SEVEN
publicações acadêmicas

INTERACTIVE WHITEBOARDS: FROM THE PAST TO THE AGE OF ARTIFICIAL INTELLIGENCE

LOUSAS DIGITAIS DO PASSADO À ERA DA INTELIGÊNCIA ARTIFICIAL

PIZARRAS INTERACTIVAS: DEL PASADO A LA ERA DE LA INTELIGENCIA ARTIFICIAL

https://doi.org/10.56238/sevened2025.030-075

Helen Cristina Minardi Baumgratz[1]

ABSTRACT
This study addresses the use of the digital blackboard as a pedagogical support tool. The digital blackboard provides visually attractive and interactive content that helps maintain student interest, mobilizing different perception channels, such as visual, auditory, and kinesthetic. The role of the teacher in integrating this technological tool into the school environment is emphasized, adapting it to the needs of the students and observing technical and didactic principles. The research highlights the transformation introduced by artificial intelligence and machine learning, outlining a more interactive, personalized future educational landscape in line with the challenges of the 21st century. The study is bibliographic and exploratory, seeking new perspectives for subsequent investigations.

Keywords: Digital Whiteboard. Interactivity. Artificial Intelligence.

RESUMO
Este estudo aborda a utilização da lousa digital como ferramenta de apoio pedagógico. A lousa digital proporciona conteúdo visualmente atrativo e interativo que ajuda a manter o interesse dos alunos, mobilizando diferentes canais de percepção, tais como visual, auditivo e cinestésico. Ressalta-se o papel do docente na integração desta ferramenta tecnológica ao ambiente escolar, adaptando-a às necessidades dos alunos e observando princípios técnicos e didáticos. A pesquisa destaca a transformação introduzida pela inteligência artificial e aprendizado de máquina, esboçando um panorama educacional futuro mais interativo, personalizado e condizente com os desafios do século XXI. O estudo é bibliográfico e exploratório, buscando novas perspectivas para investigações subsequentes.

Palavras-chave: Lousa Digital. Interatividade. Inteligência Artificial.

RESUMEN
Este estudio aborda la utilización de la pizarra digital como herramienta de apoyo pedagógico. La pizarra digital ofrece un contenido visualmente atractivo e interactivo que ayuda a mantener el interés de los alumnos, movilizando diferentes canales de percepción, tales como visual, auditivo y cinestésico. Se destaca el papel del docente en la integración de esta herramienta tecnológica en el entorno escolar, adaptándola a las necesidades de los alumnos y observando principios técnicos y didácticos. La investigación resalta la transformación introducida por la inteligencia artificial y el aprendizaje automático,

[1]Dr. in Education and New Technologies. Colégio Militar de Brasília. E-mail: hminardi@hotmail.com
Orcid: https://orcid.org/0009-0003-8297-7156 Lattes: https://lattes.cnpq.br/2837405224279735

esbozando un panorama educativo futuro más interactivo, personalizado y acorde con los desafíos del siglo XXI. El estudio es bibliográfico y exploratorio, buscando nuevas perspectivas para investigaciones subsiguientes.

Palavras-clave: Pizarra Digital. Interactividad. Inteligencia Artificial.

1 INTRODUCTION

From ancient cave paintings to modern digital resources enhanced by artificial intelligence, the way man communicates and records information has evolved over time. These transformations attest to the human ability to adapt, innovate and seek more effective and comprehensive means of expression and communication.

In the context of education, there is a continuous search for communicative tools that facilitate the visualization and sharing of information, improving the teaching and learning process. Throughout this trajectory, even in the face of technological revolutions, some traditional tools have maintained their relevance, proving to be fundamental in the pedagogical scenario. Among them, the blackboard stands out, being present in classrooms at different levels of education around the world and consolidating itself as an essential symbol in the educational environment.

Although it has evolved over time, it was only in the nineteenth century that the blackboard, as we know it today, began to gain popularity, facilitating the understanding and retention of content, as well as the interaction between teachers and students serving as a bridge between teaching and learning. More than just a tool for writing, the blackboard provides a democratic space, where ideas are shared, debated and collectively constructed.

In the midst of the development of new technologies, digital frames have emerged. These devices, equipped with *touchscreen* technology and integrated with computer systems, represent an evolution of the traditional whiteboard. They reshape the classroom dynamics by organically intertwining digital resources with the pedagogical context, enriching the teaching and learning experience.

In this scenario, artificial intelligence (AI) has emerged as a driving force that amplifies the ability of digital whiteboards to offer adaptive resources. By utilizing data from student interactions, these tools optimize the learning experience, making it more meaningful and engaging. In addition, with advanced voice recognition and natural language processing systems, they facilitate discussions and provide a more active and collaborative participation of students in the educational process.

