Report C

Artificial intelligence and education

Challenges and opportunities in Spain

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Production method

Reports C are brief documents on subjects chosen by the Bureau of the Congress of Deputies that contextualise and summarise the available scientific evidence on the analysed subject. They provide insights into areas of agreement, disagreement, uncertainties, and ongoing discussions. The preparation process for these reports is based on an exhaustive bibliographical review, complemented by interviews with experts in the field who subsequently conduct two review rounds of the text. Oficina C conducts this process in collabouration with the management team of the Spanish Parliament's Lower House Documentation, Library and Archive service.

To produce this report the Oficina C referenced 209 documents and consulted 19 experts in the subject. Of this multidisciplinary group, 47% of the experts were from the field of social sciences and 53% from the area of engineering and technology. 79% work in Spanish institutions or centres, whereas 21% have affiliations abroad.

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Summary C

The report in 5 minutes

Relevance

Artificial intelligence (AI)* has become popular since the arrival of generative AI. The paradigm shift is not only due to the availability of new tools: the key is that it is possible, if so decided, to delegate complex tasks to machines that were previously the exclusive domain of human intelligence.

Its use in education entails opportunities and risks about which there are still uncertainties: there is still not enough solid and independent evidence on the effects of introducing it in education and its effectiveness in improving learning.

Faced with high expectations from some and pessimism from others, experts urge a debate on how AI fits into the education system. Despite the speed with which new tools appear, it is urgent to decide how to provide institutions with the material means, human capabilities, methodology, and ethical and regulatory frameworks to improve education.

This report summarises the opportunities and risks of AI in education, as well as some alternatives for engaging with this technology in a safer and more responsible manner.

The most prominent AI tools are based on machine learning and in particular on deep learning, that is, programs learn from experience and are able to identify patterns in data without the need to previously tell them which are the most relevant parameters.

Among them, generative AI tools produce content (text, images, audio, video) according to the user's instructions. In particular, large language models such as ChatGPT, trained with large amounts of data from the Internet, generate texts very similar to those written by humans. However, they don't really understand the language. In simple terms, their answers are based on the probability that one word follows another, so they can be misleading. Nowadays, they store more knowledge in English, which can decrease the quality of responses in other languages. For this reason, a model trained in Spanish and the co-official languages is being developed in Spain.

Focal point

AI tools in education are numerous and use different approaches to support learning.

Some are capable of performing specific tasks, such as solving maths problems, correcting code, or translating texts. Others try to personalise learning, either through virtual tutors or educational platforms. The latter are based on training and usage data and create models capable of recommending learning paths that respond to the student's progress in the subject. Some of these tools have proven effective at an academic level, although they may have disadvantages such as impoverishing the social dimension of learning.

Generative AI tools can also be useful for adult learners as long as they are used within the standards established by the institution. You can use them for tasks such as summarising, defining concepts, clarifying the meaning of a text or simplifying it.

Some models, such as ChatGPT, offer answers that allow students to get good grades on university assignments without the use of AI being identified. Furthermore, it is currently not possible to detect whether a text has been created by generative AI and if it is suspected, the copy cannot be proven. Therefore, it is urgent to reconsider what is to be learned and for what purposes, and how students' abilities are to be examined and validated, since unsupervised tests may not reflect their knowledge.

Generative AI can support teachers and educational staff in tasks such as developing course plans, generating rubrics, adapting texts, or automating routine administrative tasks (planning schedules, assigning spaces, etc.).

Teachers can also use AI tools to support marking or gain insight into how students learn. Data obtained through different digital tools are analysed and modelled to make predictions that allow the teacher to adapt their content to the progress and difficulties of the group. Additionally, the free tool Eduteams enables users to optimise team building in class.

In addition to opportunities, the use of AI in education also poses risks. These include concerns about privacy and data protection, potential errors and inaccuracies in generated content, bias discrimination, definition of authorship and respect for human and authorial rights or the impact on human capabilities, such as creativity or curiosity. There are also risks such as social disconnection of students, placing too much trust in algorithmic decisions, or students feeling monitored and changing their behaviour. There is also the risk of a possible covert privatisation of education, the homogenisation of content without considering cultural differences, the widening of the digital divide or the high environmental cost of AI.

