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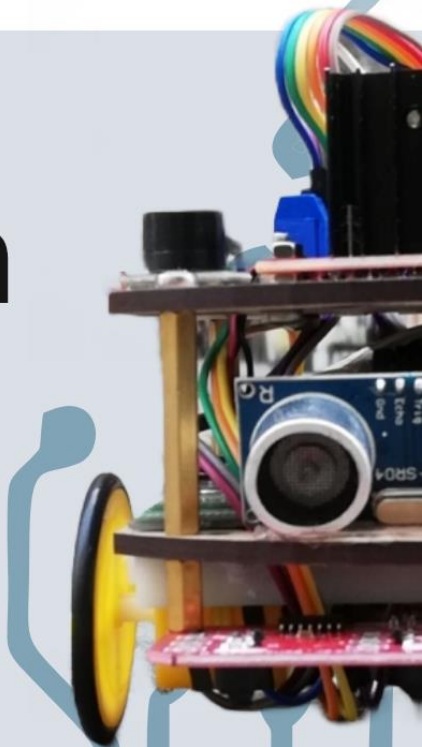

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The emergence of Artificial Intelligence in Education

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Introduction

When we think of Artificial Intelligence (AI) we are immediately transported to futuristic scenarios of science fiction, which populate our imagination and leave us in a mixture of apprehension and fascination, in the face of the supremacy of machines, in films and books. However, its growing presence in our lives is so impregnated that we do not even realize its current impact and it becomes difficult to predict its full potential for use in the near future. Despite the science fiction cover, AI has numerous practical and beneficial applications, aiding the amplification of various activities, areas and knowledge. AI can be summed up in the concept of "train and learn with data to improve statistical algorithms" (Dowd, M, 2020), which allow an increasingly efficient use of various applications such as facial recognition, intelligent digital assistants (*Google Assistant, Alexa* or *Siri*), online translators, *chatbots*, autonomous cars, or even entire factories, dependent on the workforce of robots, fully automated assembly lines, much more productive than traditional manufactures. This technology presents itself in such an emerging way, positioning several Technologies with AI in the Gartner curve upwards, proving it as an innovative trend of

reference for the next decade (Gartner, 2021). However, and despite all the benefits we can recognize for AI, there are several personalities, linked or not to science, who warn of the dangers of their supremacy, such as Elon Musk, when, in an *interview with the New York Times,* he predicted that AI would overlap with humanity in less than five years (Dowd, 2020). We also often see calls from world leaders on Social Networks for urgent regulation in this area, either through educational references or through the production of ethics manuals.

From another point of view, and attentive to the movements of the labor market, studies of some organizations point to a paradigm shift in the level of the jobs of the future, predicting that many of them will be carried out by machines, which, once again, calls for the reinvention of humanity. We also know, on the basis of an analysis of the successive civilizational revolutions, that the trends of economic agents point to an optimization and generalization of AI in our daily life. This is undoubtedly an emerging theme, with several implications in the current world and the future, being an integral part, who may even basilar, of the 4th civilizational revolution. This new civilizational revolution necessarily requires a new educational paradigm, with a new mission of the school in order to prepare students for professions that we do not yet know, because they have not yet been 'invented'.

In this reflection, centred on the bibliographic review, we will focus on the analysis of the influence that AI is exerting on today's education. For this we intend, i) contextualize the concept of AI; ii) Understand ethics related to the evolution of AI; iii) Reflect on the integration of AI in an educational context. We believe that the work may be relevant for researchers who are starting research into the transformation of education by influence of AI and for teachers who want to start the process of preparing students with skills for the future. In this sense we clarify the theme from a conceptual point of view, we address the ethical challenge that the emergence of AI will pose to new learning contexts, we reflect on ways to integrate AI in an educational context and present some

educational applications or resources that teachers can use at different levels to start the process of introducing AI in an educational context.

