

4.5 Approaches to Online Learning

Twelve distinct approaches to the phenomenon of online learning were identified and grouped into four based on semantic affinities. The first group was termed application because it designates the effort to use online technologies to achieve learning objectives, as shown in the study by Yıldız, Yılmaz, and Horzum (2025). The use of technologies and electronic media for online learning is found in the studies by Belhekar (2024) and Rashid et al. (2024), functioning as a scheme for supplying, supporting, and enhancing teaching and learning through various resources made available electronically, which allow communication between students and teachers and the handling of online materials. Also, in terms of use and application, online learning is a pedagogical practice that allows students to receive instruction through platforms, multimedia tools, and the internet (Rawi et al., 2024). The fourth approach of this group is as a learning experience supported by technological tools and the internet as an effort to improve teaching and learning (Martins et al., 2024); the experience is also conceived as an instructional method operationalized by student and instructor or student and colleagues, through the handling of digital media, at the same time

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from different locations, for the use of various types of teaching materials (Michikyan et al., 2025).

The second semantic group was named form because it encompasses two approaches that are very close both practically and semantically. The first conceives of online learning as a form of distance education, as does e-learning, which is characterized by the availability of various types of teaching materials and resources through the internet, both synchronously and asynchronously (Hariyanto; Setiawan; Samsudin, 2025). The second is a different form of education, delivered and facilitated by the internet, in which students, teachers, and instructors participate in educational activities interactively, so that the learning of certain content takes place, as well as the carrying out of assessments, all via a digital platform (Henry et al., 2024). Table 6 shows the approaches and the semantic groups created.

Table 6. Approaches to online learning

References	Approaches	Semantic groups
Yıldız et al. (2025)	Application of technologies	Application
Belhekar (2024); Rashid et al. (2024)	Use of technologies and media	
Rawi et al. (2024)	Practice of receiving instruction	
Michikyan et al. (2025); Martins et al. (2024)	Learning experience	
Hariyanto et al. (2025)	Distance Learning Form	Form
Henry et al. (2024)	Education Form	
Yuliyanto et al. (2024)	Learning Method	Method
Ntlhakana; Alli (2024)	Education Method	
Mardiana (2024)	Teaching Method	
Alhumsi (2024)	Educational Approach	Other approaches
Abdulrahman et al. (2025)	Learning	
Karaca; Akyüz (2024)	Access to Experiences	

Source: data collected by the authors.

The third semantic group brings together three approaches that see online learning as a method. The study by Yuliyanto et al. (2024) considers it a learning method carried out through the internet and which develops through the

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performance of studies through platforms; the second conception is as a method of education done virtually, with the use of technologies and electronic media (Ntlhakana; Alli, 2024); and the third is as a teaching method that uses electronic devices and tools capable of supporting the various interactions between teachers and their students throughout the entire educational process (Mardiana, 2024). This grouping presents online learning as a fundamental component of technological education, operationalized through technological learning and teaching.

The fourth semantic group brought together the other three approaches found. Alhumsi's study (2024) conceives online learning as an educational approach in which students and teachers, geographically and temporally distant, interact and participate in a variety of activities through the facilitation of personal computers and the internet, for communication and the provision of pedagogical materials; the approach consistent in the study by Karaca and Akyüz (2024) is that online learning is access to learning experiences through technologies, while Abdulrahman et al. (2025) considers it learning done via the internet, synchronously or asynchronously, in which students and instructors interact, regardless of time and place.

