

5. ICTs in Learning

Education has long been considered the privileged link that connects cultural integration, social mobility, and productive development. However, educational models and the content of today's curricula have been criticized because, in essence, they were designed to meet the demands of a society very different from the knowledge society.

We live in a time of major technological transformations that profoundly change human relationships, in which access to and the generation of knowledge are becoming the drivers of development. New generations experience the pervasive presence of digital technologies, which mediate many of their experiences and may be changing their cognitive skills.

Educational institutions face the need to innovate their teaching methods if they wish to engage and inspire younger generations. It is essential to prepare students to thrive in the knowledge society. The emergence of these new ways of learning challenges efforts to develop responses to the challenges facing societies and education systems, including the definition of learning codes, content, and guidelines.

The use of technology in education can aim to develop individuals' cognitive abilities; it can also focus on collaborative, networked work to foster participation and cooperation; it can seek to develop a skilled workforce capable of promoting innovation and technological projects, enabling countries to compete in the knowledge economy; or it can simply respond to the widespread demand among schoolchildren, young people, and adults for knowledge of the computing resources they use.

ICT applications are varied and can be found, first, in higher education and vocational training, where e-learning (or even *blended learning*) plays a prominent role; second, in basic education, where they are used primarily as tools for teaching specific school subjects and as resources for creating new learning environments; and finally, in special education, where the use of computing resources offers enormous potential to extend and enhance learners' abilities.

Introducing ICTs into classrooms encourages the development of new educational practices and highlights the need to redefine roles, especially those of students and teachers. This can enable students to become more autonomous and responsible in the learning process

, requiring teachers to move beyond their traditional role as the sole source of knowledge.

Various studies aiming to characterize the generations of young people who grew up accustomed to living with new technologies refer to them as “new millennium learners,” “the Net generation,” “the gamer generation,” “homo zappiens,” among other terms. Francesc Pedró [24] defines the new millennium learner as someone who is adept with computers, creative with technology, and, above all, accustomed to multitasking.

Along the same lines, ICTs offer opportunities to monitor each student's learning, as well as the performance of teachers, institutions, and education systems. In this new social, economic, political, and cultural context of the Information Society (IS)—made possible to a large extent by ICTs and other technological developments that have taken place since the second half of the 20th century—knowledge has become the most valuable commodity of all, and education and training have become the means of producing and acquiring it [25].

In this context, education is no longer viewed solely as an instrument for promoting people's development, socialization, and enculturation, as a means of building national identity, or as a way to foster citizenship. It takes on a new dimension: it becomes a fundamental driver of economic and social development.

5.1. Brain Changes: The Immersion of ICTs

As García Carrasco and Juanes Méndez [26] explain, humanity has undergone three major contingencies throughout its cultural history. The first was delving into the understanding of events through the mental functions exercised by speech; the second was deepening understanding through the practices made possible by reading and writing; while the third, the current challenge, consists of extending understanding through the production of meaning made possible in the context of knowledge sciences and technologies.

Literacy and ICTs serve the activities of thought, which is regarded as a “very complex thing” or, equivalently, “a faculty, a power” [26]. Among the functions that constitute thought, Pérez, cited in [26], outlines the following: sensations, attention, memory, imagination, consciousness, the freedom to make decisions or change the course of actions, emotions, and motivation.

The significance of writing, orality, and ICTs emerges when they are integrated as instruments in shaping the activity of the aforementioned functions. These functions are primary; they are neither created nor determined, but have come to us through evolutionary histories [27].

Likewise, ICTs are also instruments that enable observation of the brain's structure and, consequently, play a role in the general applications of instruments and their incorporation into mental functions. García Carrasco and Juanes Méndez point out that they open up a new field of research through which to test the effectiveness of changes produced by instrument-mediated actions.

Human beings do not merely use instruments; they employ them as mediating components and as integral elements of competencies when planning and carrying out actions, with the instrument integrated as a systemic component. “Latent abilities” refer to the potential of the structure when instrumental mediation is introduced through its creative capacity. This mediation enables genuine functional innovations—that is, the reshaping of the brain.

ICTs constitute a human technological system with the power to modify the living environment [26], because they create a context for human practice, have not only the fastest rate of evolution but also a global reach, and are a source of changes in brain activity. Quoting Small [28]: *“the current explosion of digital technology is not only changing the way we live and communicate, but is also rapidly and profoundly altering our brains. Daily exposure to high technology [...] stimulates changes in neural pathways and the activation of neurotransmitters, gradually strengthening new neural pathways in the brain while old ones weaken...”*.

Based on the insights provided by neuroscience, it is reasonable to say that the brain is affected by all changes in the cultural environment, because living and participating in these environments involves activating patterns of brain activity that can guide behavior. The senses limit the brain's properties, leading to experiences such as seeing, hearing, and feeling. Whenever an organism behaves or changes its behavior, whether in response to the external or internal environment, it does so because the brain has generated organized patterns of activity or changed the patterns it had previously established [29].

Looking back to 2009, Small states in his book *iBrain* that both the Internet and Web 2.0 technologies have changed our brains in terms of neural connections and, of course, culturally. Those most exposed to the digital world are adolescents, whose brains have evolved, developing new abilities such as the capacity for synthesis and mitigating age-related decline, but losing other abilities such as reflection, concentration, and social skills.

These changes have occurred very rapidly, leading Small to suggest that we are witnessing the most impressive and rapid evolutionary process

in our history. This makes it extremely difficult for parents and teachers to understand young people, because, in addition to generational differences, they are encountering brains programmed to carry out different activities and understand their reality in a different way. The following subsection will provide examples of the opportunities offered by technology, highlighting its neuroscientific aspects.

5.2. Opportunities Emerging from Technology

Education is part of this environment, and educational practices are where the inclusion of ICTs offers an opportunity for cultural change. Teachers must accompany students as they learn how to learn and serve as learning facilitators to support students' development.

The mediating capacity of ICTs as psychological tools is a potential that is realized to a greater or lesser extent in classroom educational practices, depending on how participants use them. The widespread introduction of technological tools such as laptops and virtual reality into classroom practices, along with new teaching strategies that use them, shapes various cognitive processes (attention, memory, executive functions) [25] in learners during the learning process.

Through ICTs, images can be easily incorporated into teaching and improve students' retention. Likewise, teachers can explain complex instructions more easily, ensuring that students understand them. They can also create interactive lessons that are more engaging, which could improve student attendance and concentration.

An interactive multimedia program can become a powerful pedagogical and didactic tool that takes advantage of human beings' multisensory capacity. Combining text, graphics, sound, photographs, animations, and videos makes it possible to convey knowledge in a much more natural, vivid, and dynamic way, which is crucial for learning. These resources can help transform students from passive recipients of information into more active participants in their learning process.

ICTs should be an integral part of modern education, enabling educational institutions to fulfill their mission of dissemination and research through their effective use. Computers should go beyond their traditional functions as simple tools for word processing and individual computing, becoming community-use tools that facilitate development