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Image FOTCIENCIA Science and technology in the classroom, the future of education © Blanca Jara Pazos and Adriana Cuevas Noboa

On the horizon

To determine the role of AI in the education system and mitigate its risks and unintended impacts, it is essential to involve not only technologists but also policymakers, social science specialists, and the educational community. In addition, there are aspects that favour a safer and more productive relationship with AI.

Firstly, the development of responsible AI of proven quality, which complies with the law, adheres to ethical principles and is robust, explainable and allows for human supervision. Secondly, it is important to establish specific laws, already in place with the European regulation on AI, which will come into force mostly in 2026, and other initiatives.

Finally, AI literacy among students and educators is key, not only to using existing technology, but also to understanding how it works, cultivating critical thinking, and being innovative and responsible in its development and application. Pre-university teachers in Spain believe they need training in AI, which is essential to adapt new tools to their pedagogical priorities.

Finally, the expert community urges the promotion of open educational resources and the development of independent public tools.

*See definition in glossary at the bottom of the report

Artificial intelligence and education

Introduction

The education sector is considered one of the most sensitive to the changes that AI can bring. In addition, students already frequently use technologies such as generative AI.

The use of AI in education entails risks and benefits, for which there are still uncertainties and a lack of systematic studies. Faced with what some characterise as a false dilemma between innovation or regression, it is proposed to debate the best way to equip educational institutions with the necessary framework to improve education.

Although it began to be developed in the mid-1950s, artificial intelligence (AI) has become popular in recent years, especially with the emergence of generative AI in 2022 (**See Box 1**)[1,2]. In the so-called era of implementation, the arrival of AI is compared to the introduction of electricity[1]. It is considered to have the potential to revolutionise dozens of different industries and transform the labour market[1,3–5]. For example, according to the INE, in Spain it is used by 9.55% of companies with more than ten employees, a percentage that quadruples in companies with more than 250 employees[6]. Furthermore, the advent of generative AI has increased the potential for automation of jobs performed by more educated employees[2]. According to experts, structural change does not only come from the availability of new tools, but also from the fact that AI allows, if so decided, complex tasks to be delegated to machines that were previously the exclusive domain of human intelligence[7].

The education sector is considered one of the most sensitive to the changes that AI will cause, both due to the tasks that can be automated or complemented by it and the potential increase in the productivity of educational staff[4,8].

Despite expectations, it is too early to know if it will be a truly disruptive technology[9]. At the moment, few countries integrate it into their educational systems[10]. However, 82% of Spanish students between 14 and 17 years old, 73% of teachers and 69% of parents surveyed say they have used some an AI tool at some point, mainly chatbots or virtual assistants[11]. In fact, 40% of students claim to use ChatGPT frequently[11].

Furthermore, 39% of teachers surveyed and 57% of parents believe that AI will have a positive impact on education, with only 27% of the former and 11% of the latter leaning towards a negative or very negative effect[11]. However, society also perceives the risk of exclusion that digital educational models, including AI, may bring, particularly due to the lack of access to the necessary infrastructure for implementing these models in some households[12].

The application of AI in education represents an educational and social challenge that is based on technological innovation, which is linked to the debate on the use of new technologies in education[13]. In this regard, a recent UNESCO report indicates that there is a lack of reliable and impartial data on the impact of educational technology, since it evolves faster than it is possible to evaluate it and sometimes validation comes from the developer companies themselves[10]. Among expert staff there is a gradient of opinions, from those who focus on the negative aspects that technology has on learning to those who perceive it as the revolution that will transform education[13]. In this debate, some voices argue that humans have always been engaged with technology and recall the controversy sparked by the introduction of large blackboards in 19th-century classrooms. At the time, students resisted the idea of solving problems on the board without the aid of books, and teachers had to discover its usefulness for giving instructions to the entire class[13]. Thus, any tool, whether digital or not, could be considered technology and it is necessary to decide what is the best way to use it[13].