4.6 Discussion of results

Online learning is understood in recent scientific literature as the educational process in which teaching and learning experiences are designed primarily to occur through digital technologies and the internet. The content, teaching activities, and interactions between teachers and students are mediated by virtual platforms, which may include synchronous and asynchronous formats, aiming to offer spatial and temporal flexibility to the student in accessing and constructing knowledge (Meng et al., 2024; Montenegro Rueda et al., 2024; Masalimova et al., 2024). Systematic studies such as that of Meng et al. (2024) highlight that online learning consists of a systemic set of pedagogies, technologies, and integrated processes designed to promote the transfer of knowledge and skills in well-structured virtual environments, where

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communication mediated by digital tools and learner autonomy are fundamental for engagement and success in learning. The literature also emphasizes that, although the effectiveness of this modality varies according to infrastructure, teaching support, and student characteristics, online learning has become established as an essential educational strategy in global higher education because it expands access to knowledge and offers multiple forms of interaction, collaboration, and personalization of learning (Montenegro Rueda et al., 2024; Masalimova et al., 2024).

In turn, e-learning, also called electronic learning, can be defined as an educational modality mediated by digital technologies and electronic communication systems that enables the delivery, interaction, and management of the learning process in virtual environments. It integrates pedagogical, technological, and organizational aspects to facilitate access to content, activities, and learning experiences in a flexible, contextually relevant way to contemporary reality (Martinez-Garcia; Horrach-Rosselló; Mulet-Forteza, 2023; Shraih; Santos-Roldán; Maldonado, 2025). E-learning is not limited to the transmission of content via the internet but also involves instructional design strategies, interactivity, and learner self-regulation, as well as dimensions related to the effectiveness of pedagogical approaches across various educational contexts, highlighting learning outcomes, engagement strategies, and learning regulation (Martinez-Garcia et al., 2023). Studies such as those of Shraih et al. (2025) emphasize that quality management in e-learning environments encompasses factors such as technological infrastructure, student satisfaction, institutional readiness, and instructor-learner relationships to ensure effective and sustainable educational experiences at higher education levels.

Digital Technology Education (DTE) is a field of educational research and practice focused on the intentional use of digital technologies to enhance, support, and transform teaching and learning. It encompasses more than simply replacing traditional practices with digital tools: it provides richer, more interactive, personalized, and cognitively powerful learning experiences, as shown in studies by Sailer et al. (2024), Nurfadilah, Nurlina, and Bancong (2025), and Daniela

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(2025). Systematic studies and meta-analyses have demonstrated that the impact of DTE is mediated by how technologies facilitate specific learning activities, such as feedback, cognitive support, and the design of constructive activities, rather than by their mere presence (Sailer et al., 2024). Recent research also highlights that TEL incorporates a diverse range of technological artifacts, including adaptive platforms, learning analytics, Artificial Intelligence, virtual reality, and immersive environments, which, when integrated into effective pedagogical practices, promote greater engagement, learner autonomy, and improved learning outcomes (Nurfadilah et al., 2025; Daniela, 2025).

Finally, digital learning can be conceptualized as an educational process in which digital information and communication technologies are fully integrated into the teaching and learning environment, not only as isolated tools, but as elements that transform, expand, and reconfigure traditional pedagogical practices. This learning promotes accessibility, engagement, personalization of learning, and methodological innovation (Zou et al., 2025). This modality involves everything from the use of online platforms, artificial intelligence applications, and immersive virtual reality environments to mobile and analytical tools that adapt content to students' individual needs, fostering more dynamic, student-centered experiences. The study by Zou et al. (2025) highlights that digital learning is characterized by more than just the digitization of content, configuring itself as an educational phenomenon that requires robust infrastructure, digital skills from both teachers and learners, and a pedagogical perspective that values instructional design, inclusion, and equity in access to technologies.

The similarities can be summarized as follows: a) all involve digital technology in the learning process, b) seek greater flexibility, accessibility, and global reach, c) promote synchronous and/or asynchronous learning and interaction mediated by digital platforms or tools, and d) aim for personalization and learner autonomy. The differences are as follows: a) online learning focuses specifically on learning via the internet (remote access); b) e-learning is structured in digital environments (usually LMS), and may include more pedagogical resources; c) TEL is a broader concept that doesn't depend solely on online

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environments, as it integrates technology into any pedagogical context to improve learning; and d) digital learning is the broadest term of all. Table 7 presents a comparison between the different learning modalities mediated by technologies.