This combination of technology and pedagogy, powered by artificial intelligence, not only modernizes the teaching environment but also promotes meaningful interaction between students and teachers, making learning more engaging and adapted to the demands of the twenty-first century.

2 TECHNOLOGY AND EDUCATION: THE TRANSFORMATIVE IMPACT OF PROF. ALBERTO MANZI

In 1861 the Italian unification, called *Risorgimento*, was a complex process of integration of the Italian Peninsula composed of several independent states, each with its own characteristics, currency and regional dialects that prevailed to the detriment of a unified language throughout the national territory. According to Silva:

> The question of a common language among the entire Italian peninsula becomes more and more present and with it, a feeling for an independent nation. The process of autonomy between nations in Italy was called *Risorgimento*, a political and social movement that led to Italian independence and unification in 1861. (SILVA, 2022, p. 11 *apud* PARMENTOLA, 2006)

The illiteracy rate was high for the population that depended predominantly on agriculture for subsistence.

> [...] at the time of unification, the percentage of citizens who had a European language other than Italian as their mother tongue did not reach 1% of the population, that is, 80% of the Italian population was made up of illiterate people who had no contact with the written use of the language and 20% did not know Italian. (SILVA, 2022, p.11 *apud* DE MAURO, 1970).

In the camps, students faced difficulties in attending schools due to the agricultural obligations necessary to support the family. The conflict in schedules between work and school became a challenge to the construction of an educational system that would combat illiteracy, especially in rural areas. Another important challenge was the linguistic diversity in the country, as most Italians spoke regional dialects, making it difficult to promote cultural and linguistic unity.

> Italian was still the language of literature and belonged to the higher and more educated layers of society, thus excluding the other classes and the different regions existing in the territory. This difference meant that Italian did not reach all places and all people at the same time, and, as a result, the problem of literacy continued because the dialect was still very present in everyday communication, which made it difficult to introduce this new common language (SILVA, 2022, p.11 *apud* DE MAURO, 1970).

This multifaceted context has shaped the introduction of significant reforms in Italian education. The "Casati Law" in 1859, for example, instituted compulsory two-year education

for children aged six and over, thus becoming the first education law in unified Italy. Subsequently, in 1877, the "Coppino Law" was enacted, which established three years of compulsory basic education, although with exceptions for children in adverse situations that could hinder access to school. Caira argues that:

> In theory, the school presented itself as the most appropriate instrument for the dissemination of the common language the Cazati (1859) and Coppini laws (1877) had determined the principle of compulsory basic education, providing for heavy sanctions for parents who did not send their children to municipal schools if they had not provided them with another form of instruction. (CAIRA, 2009, p.28)

With formal education, in the mid-twentieth century, the literacy level of children and young people increased significantly, allowing them to acquire reading and writing skills. However, educational disparities persisted among older generations, especially among women in rural areas, who did not have the same opportunity to access education. To meet this large-scale challenge, the government turned to television, which at the time was becoming increasingly popular and accessible, presenting the possibility of reaching a wide audience. However, the first educational programs created for television faced difficulties, mainly due to the inexperience of teachers in acting in front of the cameras.

For Gómez (2002, p.66), the lack of an educational strategy for the use of new technologies often leads to the underutilization of their potential. This is because the proper adoption of these technologies by students and teachers does not happen automatically, requiring a conscious and targeted approach.

In addition, in this context of integration between television technology and education, the important role of communicators in creating a more dynamic educational environment is highlighted, ensuring that the needs of students are met.

> In an adequate link between new information technologies and education, the role of professional communicators is multiple. On the one hand, the communicators would be the professionals who would be in charge of the design of the strategies for the production of communicative materials, databases, audiovisual formats and networks for intercommunication, taking into account mainly the communicative characteristics of the potential users-learners. (GOMÉZ, 2002, p.68).

In this way, in 1960, an Italian public broadcaster, in collaboration with the Ministry of Education, managed to overcome the initial challenges by selecting Professor Alberto Manzi. His exceptional pedagogical approaches and unique method, as well as his ability to

communicate, have been incorporated in innovative ways into television technology and have had a transformative impact on the success of the program "It's Never Too Late". His captivating and empathetic communicative style played a key role in breaking down the barriers that many adults faced when learning to read and write, making him an influential figure both as an educator and as a communicator.