Defining Artificial Intelligence

Early indications of AI also date back to the 1950s. One of the pioneers was Alan Turing, when he asked the question "Can machines think?" in the article for Mind magazine, *Computing Machinery and Intelligence*, thus reaching the notion *of Learning Machines* (Turing, 1950). This is how the well-known Turing Test was born, defined by the author as the "Imitation Game" where it was intended to test AI in a man-machine competition. It is, however, consensually accepted that It was John Macarthy the first author to establish a definition of AI, characterizing it as "the science and engineering of making/building intelligent machines" in the mid-50s of the last century (Peart, 2020). AI has been evolving and is now defined by the European Commission as:

> *... software systems (and possibly also hardware) designed by human beings, who, having received a complex objective, act in the physical or digital dimension, perceiving their environment through the acquisition of data, interpreting the data (...) collected, reasoning about knowledge or processing the information resulting from this data and deciding the best actions to take to achieve the established objective. As a scientific discipline, AI includes various approaches and techniques, such as machine learning (...), automatic reasoning (...) and robotics (...)"*
>
> (European Commission, 2019, p. 6)

In this context, we are born with *the concept of Machine Learning,* a branch of AI, focused on building applications that learn from the data obtained and improve its performance and accuracy over time.

In programming science, an algorithm is a sequence of statistical processing steps. Within machine *learning*, algorithms are 'trained' to find patterns and characteristics in *massive amounts of data (Big Data)* in order to make decisions and predictions based on new data. The better the algorithm, the more accurate the decisions and predictions will be as they process more data" (IBM, n.d.).

One of the tools that we use most often, and based on this branch, are online search engines, in which, almost instantly we get the answer to the question or request posed, thanks to the accumulation of data from successive searches, worldwide performed. Machine *Learning* is increasingly being explored to solve real-world problems to help man solve pressing and global issues such as environmental pollution or even detect diseases in early states. Around the world there are several teams of researchers dedicated to this topic, exclusively, such as the University of Adelaide, Australia. The final products to be obtained, such as vehicle automation or practical applications in medicine, among others, can be found on the official website of the University of Adelaide: https://www.adelaide.edu.au .

Another emerging concept in this area is Artificially Intelligent Robots, which are a bridge between robotics and AI. We also come up with the term 'Robot Software' which refers to a type of computer program that operates autonomously to complete a virtual task. Examples of this software are the search engines 'bots' (*web crawlers*), the automation of robotic processes and chatbots, which appear on websites and "speak" with a set of pre-written responses (Owen-Hill, 2017). Currently, the most famous humanoid robot is *Sophia, the first* to have a nationality. This type of robot can perform various human tasks and can even express feelings through fifty facial expressions (Dang, 2019). Here we are, then, faced with a dilemma of ethical issues, which will need to be answered by responsible entities.

Ethical Challenges in the Context of Learning

By analysing what has been mentioned above, it turns out that AI is evolving at a breakneck pace, and global regulation is imperative, because ethical issues arise that cannot be ignored. At the UNESCO International Conference on Education (2021) in Paris, representatives from 193 countries approved the "Ethical Recommendations for Artificial Intelligence". This document emanated several values that countries should take into account. AI must respect, protect and promote human rights; environment and ecosystems must also be preserved; AI must be inclusive and meet diversity; peace and justice in society. Some principles have also been agreed to ensure that AI will not cause harm or be discriminatory, should be fair, responsible, sustainable, transparent and take into account data protection, among other things. The impact of AI on people and society should be monitored and assessed in all countries. From this conference, several recommendations have been made for taking into account in the area of Education, including the development of AI Literacy, by updating their curricula.