Table 7. Comparison between the different learning modalities

Aspect	Online Learning	E-learning	TEL	Digital Learning
General Definition	Teaching and learning process via the Internet, with content and activities accessible remotely.	Teaching mediated by digital technology to provide content and online interaction.	Use of digital technologies to improve and expand learning experiences	Any learning that involves digital technology
Delivery Mechanism	Through the internet, virtual platforms, collaborative environments, and synchronous/asynchronous activities.	Internet and digital systems, generally in structured online environments.	Variable technologies are used to enhance the educational process.	Digital devices, resources, and tools to facilitate learning in diverse contexts.
Scope	Primarily geared towards remote learning.	Technology-mediated learning	Broader than e-learning/online, with technology integrated into pedagogical methods.	Very broad: incorporates any use of digital technology.
Interaction / Humanization	Often high: forums, video conferences, tutoring, and collaboration.	High: structured interaction, teacher support, and digital feedback.	Teacher-student interaction, adaptive tools, and personalized learning.	Interactive or not: it depends on the digital tools used.
Flexibility and Accessibility	Very flexible.	Flexible, with continuous access to content.	Can increase flexibility by integrating diverse devices and resources.	Highly flexible, includes everything from mobile learning to multimedia resources.
Technology Dependence	High: requires connectivity and online platforms.	High: depends on devices and the internet.	Variable: face-to-face or remote	High: learning through digital technology.
Personalization and Adaptability	Moderate: depends on platform tools.	High: many solutions allow for personalized learning paths.	Very high: includes AI, data analysis, adaptive recommendations, etc.	Depends on how the technology is used
Main Pedagogical Focus	Remote access and interaction.	Didactic structuring in a digital environment.	Enhancement of learning with diverse integrated technologies	Application of digital tools in learning
Limitations / Motivators	Inequality of access; need for teacher support and active engagement.	May face infrastructure barriers and challenges in maintaining meaningful human interaction.	Complex pedagogical integration requires specialized teacher training.	Unequal access to tools; risk of superficial adoption of technology without pedagogical impact.

Source: data collected by the authors.

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Online learning is specifically based on the delivery and access to content through the internet and virtual environments, differentiating it from other terms such as e-learning, which may emphasize more the technological aspects of delivery in varied contexts, and from broader terms such as digital learning and technology-enhanced learning, which encompass a wider spectrum of technological integrations (e.g., use of AI, augmented reality, or adaptive systems), not necessarily restricted to continuous mediation via the internet.

E-learning represents an integrative, multimodal, and technology-mediated learning process, focusing on tools, pedagogical effectiveness, and learning outcomes, and articulating technology, curriculum, and educational interactions in a systemic way. In accordance with the comparative framework, its definition shows that it is distinguished by its emphasis on the structure and management of virtual learning environments (VLEs/LMS) when compared to more general online learning (which focuses on the internet as a means of access), broader digital learning (which encompasses all use of technology), and TEL (which can occur in face-to-face and remote contexts). It also highlights its conceptual and practical scope in the contemporary educational landscape, as well as its multiple dimensions of implementation, interaction, and pedagogical quality.

TELE is broader and more integrated than traditional technology-assisted education models because it focuses on the interaction among technology, pedagogical design, and learning activities, and aims to develop innovative educational practices and strengthen 21st-century skills. In accordance with the comparative framework, the scope of TELE extends beyond simple online delivery (focused on the internet context) and differs from e-learning by emphasizing the qualitative improvement of learning experiences through the pedagogical integration of technologies. It also differs from broader digital learning by its explicit emphasis on strategies that enhance cognitive processing in the teaching-learning process, whether face-to-face or remote, by synergistically combining technology, data analysis, and instructional design.