Gómez also points out that:

> The triad of communication, education and new technologies summarizes one of the substantive problems of the new millennium. It constitutes a central challenge, not only for communicators and educators concerned with the advancement of telematic and digital technology, and their multiple mutual links, but also for democracy and, of course, for culture, as major processes that contextualize and condition the generation, circulation and consumption of knowledge. (GOMÉZ, 2002, p.57-58).

Entering the homes of millions of Italians and allowing education into their homes, Manzi's story has intertwined with the evolution of distance learning in Italy. Through television, he created a welcoming and encouraging environment, using a paper board mounted on an easel to teach and explain concepts, make demonstrations and create drawings that helped in the understanding of the contents. The whiteboard was an important pedagogical tool in his classes, allowing him to visually interact with viewers and communicate information in a clear manner. His innovative approach to using the blackboard contributed to making his lessons educational and engaging for the audience. Although it was television that was the technology that passively brought images to the homes of countless Italians, it was the blackboard that acted as an active instrument of teaching and learning.

3 BLACKBOARD TECHNOLOGY IN EDUCATION

In remote eras of history, the desire of human beings to communicate led to remarkable advances in the evolution of writing technology that allowed the recording of information permanently. About 40,000 years ago, primitive man used the wall and ceiling of caves to graphically represent and share the activities of his daily life. As Farto, Maciel and Lima emphasize:

> Rock art, cave painting or even rock engraving are terms given to the oldest known artistic representations, the oldest dating from the Upper Paleolithic period (40,000 BC) engraved in shelters or caves, on their walls and rocky ceilings. (PLENTIFUL; M; LIMA, 2013)

Cave paintings were not only artistic manifestations, but also acquired a form of communication and expression that played a cornerstone role in the formation of human identity and in the sharing and preservation of knowledge and culture over generations.

> Before figures of antelopes and mammoths, of running men and fertile women, we scratch traces or stamp the palms of our hands on the walls of our caves to signal our presence, to fill an empty space, to communicate a memory or a warning, to be human for the first time (MANGUEL, 2009, p. 30)

The cave paintings on the walls of the caves represented humanity's rudimentary attempts to preserve memory and establish forms of communication. However, around 2,000 BCE, Mesopotamian civilizations marked the emergence of a highly structured and functional writing system that needed a new sturdy information-bearing medium that could be easily recorded and was widely accessible.

> [...] clay has been used in Mesopotamia since the third millennium BC; the characters were traced on clay plates that were still soft and damp, by means of a triangular instrument; That is why the writing of the Sumerians and the Assyrians has the form of a wedge (cuneiform script) [...] (LABARRE, 1981, p. 8)

Made from natural material, the clay tablets made it possible to record and share information over the generations. Clay was a resource abundantly found in the Mesopotamian region, making it an economical and practical option for the preservation of knowledge.

This writing system remained almost unchanged for almost a thousand years, until papyrus emerged as an alternative. It was produced from the aquatic plant *cyperus papyrus* that grew in the regions of the Nile River delta (Lima and Azeredo, 2006, p.41). Over time, papyrus was replaced by parchment, made from the skin of animals. They were of excellent quality, but had a high cost (Abreu, 2017, p. 16). According to Katzenstein (1986, p.179), the parchment, whose Latin word is "*pergaminu*," may have been invented in the city of Pergamon in the second century B.C. However, it is important to note that there is still no scientific evidence to confirm its veracity.

Finally, in the second century A.D., the Chinese Tsai Lun developed the technique of making paper using fibers from materials such as silk. As manufacturing techniques improved, manufacturers began to explore other sources of fiber for the production of paper. According to Teixeira *et al*:

> The role as it is known today emerged around 105 AD (second century) in China, and historians attribute the invention to the Chinese Ts'aiLun. The manufacturing process was carried out by cooking non-woody vegetable fibers [...] (TEIXEIRA *et al.*, 2017, p. 1368)

After the invention of paper, its use spread throughout Europe between the thirteenth and fifteenth centuries (Dias, 1999, p. 270). Over time, they discovered that pulp was an excellent source of raw material because it was a viable, economical and accessible option for large-scale production and thus meet the demands of the whole world. In this way, paper supported writing and replaced the use of clay tablets, parchment, and papyrus, representing a considerable advance in the way of recording and sharing information.

However, for millennia, replication of records was limited to manual word-for-word copying, restricting access to information to a small group of people. Only after the invention of the printing press by Gutenberg, in the sixteenth century, was it possible to reproduce and propagate texts en masse through newspapers, magazines and books, allowing people from all spheres of society to have access to reading and writing. According to Chagas, Linhares and Ribeiro (2012, p.466), "this would indeed be Gutenberg's revolution, of making it possible to reproduce on a larger scale, lowering the costs of the book and making them accessible."