· Artificial intelligence: Although there is no single definition of AI[5], the framework convention on AI of the Council of Europe[196] has adopted the definition of 8 November 2023 of the Organisation for Economic Co-operation and Development (OECD). This defines an AI system as one based on machines that, with explicit or implicit objectives, deduces, from the inputs it receives, how to generate results. such as predictions, content, recommendations or decisions that may influence physical or virtual environments. Different AI systems vary in their levels of autonomy and adaptability after deployment.[206].
· Chatbot: Computer program that simulates a human conversation with the user in real time.

Generative artificial intelligence is a technology that can create content on demand based on user input.

The generated texts closely resemble those written by humans, but are constructed on the basis of probability and may include unreliable information.

Although many models are multilingual, they contain mostly English-language knowledge, which affects the quality of responses in other languages. In Spain, a model trained in Spanish and the co-official languages is being developed.

Box 1. The hatching of generative AI

Generative artificial intelligence is a technology that can create content, such as text, images, audio or video on demand from prompts that the user writes in natural language[26].

The ChatGPT tool (whose acronym translates as a language model based on a previously trained generative transformer) is a generative AI application specialised in dialogue (chatbot), which was launched by the private company *OpenAI* in November 2022[26,27]. Others followed, such as Google's Gemini., Microsoft Copilot or the free Meta software, Llama 3.1. In addition, there are tools that provide text sources and specialised options for scientific articles such as Consensus or SciteAI[28]. In particular, ChatGPT has been rapidly adopted, it is especially popular among young people and has more than 200 million users worldwide. Among them, more than 4 million reside in Spain[10,26,29].

ChatGPT is a large language model (LLM) based on deep learning, with billions of parameters, to control the system response[27]. The goal is for the model to learn to predict which word is most likely to follow the previous one in a sentence[27]. To achieve this, it is trained on a vast amount of text downloaded from the internet, and in later stages, its responses are refined through human supervision[27]. The result is texts that closely resemble those generated by people[27]. However, these models do not really understand language[30] and, as they are not based on logical rules but on probability, the information generated is not always reliable.[31] and can be a source of misinformation[26,32]. Furthermore, the training of the recently released ChatGPT-4o model ended in October 2023, so it does not provide up-to-date information. However, other servers that incorporate these technologies have continuous access to the Internet and do so[33].

Although many large language models are multilingual due to their training, they currently store more knowledge in English. This can result in users of other languages receiving different or lower-quality responses to the same question[34,35]. In this regard, a large-scale language model trained in Spanish, Catalan, Basque and Galician is being developed in Spain, funded by the Strategic Project for Economic Recovery and Transformation (PERTE) of the New Language Economy[36].

Another aspect to take into account is that these models always offer an answer, but they do not usually try to clarify what the user is referring to beforehand, nor do they usually explicitly provide reliable information on the degree of certainty of their statements[37,38]. There is ongoing research to improve these aspects[39,40].

Among the ways to improve this type of models, one of the most common is to increase their size, which increases the number of parameters and the amount of training data[41]. Although there are other options with lower energy consumption, this improvement strategy entails environmental costs and increases the price of implementing the models, limiting access to new developers and the languages that can benefit from the improvements[41]. For this reason, some experts are wondering whether it is necessary to continue increasing its size and are proposing more rational approaches, with a prior review of the data that feed their model[41].

Currently, the user can refine some of these models by feeding them with their own databases to increase their degree of specialisation in a certain area, adapt the responses to a certain style or improve their performance in a task[42–44]. This entails an investment of time and resources[42–44].

Although they can be improved[45,46], some of these models, the so-called multimodal ones, have been trained with images and text and theoretically represent the semantics of language in a way more similar to humans, by having improved capacities to relate data of different types[47–49].

· Prompts: Context or question that the user writes to interact with generative AI.
· Deep learning: Most successful branch of machine learning, which has marked a before and after in AI[1,57]. This method is capable of identifying patterns from the data entered, without the need to previously indicate which characteristics are the most relevant parameters[1,57]. It is achieved through multilayer networks that break down the problem into different levels of complexity and are refined with data training until a satisfactory result is inferred[5,57].

The use of AI in education entails benefits and risks, about which there are still uncertainties[14,15] and a lack of systematic studies[16–19]. However, some stress that technological uncertainty is always temporary and that alarmism distracts from the real problems that need to be considered at the present time.[14]. They also indicate that AI is substantially different and complementary to human intelligence and that the challenge is to establish an ecosystem where they can cooperate.[20,21]. Along these lines, others propose to avoid utopian or dystopian visions, which they describe as a false dilemma between innovation or regression.[22,23].