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In accordance with the comparative framework, digital learning shows that it is broader than online learning and e-learning, as it is not limited to the delivery of content over the internet or the use of structured virtual environments; on the contrary, it incorporates an entire ecosystem of digital tools and practices that substantially reconfigure how knowledge is accessed, constructed, and applied in the educational context. Furthermore, it differs from technology-enhanced learning, which generally focuses on how specific technologies improve pedagogical activities. In contrast, digital learning encompasses the systemic transformation of educational processes through technology, including social, cognitive, and organizational aspects of current digital education.

Based on the similarities contained in the comparative table, technological learning can be defined as the process by which the student constructs knowledge, develops skills, and mobilizes their competencies through the intentional mediation of digital technologies, using resources, platforms, devices, and virtual or hybrid environments to access, interact, produce, and share knowledge. This definition stems from the common point among the modalities analyzed: all involve the structured use of digital technologies to support, mediate, and expand learning. However, instead of emphasizing the medium (internet), the environment (LMS), the degree of pedagogical integration (TEL), or the systemic nature of digitization (digital learning), the notion of technological learning focuses on the student's action in relation to technology, understanding them as an active agent who learns with and by technology. It is, therefore, a concept that prioritizes the formative dimension of the student's experience in technologically mediated contexts, emphasizing autonomy, self-regulation, digital literacy, critical thinking, and problem-solving in digital environments.

This definition proposes that technological learning is not the result of exposure to digital content. Still, an active process of cognitive, social, and technical interaction, in which the student interprets information, participates in collaborative activities, uses digital tools to create knowledge, and develops the skills necessary to operate in a digitized society. Technological learning presupposes intentionality, engagement, and student responsibility in the qualified

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use of technologies. Unlike an instrumental perspective, which sees technology only as a tool, this conception recognizes that the technological environment transforms how we think, learn, and communicate. Therefore, technological learning entails knowing how to navigate digital ecosystems, critically evaluate information, adapt to new interfaces, and actively participate in knowledge networks.

In the logical scheme in which technological education = technological teaching + technological learning, technological learning falls on the student's end. While technological teaching corresponds to the organization, mediation, planning, and pedagogical conduct carried out by the teacher with the support of technologies, technological learning refers to the student's internal and external movement as they appropriate these resources to build knowledge. In this sense, technological education becomes a reality only when there is coherence between what the teacher proposes and what the student effectively mobilizes in terms of digital, cognitive, and socio-emotional skills. Technological learning, therefore, is not passive; it demands proactivity, epistemological curiosity, and the capacity for continuous adaptation.

The proposed definition also allows us to understand that technological learning transcends specific modalities. It can occur in face-to-face, hybrid, or entirely online contexts if there is significant digital mediation. This means the focus is not on the course format but on the quality of the student's interaction with technologies and other subjects in the educational process. A face-to-face environment that uses digital simulations, virtual laboratories, or data analysis can also promote technological learning if students develop the skills to use these tools critically and productively. Another central aspect of this definition is the notion of integrated digital competence, since technological learning involves not only technical skills (such as operating platforms and using software), but also informational skills (such as searching, selecting, and validating data), communicational skills (interacting ethically in digital environments), creative skills (producing multimodal content), and strategic skills (self-regulating one's own

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learning process). It is, therefore, a complex and multidimensional learning process that articulates cognitive, technical, and ethical knowledge.

When considering student responsibility, technological learning also implies autonomy and self-regulation. Students need to manage time, attention, and study strategies in environments often marked by multiple stimuli and distractions. Technological learning requires academic maturity and critical awareness of technology use, since it is not enough to be connected: it is necessary to know how to learn in a network. This distinction reinforces that simple access to technology does not guarantee effective technological learning.

The proposed definition also aligns with the principle of formative co-responsibility. If technological teaching structures the pedagogical conditions, technological learning is the student's active response to them. There is, therefore, a dialogical relationship: the teacher creates experiences mediated by technology; the student transforms them into knowledge through engagement and reflective practice. Without this dynamic interaction, technological education remains incomplete. Additionally, technological learning incorporates the social dimension of knowledge construction, as learning often occurs in collaborative networks, forums, virtual communities, and shared projects in digital environments. Students learn not only individually but also through peer interaction, using digital tools to co-create solutions and broaden perspectives. This characteristic reinforces the idea that technological learning also involves participation in digital learning ecosystems.