In this way, writing, the invention of paper, the development of the printing press and the emergence of mass media led to the growth and democratization of literacy and education, an essential part of human life. Without it, each generation would be deprived of the information, skills, and abilities needed to meet the daily challenges and progress of society.

The ability of the human species to organize, store, and share knowledge through oral and written languages has built a solid foundation for the advancement of formal education, which has evolved over the centuries, from the first schools of ancient Greece to contemporary educational institutions, providing a structured environment for students to learn. Clay tablets, papyrus, parchments and more recently paper were important educational tools that supported learning. However, teachers faced the challenge of visually presenting the lessons to reach students as a whole.

In 1800, James Pillans, principal and geography teacher at the Old High School in Edinburgh, Scotland, came up with a seemingly simple solution to this problem by hanging a large piece of slate on the classroom wall.

> It was the brilliant teacher James Pillans who hung a large piece of slate on the wall of the classroom and wrote it in chalk for all to read, to the amazement and admiration of everyone. Prof. James was principal and geography teacher at the Old High School in Edinburgh, Scotland, in 1801, when he invented what we know today as a chalk writing blackboard. (VOLKER, 2020, p.34).

In the United States of America, in 1801, George Baron, a professor at the Military Academy at West Point, was one of the first to use the blackboard in his mathematics classes (REBELO; BARRETO, 2014, P.22). The popularity of the chalkboard grew rapidly, and it became the center of almost every classroom in the United States. It was a versatile tool for teachers, functioning as a book when filled in and a blank page when erased. In addition, it served as an effective focal point for keeping students' attention. This allowed for visual illustrations, making the teaching process more engaging (Domingues, 2015).

Originally, the frames were often made of wood painted dark colors, and the white chalk paint contrasted with the dark background. However, this all-black surface often caused annoying glare and reflections, impairing visibility in well-lit classrooms. To solve this problem, in 1930 paintings with a green porcelain surface were introduced, which helped to reduce glare and improve the visibility of information written or drawn with chalk, making it more comfortable for the human eye to perceive throughout the work.

Chalk is a porous and brittle artifact usually made of plaster and produced in the form of white or colored cylinders, widely used to create visible marks on slates that could be erased and rewritten as needed. However, this process released small dust particles into the air, which could be harmful to health.

In response to educators' concerns about the problems associated with the use of school chalk, whiteboards made of wood and coated with a layer of synthetic melamine resin, a type of thermoset plastic that allows the use of special markers in place of chalk, emerged. However, with continued use, the surface of these paintings wore away, and the ink on the markers became difficult to erase. In this context, the magnetic whiteboard appeared in the 1970s and in the following decade, they became popular in meetings and presentations, and in the 90s, they began to be more common in classrooms (MILLER, 2013).

Made from ferrous materials, the whiteboard made it possible to use special pens that did not cause stains like the marker on melamine boards. In addition, the magnetic surface allowed the attachment of magnets and other accessories that could be easily moved and

repositioned on the surface of the board, which could make learning more interactive and visually appealing.

White slates have evolved over time, offering a variety of material options to choose from. Ceramic slates are known for their strength and ease of cleaning, while glass slates offer a modern look, durability, and a smooth surface for writing and erasing. The selection of material depends on the needs and context of use, providing the necessary flexibility to meet the specific demands of classrooms and contributing to a more productive learning and collaboration environment.

The turn of the twenty-first century marked the development of new educational technologies with the integration of the functionality of a traditional whiteboard with advanced digital resources, such as sensitive touch, projection capacity and connectivity with computers. Fagundes (2008, p. 8) states that "the interactive digital whiteboard is a presentation tool with a modern and innovative technology that can assist in the creation of new teaching methodologies". It combines hardware and software to create an interactive tool that makes it possible to integrate various types of media, such as sound files, images, and videos, into a single frame, allowing users to write, draw, manipulate, and interact with digital content.

Finally, it is observed that since the earliest times of human civilization, the integration of support for writing and information sharing has come a long way and has been shaping the teaching space, improving the interaction between teacher and student and influencing the evolution of teaching methods over time.