As an alternative, they call for action to reflect on how best to equip educational institutions not only with the necessary tools and methodologies, but also with the human capabilities, mentality, ethics and regulatory frameworks to support the evolution of education[23]. In this way, the speed with which new technologies emerge makes it difficult to update legislation, pedagogies and monitoring methods at the required pace.[24,25].

To adapt education and training to the digital age, which includes AI as another tool, plans are being developed at European and national levels (**See Key point 2**).

Various plans have been put in place at European and national level to adapt education and training to the digital age, including AI tools.

Key point 2. Plans to adapt education to the digital age

To adapt education and training to the digital age, which includes AI as another tool, the European Commission launched the Digital Education Action Plan 2021-2027 in 2020[50].

At the national level, the new Artificial Intelligence Strategy has recently been published, which reinforces and accelerates the 2020 edition (ENIA)[51]. Additionally, the Digital Spain Agenda 2026 , in its strategic axis focused on people, sets the objective of completing the digital transformation of education[52].

To this end, between 2021 and 2024, a budget of €1.412 billion was allocated to the initiatives of the National Digital Skills Plan, aimed at digitising education and developing digital competencies for learning and lifelong professional development[53,54]. At the university level, through coordination between the Ministry of Science, Innovation and Universities and the Conference of Rectors of Spanish Universities (CRUE), it is proposed to modify the study plans to expand the digital training of future teachers and include digital training in the curriculum of the different degrees, among other measures[53].

The objective of digitalisation of education, which includes AI, was specified by the Ministry of Education, Vocational Training and Sports in the Plan for Digitalisation and Digital Skills of the Educational System (Plan #DigEdu)[55].

In summary, the Digital Spain Agenda 2026 establishes the global vision for the digitalisation of the country, the National Digital Skills Plan defines how to improve the digital skills of the population and the #DigEdu Plan is the specific strategy to bring digitalisation to the educational system[53,55].

AI opportunities for students

There are multiple AI-based applications whose purpose is to support students in their learning.

There are multiple AI-based applications whose purpose is to support students in their learning[19,56]. For example, some solve the mathematical operations that the user scans step by step, others interpret the student's diagrams and offer feedback, others help to write or correct code, improve drawings or animate them[19,57,58]. There is also educational software for learning languages, translating texts or answering students' questions[19,57,58]. Regarding its use in classrooms, the Ministry of Education, Vocational Training and Sports has published a guidance document that analyses the degree of compliance with European legislation on the protection of personal data of more than 70 AI applications with a free version[58]. Among the most popular are generative AI tools and adaptive learning tools.

Generative AI tools

Currently, the use of generative AI tools is not recommended for children under 13 years of age.

For students with access to it, the uses are very varied. There are already guides with recommendations for ethical use.

Despite its widespread use among students[11], the most popular applications are recommended only for children aged 13 and over[59] and, in some cases, from 18 to 60. This is because the content generated may not be appropriate, children under the age of 13 need parental consent to use ChatGPT, although neither tool has an age verification mechanism[60].

Adult or consenting learners can use generative AI to summarise, outline, highlight keywords, obtain definitions and expand an explanation, express an idea in an alternative way, search for basic bibliography, structure papers, translate or simplify texts, review their grammatical style and format, generate self-assessment questionnaires, correct code, write their CV, act as an opponent to prepare debates, generate images, presentations, etc. [33,61–64]. But they must be aware of the risk of inaccuracy, the lack of depth of content and the need to monitor the results[33,61–64]. It is recommended that users do not settle for the first answer and learn to communicate with the application using effective instructions[61]. For ethical use, students must adhere to the guidelines set by their teachers regarding generative AI tools, reference them if used, and develop the critical skills necessary, according to their educational stage, to identify biases or false information in the generated results. They should also avoid providing personal information and refrain from directly copying automatically produced texts without engaging in analysis that fosters learning[61] (**See Key point 3**).

Educational institutions have the task of assessing the suitability of these tools in education.[24].