On an epistemological level, technological learning marks a paradigm shift in how knowledge is produced and accessed. Information is no longer restricted to linear, centralized sources: it circulates through dynamic networks. When learning technology, students need to develop skills to manage the informational complexity it entails. Thus, technological learning involves discernment, critical analysis, and the ability to synthesize information in data-saturated digital contexts.

Finally, the proposed definition integrates the similarities observed across the analyzed modalities (digital technology, platform-mediated mediation,

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flexibility, interaction, and personalization). Still, it reorganizes them from the learner's perspective. In this way, technological learning constitutes the student dimension of technological education, complemented by technological teaching in the teacher dimension. Together, these two components form a coherent system in which technology, pedagogy, and student protagonism converge to promote formative experiences aligned with the demands of contemporary society.

5. Conclusion

This study presented a proposed conceptual definition of human technological learning grounded in online, e-learning, digital, and technology-enhanced learning. It was identified that these modalities share common elements (technological mediation, spatio-temporal flexibility, digital interaction, potential for personalization, and the need for digital skills) that enable a definition that transcends fragmented categories and emphasizes the student's active role in constructing knowledge through technology. Thus, technological learning can be understood as the process by which students mobilize cognitive, digital, and socio-emotional skills to learn in technology-mediated environments, transforming digital resources into effective instruments for intellectual and formative development. This definition emphasizes the centrality of student action, considers pedagogical mediation, and organizes the field conceptually from a systemic perspective, articulating technology, pedagogy, and student protagonism. By integrating the similarities of different approaches, the proposal contributes to reducing terminological ambiguities and strengthening a more cohesive conceptual basis for research, public policies, and educational practices. In this way, technological learning comes to be understood not only as the use of digital tools but as an intentional, critical, and transformative process of knowledge construction in digital contexts.

However, implementing this proposal faces significant challenges. Among them are inequalities in access to technological infrastructure, insufficient teacher training in technological education, and limited digital skills among some students. Consolidating technological learning requires investments in connectivity,

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equipment, secure and accessible platforms, and institutional policies that promote digital inclusion. Another challenge lies in overcoming an instrumental view of technology, still present in many educational contexts, which reduces digital use to the mere replacement of traditional practices. For technological learning to materialize, it is necessary to develop a pedagogical culture oriented towards innovation, collaboration, and critical thinking. On the other hand, the opportunities are equally significant: increased access to education, curricular flexibility, personalization of learning paths, use of data analysis for formative monitoring, and development of skills aligned with the demands of the 21st century. The coherent integration between technological education (teacher responsibility) and technological learning (student responsibility) can enhance educational experiences that are more dynamic, inclusive, and adaptable to contemporary realities.

Regarding socioeconomic vulnerability, this definition's applicability holds significant transformative potential. By recognizing that technological learning involves the development of digital, informational, and critical skills, a formative foundation is created that enhances employability, autonomy, and the capacity for active participation in the digital society. When implemented alongside equity policies, such as device provision, free internet access, continuing education, and pedagogical support, this concept can help reduce structural inequalities, enabling students from socially vulnerable backgrounds to access educational and professional opportunities previously restricted to privileged groups. Furthermore, technological learning strengthens an individual's capacity for lifelong learning, broadening the horizons of social mobility by promoting autonomy and self-regulation. However, it is crucial to recognize that technology, in isolation, does not eliminate inequalities; it must be integrated into an educational project committed to social justice, inclusion, and human development. Thus, the proposed definition not only conceptually organizes the field of technology-based learning but also offers a foundation for educational policies that can mitigate vulnerabilities and promote a more democratic and transformative education.

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