4 INTERACTIVE AND INTERACTIONIST WHITEBOARD

The interactive digital whiteboard is a term that has been gaining prominence in modern educational scenarios, evoking an image of innovation and engagement in the learning process. The name itself suggests a technology that goes beyond simply displaying information and offers a new level of engagement and participation. To understand this innovation, it is essential to explore the concepts of interaction and interactivity, which are often used as synonyms, but have different nuances in their meanings. According to Vittadini, the concept of interaction is characterized by:

> "Situating oneself in a space-time in which a common field of action is established, in which the subjects involved must be able to contact each other. The capacity for action of each subject is also fundamental, which must be in a position to influence the

> subsequent development of the interaction, determining it with its action: each action of a subject must serve as a basis for the actions carried out later by the others. Finally, the interaction is carried out based on a series of rules and can even introduce changes in the context." (VITTADINI, 1995, p. 151). 2

Interaction is an essential element of human communication in all its forms, contents and manifestations. It enables the transmission of information, the sharing of experiences, the establishment of emotional connections and the construction of relationships. According to Mielniczuk:

> In Communication, interpersonal dialogue is a form of interaction. A situation in which two or more people put themselves in direct contact or through some mediation to participate in a common action, where all the subjects involved have the power to act. For each proposed action, there will be a different reaction, modifying the context of the group (MIELNICZUK, 2001, p. 173,174).

Teachers interact with students to impart knowledge and encourage active participation. Students, in turn, interact with their classmates and teachers to answer questions, discuss topics and collaborate on pedagogical projects. Facilitating this interaction in the classroom is essential to enhance understanding of individual student needs and create an enabling environment to meet those demands. When teachers and students interact in a continuous and collaborative way, it becomes possible to identify the particular aptitudes, challenges and interests of each student, adapting teaching according to these specific characteristics. This constant exchange of information not only personalizes learning, but also strengthens the bonds between educators and students, enriching the teaching experience and promoting an inclusive environment, in addition to bringing internal and relationship changes with other students.

While interaction refers to communication and engagement between parties, interactivity is a dimension of interaction. This term has recently entered the dictionaries of the Portuguese language and has become more evident with the advent of Information and Communication Technologies (Mielniczuk, 2005, p.173).

---

[2] "situar-se en un espacio-tiempo en cuyo ámbito se establece um campo de acción común en el que los sujetos involucrados deben poder entrar en contacto entre se. Es asimismo fundamental la capacidad de acción de cada sujeto, que debe estar en condiciones de influir en el sucesivo desarrollo de la interación determinandolo con su actuación: cada acción de un sujeto debe constitu la premisa de las acciones realizadas posteriormente por los demás. In short, interaction takes place on the basis of a series of rules and can lead to introducing changes in the context" (VITTADINI, 1995, p. 151).

Interactivity is often employed to describe the interaction between a human being and a technology. According to Santaella (2004, *apud* Loyola, 2012, p. 62), the term "interactivity" emerged in France in the 1970s to describe the conversational nature, the importance of interfaces and the communicative bidirectionality that characterize the interaction between humans and machines or between digital systems. This concept is key to understanding how people relate to technology and how interfaces are designed to facilitate effective and engaging communication.

Lemos (1997, p.3) conceives interactivity as a specific modality of interaction, characterized by the real-time dialogue between humans and machines through graphical interfaces. In the man-machine relationship, levels of interactivity can be identified. Rhodes and Azbell (*apud* PRIMO; CASSOL, 1999, p. 08) classify interactivity into three levels of control: reactive where the program controls the options and feedback, coactive where the user can control the sequence, rhythm and style, and proactive where the user has control of both the structure and the content.

Sorting by levels of interactivity gives educators the flexibility to adapt their teaching strategies according to learning objectives. In a day, they can take a more reactive approach to explaining concepts. In another, they can promote more coercive activities to actively involve students. And at strategic moments, they can stimulate proactive interactivity, encouraging creativity and problem-solving. Each level provides a unique experience, adapting to pedagogical needs and learning objectives. As interactivity evolves from reactive to proactive and coactive, the graphical interface adapts, providing a more enriching and user-centered experience, expanding the possibilities for interaction and personalization.

The digital whiteboard graphic interface is the visual layer that connects teachers and students to the available tools and resources. It encompasses everything that users see and interact with on the blackboard, such as touching the screen, using digital pens, accessing menus and using the various tools available. Digital whiteboards offer a diverse set of tools that make up their functionality and allow dynamic interaction with educational content, as well as attract and retain students' attention using different channels of perception, including visual, auditory, and kinesthetic.

Most digital whiteboards have a set of tools available, and among them, some stand out. The Digital Brush or Pen together with the *Color Palette*, allow you to write, draw, sketch maps and diagrams in various colors directly on the board and the Eraser allows you to make precise corrections, ensuring that the content is clear and error-free. It should be noted that,

using several pens, several students can interact simultaneously on the blackboard. This is extremely important because it promotes the active participation of multiple students during classes, encouraging collaboration and engagement in educational activities.