Tools to personalise learning

There are tools capable of personalising teaching based on students' prior knowledge, skills, and responses. This technology presents risks and benefits.

Decades ago it was shown that individual tutoring improved students' academic performance and reduced the differences between them[78]. Still, even in small classes, personalising content for each student is a major effort[19,57,78]. However, since the 1970s, AI-based platforms have been developed that allow learning paths to be adapted, based on each student's prior knowledge, weaknesses and strengths[57]. Using training data and the results generated through use, machine learning makes it possible to create and update personalised models, or an average student model, which are used to recommend new itineraries that respond to their progress[57]. Some algorithms, when dealing with complex subjects, are capable of generating trillions of diffent learning paths[57].

These platforms, together with virtual tutors, allow students to receive immediate feedback at any time without fear of being judged for their answers. In addition, they extend learning time beyond school[79], point out to the teacher the areas where students have more difficulties and use elabourate resources such as animations, 3D representations or recordings with the correct pronunciation[57]. There are also options aimed at students with disabilities or learning difficulties, such as dyslexia[80–83]. While some reports indicate that students with disabilities are at a disadvantage when using digital technologies due to accessibility barriers, others point out that it is necessary to work to bring new technologies to everyone[19,84].

On the other side of the coin, the individualisation of learning means ignoring its social component and focusing the objective on academic performance[57,85]. The consequences that this may have on the psychological well-being of the student and on his or her ability to self-regulate are unknown, since these methods require more self-control and discipline[57,85]. Furthermore, to predict the next steps in the pathway, the model relies on the average student's responses or on data from the student's past[57]. However, people are constantly evolving and their behaviour and circumstances may not be predicted[57].

· Learning paths: Sequence of activities that are carried out to learn a certain content or skill.
· Virtual tutor: AI-powered tool that offers personalised educational assistance.

Generative AI tools could pass exams or generate works of art. Its use carries risks such as preventing learning or incurring errors, copyright violation or plagiarism. Currently, it is impossible to prove the copying of texts produced by generative AI.

It is necessary to rethink what is going to be taught and for what purposes and how the students' abilities are going to be examined and validated.

Although in some cases these technologies have been banned, in others guidelines have been established for their appropriate and ethical use.

Key point 3. Homework, research papers and assessment in the era of generative AI.

Generative AI is capable of passing university exams and creating artistic works[24,64–69]. Furthermore, one study found that AI-generated papers passed muster with humans 94% of the time and received even higher grades, especially early years[65]. Therefore, it is necessary to reconsider what is going to be learned and for what purposes and how the students' abilities are going to be examined and validated, since unsupervised tests may not reflect their knowledge[24,64,68–70]. Regarding the content, the expert community believes that it is necessary to continue acquiring fundamental skills at a high level in order to develop complex thinking, even in those tasks that AI can perform better than humans[24]. It is also important for students to learn how to use current tools, without replacing the learning of critical skills[70,71].

Regardless of its educational value, students find generative AI useful[11,72]. They can solve their tasks much more quickly and even produce texts that they judge to be better than their own without having to go through the learning process[57,73]. The misuse of this technology is particularly relevant in undergraduate and postgraduate research projects, as students may, even unknowingly, make mistakes, violate copyright laws, or commit plagiarism (**see below**)[68,74].

Some argue that the problem is not new, as students have always used all kinds of resources that are not always detectable (encyclopedias, the Internet, external help, etc.) to solve their tasks and pass their assessments. and that generative AI simply magnifies and makes visible problems that were already present[57,71,75]. In this case, however, the turning point is given by the impossibility of distinguishing whether a text has been generated by AI[71,76]. Even the most advanced generative AI detectors, which lose effectiveness if single words or phrases are modified, only offer a probability that the text is not of human origin[71]. However, since there is no access to the text that generated the model, it is not possible to prove the copy if the student denies it[71].