Also, as far as ethics is concerned, the Massachusetts Institute of Technology (MIT) suggests a list of APPs that allow us to monitor, in real time, the behaviour of artificial intelligence applications we use. This ecosystem of "responsible AI" ventures, so dubbed by this Institute, aims to help organizations of any kind monitor and reorient their applications so that their use does not clash with established ethical principles. From the list presented by MIT in a recent article (MIT Technology Review, 2021), the APP Parity, which offers help in conducting audits to different organizations, whether business, educational, consulting. This APP guides the conduct of the audit, in a logic of analysis regressed to the company's data, analysing its models of action and verifying that they comply with the established rules. For example, the application of this resource in a School would be feasible to audit compliance with the General Data Protection Regulation by analysing the files published or submitted by the School and verifying whether or not there were leaks of sensitive data from the school community.

Within the list suggested by MIT, we can also find APPs that are on the basis of recurring social networking tools, such as the algorithm that tells us why we see a particular ad or post in our news feed, such as Fiddler. This application would be a huge asset, for example, in a Virtual Educational Community, helping each member to access content related to their area of interest more quickly, without sealing access to other content, potentially of interest, or wasting time in a maze of information that was not a priority at that specific time. Technology has evolved faster than the ethics associated with its use. In the case of AI, we must be able to anticipate problems for ethical and conscious use in any human activity, particularly in an educational context.

AI in Educational Context

Given the emergence of this theme, there are already several articles and researchers who are dedicated to ai studies in Education (Zhang & Aslan, 2021) and have been pointing out some directions and applications. Generally, in the consulted bibliography, AI in education comes with two great perspectives of approach: AI as an end, that is, AI as an object of study itself, with a view to the development of competencies for the future and, another approach, where AI emerges as a means or way of transforming the entire educational ecosystem. These two perspectives sometimes seem to intersect.

The AI4k12 initiative team, based at Carnegie Mellon University in the United States of America, which is part of Dave Touretzky, lists five great ideas that serve as guidelines for students from Preschool to 12th grade (K12) that are: perception, representation and reasoning, learning, natural interaction and social impact. These five ideas are illustrated in Figure 1.

Taking into account these five main axes of action, the teacher will be able to better adapt their practice, in order to guide students in the acquisition of skills, in line with what will be required in the near future. Possibly, the biggest challenge posed to policy makers and education experts today will be the readjustment of the entire learning framework, with a view to the inclusion of AI, meeting the constant and growing challenges of a society supported by it.

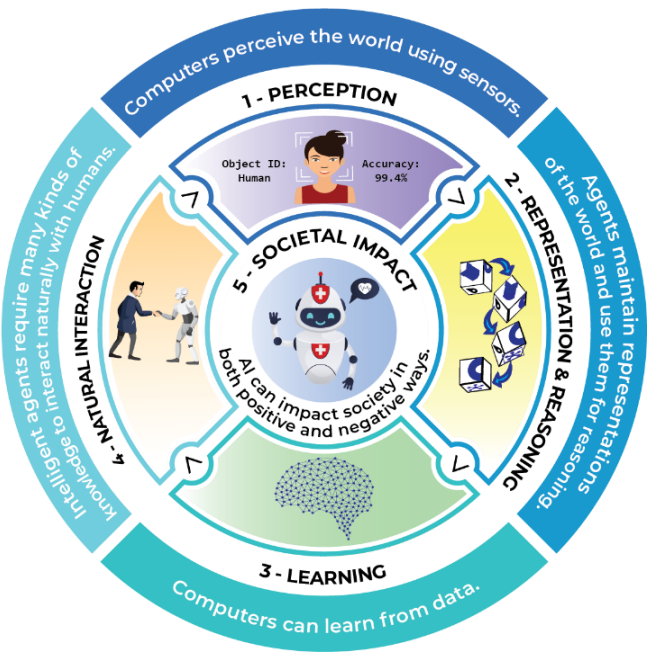

Figure 1- Axes of action of Artificial Intelligence. [Credit: Initiative AI4K12.]

One of the reports of the Nesta project (2019) states that there are three categories of IAED tool being used today in schools and colleges**:** student-facing (e.g., adaptive learning platforms), teacher-facing (e.g. automated assessment tools or advanced teacher dashboards), and a third focused on the system (e.g., analysis of school data to predict the performance of the school inspection)".