The use *of Geometric Shapes* is particularly useful in subjects such as Mathematics, Physics, and Chemistry. Teachers can use rectangles, circles, and triangles to demonstrate geometric concepts, illustrate mathematical formulas, making lessons more visual and understandable for students.

The *Object Selection and Manipulation Tools* make it possible to move images and texts on the digital whiteboard, creating clear schemes and diagrams to illustrate complex concepts. In addition, these tools allow you to highlight relevant passages in the study materials, making notes directly on the screen and highlighting important images for students' understanding. The Zoom tool allows you to zoom in on specific details and can focus on one or another part of the image to examine it in more detail.

The digital whiteboards also offer integrated *Videoconferencing* features, allowing students who were unable to attend face-to-face classes to participate in live classes, promoting inclusion and interaction in real time, allowing students to follow the progress of the class. In addition, the ability to share students' computer and mobile device screens allows for presentations and demonstrations involving the entire class.

Online *Chat* and *Collaboration* tools allow students to actively participate by asking questions and collaborating with classmates and teachers. It should be noted that teachers can organize these questions in increasing order of difficulty, starting with simpler questions and gradually advancing to more complex ones, structuring the interaction progressively.

Class *Recording* is an important resource, not only for absent students, but also for all students. When the recordings are made available in the school's virtual learning environment, students have the opportunity to revisit the content, deepen their understanding and consolidate learning. This promotes student autonomy by allowing them to study at their own pace and prepare for assessments.

All these tools on the digital whiteboard support students facing learning disorders, offering solutions that can be adapted to their specific needs. The effectiveness of these tools is directly linked to the careful choice of the most appropriate one, taking into account the learning difficulties and the type of task to be performed. For many of these students, these technologies can prove to be effective allies, especially in areas such as reading, language, organization and information processing.

The use of these tools can be recommended as part of each student's Individual Education Plan (IEP) and be combined with the application of Universal Design for Learning (UDL) by educators with the aim of supporting both students with special needs, as well as those with different learning styles and needs, by creating integrated and adaptive learning environments, where each feature is deliberately selected to complement and enrich the other.

To cater to different learning styles, diverse sources of information such as text, images, diagrams, animations, films, and educational websites provide a variety of approaches to understanding a topic. However, if not planned and managed correctly, these resources can overwhelm students and hinder learning, rather than enhancing it. In order for students to understand and internalize the content taught, educators must take into account individual cognitive capacity and respective limits when planning their lessons.

Filatro (2018, p. 50) points out that John Sweller, an Australian psychologist specializing in cognition, developed the theory of cognitive load arguing that learning becomes more efficient when the information provided to the student corresponds to his or her ability to process it. The central objective of the theory is to optimize teaching and instructional design in a way that does not overload working memory, ensuring more productive learning.

In an ideal educational setting, it is important to know the cognitive capacities of students and understand how far they can go in order to adjust the method and pace of teaching according to individual needs. By recognizing the limits and potentials of each student, educators can create more appropriate didactic strategies, ensuring that the content is assimilated without overloading or underestimating the student. This personalized fit facilitates understanding, motivation, and knowledge retention, promoting a more inclusive and productive learning environment.

Thus, the incorporation of interactive whiteboards in classrooms requires attention to three principles. The first of them is the technical aspect, which comprises the need for a technological infrastructure, support, constant software updates and adequate training for teachers. Next, we have the didactic principle, which requires educators to plan their classes in order to get the most out of interactive whiteboards, adapting the content to the target audience, finding ways to awaken students to cognitive activity, and promoting engagement and collaboration among them. Finally, the interactive principle highlights the ability of whiteboards to integrate images, sounds, videos, and three-dimensional models, where

students can touch, move, cut, rotate, and explore these elements, allowing them to interact with these virtual objects in an immersive way.

This further underscores the importance of the teacher's overarching role as a mediator and facilitator of learning, mastering the technological tools to create a stimulating and interactive environment. However, even in the face of the constantly evolving technological context, he continues to be responsible for the role of experienced decision-maker on the most appropriate forms of teaching, whether through traditional or technological approaches. This is because technology, while offering numerous advantages, is not always the most appropriate solution for all educational scenarios. The teacher, with his pedagogical knowledge and understanding of the students, has the ability to discern when and how to incorporate technology effectively.

Finally, just as Manzi used television to teach literacy to those who could not attend school, exploring visual and interactive resources on his paper board, promoting the active cognitive activity of his students, contemporary teachers have interactive whiteboards and other technologies to enrich the learning experience, also playing the role of communicators capable of presenting the content clearly, Attractive and relevant, maintaining students' interest and understanding.