In the category aimed at students, the Intelligent Tutoring Systems (Its) are highlighted, in which students benefit from individualized tutoring, using their personal devices, where they receive information and pedagogical support, perform tasks and answer questionnaires, and are then directed in their learning, according to the strengths and weaknesses evidenced. More recently, Ouyang and Jiao (2021) also present three iAED paradigms: AI-empowered, where students are the leaders of their learning and AI emerges as a support tool to increase human intelligence; a IA-supported, in which the students are collaborators, leading to the personalization of learning; AI-directed, where AI directs the learning process, as is the case in ITS.

These tutoring systems are critical of the absence of socialization, both among students - teachers and peers (NESTA & Holmes, 2020). Still in the student-facing category, *Intelligence Unleashed, an Argument in AI for Education (Luckin et al., 2016),* states that AI can support collaborative learning through adaptive group training; in specialized support, which will allow students to overcome obstacles and improve their performance*;* Virtual mediators, either in the form of a trainer/tutor or "virtual pair" who will support the student in sharing knowledge; and finally on the virtual moderators side, who will assume the role of "organizers" of information, allowing their quick interpretation and access, as well as guiding peer discussion.

From the perspective directed at the teacher, it is important to mention the contribution of Robert Murphy, who suggests two important applications in this category, "... automated job classification systems and early detection of students at risk of failure and/or dropout" (Murphy, 2019). These applications are of particular importance, as they allow the teacher to act in a timely manner, providing the student with an effective learning path. In the category directed to the system, which, perhaps, will not be so implemented in our reality, it will have more applicability at the level of guardianship, in order to be able, in real time, to have an overview of the general performance of students or each teaching unit (read Grouping of Schools or non-grouped school) in particular.

Given this situation, there is a need *to implement AI Literacy,* a notion that has already been defined by two researchers from the Georgia Institute of Technology as "a set of competencies that allows individuals to critically evaluate AI technologies, communicate and collaborate effectively with AI and use it as an online tool, at home and in the workplace" (Long & Magerko, 2020, p.2). These same authors developed a framework for the development of AI literacy through 16 competencies: AI recognition, intelligence understanding, interdisciplinarity, *general AI* versus Narrow *AI, strengths and weaknesses* of AI, imagining the future of AI, representations, decision making, *machine-learning steps*, the human role in AI, data literacy, learning from data, critical interpretation of data, action and reaction, sensors and ethics. As an emerging theme, the creators of this framework reservation the need for a wide-ranging debate around this theme, hoping that it will serve as a script and inspiration for the development of AI literacy.

Educational Resources for AI Learning

For teachers who already feel inspired and recognize the full potential of this theme, we suggest a set of resources, directed to Primary and Secondary Education, categorised in Table 1:

It should be noted that the selection of resources, in the table above, was carried out with a view to three essential premises: accessibility, most of which are free or with a long trial period; intuition, i.e. allowing a simple and easy use, either by teachers and by students; and, finally, practical applicability, in an active learning methodology, focusing on the acquisition and consolidation of competencies for the 21st century.

Table 1: Teaching Resources / Learning with AI

Resource	
AI for teachers	Integration of Knowledge of AI throughout schooling; Free professional development, webinars, conference presentations... https://aiforteachers.org/about-us
Aik12-MIT	MIT research project, focused on the dissemination of external websites, projects, curricula and APPs directed to learning about artificial intelligence. https://aieducation.mit.edu
AI4K12	Provides an online resource directory where teachers can find AI-related videos, demo software, and descriptions of activities incorporated into lesson plans. http://ai4k12.org
Ready AI	Platform that offers some free online courses, for children, to purchase basic concepts about AI. https://www.readyai.org/
ElementsAI	Platform that offers a free online course, to purchase basic concepts about AI. https://www.elementsofai.pt/
Code.org	Platform that offers a free online course and games, for children, for the acquisition of basic concepts about AI. https://studio.code.org/s/aiml-2021 https://code.org/oceans
Google Teachable Machine	Platform provided by Google that allows you to easily create ML templates. https://teachablemachine.withgoogle.com/
Machine Learning for Kids	Practical experiences to train machine learning systems, allows to teach programming to children with connection to Scratch and App Inventor platforms, as well as creation of games, with machine learning models. https://machinelearningforkids.co.uk/