In this way, may the genius, creativity and commitment of Manzi, who accepted the challenge of transforming lives and shaping the future of education in his country, serve as a beacon of inspiration to all teachers who, today, have technological tools to train and prepare students to walk a path full of possibilities and overcome the challenges that arise.

5 THE CONVERGENCE OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING ON INTERACTIVE WHITEBOARDS: A REVOLUTION IN EDUCATION

The convergence between artificial intelligence and machine learning in interactive digital whiteboards has been unveiling a vast horizon of possibilities, with the potential to transform the learning environment and communication in classrooms. Dispensing with the connection to external devices or computers, these whiteboards are accessible and intuitive tools for educators and students.

At the heart of this technological revolution are artificial intelligence and machine learning algorithms integrated into whiteboards, enabling them to process, understand, and react to information in a dynamic and adaptive way. These algorithms allow simple scribbles

to be converted into clear visual representations. Given a variety of suggestions, the user can select and embed desired images to the screen.

A practical example of this innovation is automatic content recognition, which transcribes handwritten texts into digital format, improving annotation and facilitating information sharing. Additionally, the ability to capture conversations and translate words from different languages allows students from different backgrounds to share their perspectives without language barriers, enriching the educational environment.

These whiteboards also have the ability to condense lengthy videos into concise summaries and generate *flashcards* from lectures, notes, and teaching materials, making revision more productive. Another relevant feature is the analysis of student engagement and behavior during interactive classes. Based on this data, it is possible to provide personalized recommendations and shape the learning experience to the needs of each student.

By integrating generative artificial intelligence technologies, complex visual content can be generated, such as flowcharts, mind maps, and diagrams. Such a capacity amplifies teaching options, fostering creativity and collaboration.

With the growing interest in remote learning solutions and the continued integration of artificial intelligence and machine learning technologies, the future of interactive whiteboards is auspicious. Becoming increasingly versatile, they offer personalized and collaborative educational experiences that empower educators and inspire students. Thus, these blackboards are redefining the educational scenario, paving the way for an education aligned with the demands of the twenty-first century.

6 FINAL CONSIDERATIONS

The trajectory of education and the tools that support it is a rich and evolving tapestry, which begins with the prehistoric marks in the caves and extends to the modern interactive whiteboards. The evolution of the slate, at its core, represents the constant human desire to communicate, teach, and learn in increasingly efficient and engaging ways. What started as simple drawings on cave walls has become the traditional whiteboard, and now, it has become the digital whiteboard, full of resources and adaptability, reflecting the technological revolution in the classroom.

In the midst of this journey, inspiring figures such as Alberto Manzi have demonstrated that the effectiveness of teaching does not lie only in the tool, but mainly in the methodology and passion of the educator. Manzi, using a television and a paper board mounted on an

easel, reached and engaged millions, showing that the essence of education transcends the medium. He used the technology available in his day in innovative ways, just as today's educators seek to do with interactive whiteboards.

Cognitive load theory reminds us of the importance of understanding and respecting the limits of students' working memory when presenting information. Interactive whiteboards, with their multiple functionalities, have the potential to both enrich and overload the learning experience, making the strategic and conscious use of these tools essential.

As we look at the present and future of education, we see a parallel between Manzi's engaging style and the use of interactive whiteboards. Both seek to capture attention, facilitate understanding, and promote lasting learning. The difference is in the tool, but the goal remains the same: to teach in an effective and attractive way. In conclusion, while tools and technologies in education continue to evolve, the passion, creativity, and commitment to teaching, exemplified by figures like Manzi, are timeless and remain the heart of the educational journey.

In view of the above, new works are suggested that can explore the evolution of the blackboard in the educational context, from its most rudimentary origins to its interactive digital versions. It would be interesting to address the adaptation of pedagogical practices with the incorporation of new technologies on the blackboard, as well as to investigate the impact of these changes on the dynamics of the classroom. In addition, studies that evaluate the effectiveness of interactive digital whiteboards compared to traditional ones, in terms of engagement and retention of content by students, would be of great relevance. Another promising approach would be to explore the interaction between teachers, students, and the blackboard, and how this relationship shapes and is shaped by educational practices. Finally, it would be enriching to investigate the pedagogical possibilities emerging with the integration of artificial intelligence and other advanced technologies into digital whiteboards, outlining the future of this iconic tool in education.