Otto Academy	Introduction to the fundamental principles of computational thinking, robotics and AI, through the realization of some courses or with the construction and programming of its own robot, *the Otto Scratch AI*. https://ottoschool.com/en/
mBlock	Programming tool, designed for teaching/learning in STEAM areas with a recent extension of AI. https://mblock.makeblock.com/en-us/ https://www.mblock.cc/en-us/blog/mblock/update-ai-axis/
Scratch	Platform developed by MIT Media Lab, available for free, that allows programming of games, stories and interactive animations, with the use of the programming language by blocks and with an AI extension. https://scratch.mit.edu/
Cognimates	An AI education platform for game building, robot programming and ML model training. http://cognimates.me/home/
AIWS	Scratch visual programming platform, which provides AI content. https://aiworldschool.com/S4AIWS_freeplay/
Pictoblox	Educational platform for programming and learning of AI, using block programming. It is a spin-off of scratch, which allows you to add AR / VR features, in an easy and intuitive way. https://thestempedia.com/product/pictoblox/
AutoDraw	Online drawing platform with ML that identifies what you are trying to draw. https://www.autodraw.com/
Quickdraw	A Neural Network that identifies our designs and helps you understand the concept of ML. https://quickdraw.withgoogle.com
Duolingo	Personalized language learning application using AI. https://www.duolingo.com/
Dream AI	Online application that creates works of art in seconds using AI. https://www.wombo.art/
Seeing AI	An intelligent application provided by Microsoft, which provides information about what is around the person intended for the blind. https://www.microsoft.com/en-us/ai/seeing-ai

Conclusion

AI is an area of computer science that proposes to simulate human intelligence, capabilities and behaviour through programming, seeking machines to perform human activities. It is an emerging and captivating theme, which is now an essential foundation of our digital universe. It appears in the bibliography with the potential to bring about a fourth civilizational revolution, which would consequently imply an educational revolution. However, the ethical issues raised give rise to the anticipation of legislation that ensures the correct and responsible use of AI. Currently, tasks as simple as performing an information search would return to the *old concept of scavenger hunting,* a time-consuming and herculean work of searching for bibliographic references manually. Actions such as choosing a restaurant, with a *simple click* on any APP, immediately translating an issue, an expression, in any foreign country, or knowing, in seconds, which way with the best traffic conditions, to quickly reach the destination, would be out of the question. The school has in hand the main role in the preparation of students, children today, the future tomorrow. A task that seems almost guessing, because, given the speed of evolution of tools and resources available, any and all predictions that are made, will be obsolete in the short term. However, the task of teachers will not be so much of futurology, but to provide students with tools that allow them to acquire logical reasoning skills, problem solving and, above all, collaborative work development and using creative solutions. The competencies for the 21st century are shaped in all the most recent Normative Documents, giving teachers clues to the development of work in the present, with a view to success in the future. The time horizon, combined with the analysis of the evolution of society and technology, allows us to foresee, that the future will go through automated resources, which means that the urgency will be to guide the work to transform students into producers of digital resources, rather than mere consumers.

Using the growing number of available solutions, teachers are, although very timidly, beginning the integration of AI in their teaching practice, with a special focus on the use of APPs to facilitate the

understanding of more abstract concepts. It is recognized that, currently, there are still some limitations to the integration of AI in Education, such as the lack of technological resources, the lack of legislation and reference *to its application in curriculae,* which adds to the lack of training of teachers in this area. As UNESCO has recommended, the development of Global AI literacy is urgently urgent.

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