REFERENCES

Abreu, C. J. M. C. de. (2017). A evolução dos suportes de registro do conhecimento [Trabalho de Conclusão de Curso, Universidade Federal Fluminense]. Repositório Institucional da UFF. https://app.uff.br/riuff/bitstream/handle/1/24555/CRISTIANO_J.%20M.%20C.%20DE%20ABREU%20%282017%29.pdf?sequence=1&isAllowed=y

Caira, R. (2009). O italiano falado em Curitiba por um grupo de falantes nativos que vive no Brasil há cerca de cinquenta anos [Dissertação de mestrado, Universidade de São Paulo]. Repositório de Teses da USP. https://teses.usp.br/teses/disponiveis/8/8148/tde-25112009-100953/pt-br.php

Chagas, A. M., Linhares, R. N., & Ribeiro, K. A. (2012). As revoluções na leitura: Do livro de Gutenberg aos textos digitais. In Anais do 3º Simpósio de Educação e Comunicação, Edição Internacional (pp. 461–476). http://geces.com.br/simposio/anais/anais-2012/Anais-461-476.pdf

Dias, C. A. (1999). Hipertexto: Evolução histórica e efeitos sociais. Ciência da Informação, 28(3), 267–275.

Domingues, J. E. (2023). Lousa e giz: Você aproveita bem essa tecnologia. Ensinar História. http://www.ensinarhistoriajoelza.com.br/lousa-e-giz-voce-aproveita-bem-essa-tecnologia/

Fagundes, L. P. (2008). O uso da lousa digital interativa em uma prática pedagógica [Trabalho acadêmico]. Repositório da UNICAMP. https://hdl.handle.net/20.500.12733/1608572

Farto, T. do V., Maciel, K., & Lima, W. de. (2023). A história das pinturas rupestres. A História da Educação. https://ahistoriadacomunicacao.wordpress.com/category/pinturas-rupestres/

Filatro, A. C. (2018). Como preparar conteúdos para EAD (1st ed.). Saraiva Educação.

Greenhalf, K. (2015). The history of the classroom blackboard. Concordia Online Education. http://education.cuportland.edu/blog/reference-material/the-history-of-theclassroom-blackboard/

Gómez, G. O. (2002). Comunicação, educação e novas tecnologias: Tríade do século XXI. Comunicação & Educação, (23), 57–70. https://www.revistas.usp.br/comueduc/article/view/37017

Katzenstein, U. E. (1986). A origem do livro: Da idade da pedra ao advento da impressão tipográfica no ocidente. Hucitec.

Labarre, A. (1981). História do livro. Cultrix.

Lemos, A. (1997). Anjos interativos e retribalização do mundo: Sobre interatividade e interfaces digitais. Tendências XXI. http://www.facom.ufba.br/ciberpesquisa/lemos/interac.html

Lima, I. C. D., & Azeredo, R. (2006). A evolução do livro escrito. SAPIENTIA-CESAT-PIO XII-UNICES. http://faculdade.pioxii-es.com.br/anexos/Sapientia05/RC_N5_Unices_artigo_1.pdf

Loyola, L. C. (2012). Interação e interatividade nas novas tecnologias de comunicação e da informação. Destarte, 2, 60–78. https://estacio.periodicoscientificos.com.br/index.php/destarte/article/view/645/574

Manguel, A. (2009). Lendo imagens: Uma história de amor e ódio. Companhia das Letras.

Mielniczuk, L. (2001). Considerações sobre interatividade no contexto das novas mídias. In A. Lemos & M. Palacios (Eds.), Janelas do ciberespaço (pp. XX–XX). Sulina.

Primo, A. F. T. (1999). Explorando o conceito de interatividade: Definições e taxonomias. Informática na Educação: Teoria & Prática, 2(2), 65–80.

Rebelo, M., & Barreto, C. (Eds.). (2014). Estratégias de ensino voltadas para a aprendizagem (1st ed.). CECIERJ.

Silva, P. C. da. (2022). A língua italiana: Uma trajetória de mudanças e desafios. Repositório da UFRJ. http://hdl.handle.net/11422/20096

Slavin, R. E. (2012). Cooperative learning and achievement: Theory and research. In Handbook of psychology (2nd ed., Vol. 7, pp. 199–212). Wiley.

Teixeira, M. B. d'H., & outros. (2017). O papel: Uma breve revisão histórica, descrição da tecnologia industrial de produção e experimentos para obtenção de folhas artesanais. Revista Virtual de Química, 9(3), 1364–1380.

Vittadini, N. (1995). Comunicar con los nuevos media. In G. Bettetini & F. Colombo (Eds.), Las nuevas tecnologías de la comunicación (pp. XX–XX). Paidós.

Volker, P. (2020). Educação da ausência. Revista Bis, 11(1), 34–35. file:///C:/Users/hmina/Downloads/REVISTA%20BIS%20-%20EDICAO%2051%20-%20SITE.pdf