Although in some cases it has been decided to completely ban these technologies, in others guidelines have been established to train and guide students and teachers in their appropriate and ethical use[24,61,68,71,77]. On the one hand, it is recommended to rethink the evaluation of the works taking into account the available technology[68,75]. For example, grades could be based on tests or classroom assignments without technology, on presentations or oral exams, or on exercises that specify which tools can and cannot be used, with innovative questions or formats that large language models cannot easily solve. It may also be required to explicitly state in the research papers which technologies have been used and in what form[61,68]. Likewise, it is recommended to value processes more than products, to continuously supervise students and to accompany them in the use of technology, encouraging higher capacities such as critical thinking[68,75]. Some of these approaches (oral examinations, continuous supervision) require more time in the classroom and therefore more staff, which leads to increased costs or the transformation of school organisation and dynamics[68].

Therefore, the algorithm may have difficulty interpreting fluctuations from normality or even registering them, since many variables with educational relevance (e.g., classroom conversations) are not within its reach·.

Personalised learning through automation technologies could also widen the gaps between students with higher and lower academic performance and even pigeonhole them (known in psychology as the Pygmalion effect or self-fulfilling prophecy), by exposing them mostly only to content that they will like or feel comfortable with.[57]. In addition, students can discover their weaknesses and sabotage them. For example, students may respond incorrectly to get easier tasks that they can complete in less time[86]. Additionally, completing a classmate's assignments could lead the system to incorrectly infer that the student is making progress, resulting in the assignment of increasingly difficult tasks that may ultimately demotivate them[86].

Despite uncertainties, some of these tools have demonstrated their effectiveness, often in the teaching of mathematics, although often in short studies, with research in universities or institutes and less evidence in earlier stages or in other areas such as reading and writing[19,87–90].

· Plagiarism: Using content created by another person as if it were your own, without explicitly crediting where the information comes from.

Others point out that it is necessary to investigate whether the improvement comes from using the tool itself or from receiving longer instruction.[90]. Its critics argue that it is merely a temporary fix that diverts resources from addressing the root of the problem: the need for more qualified teachers[19].

AI opportunities for educational staff

The aim of these technologies is not to replace teachers but to enhance their capabilities.

Generative AI tools can speed up the completion of some teaching tasks.

AI-based assessment systems are considered high risk. An intermediate way would be to use AI to support the teacher in corrections.

Some point out that AI proponents aim to replace teachers or relegate them to minor tasks[19]. Others, however, hope that technology will free teachers from some tasks so they can focus on more relevant ones[19]. According to this view, the goal of using AI to assist teachers is not to replace them with technology but to expand their capabilities through new tools, the so-called augmented teacher[57].

Generative AI tools

With the right prompts and a subsequent review, teachers can leverage this technology to develop lesson plans, identify key learning objectives, create rubrics and infographics, summarise or adapt topics for students with functional diversity or different proficiency levels, transform texts into various styles, find new educational resources, design assessments, generate audio and video from text, and explore other applications mentioned earlier[61,64,79,91,92].

It may be interesting to use them in class to make students see their limitations, for example, by identifying errors[57].

Tools for assessment and feedback

The Beijing Consensus on AI and Education, sponsored by UNESCO, proposes to harness the potential of data to assess the different competencies of students, provided that the associated risks are mitigated [16]. It also uses AI to support large-scale and remote assessment[16]. Proponents of using AI for marking propose that, in addition to saving teachers time, more objective grades could be obtained and the evaluation period could be extended, which would reduce the dynamics aimed at preparing tests[93,94]. However, AI may be biased and unfair in its corrections, perpetuating past inequalities[19,93]. Furthermore, AI analysis may not have the depth of interpretation of humans[19,93]. These characteristics have led to these systems being considered as high risk (see Regulation below)[95]. Furthermore, subjecting a person to an automated decision with legal or significant effects is already prohibited under Article 22 of the General Data Protection Regulation if there are no certain guarantees, such as qualified human intervention[96].

An intermediate way would be to use AI to support the teacher in corrections. In this way, technology would offer suggestions and shortcuts, but the grading would be done by the teachers[19]. AI could also be used to guide students during continuous assessment, correcting first drafts of their work in order to provide feedback before they submit the final version[19].

Tools to optimise team building

The free program Eduteams, developed by the CSIC, distributes students into diverse teams, so that all groups are equally capable of performing the task and students can learn from each other.

Students learn more, retain information longer, and are more satisfied with their classes when they work in teams and follow active learning dynamics[97–99]. In order to group them in the most balanced way possible, the Spanish National Research Council (CSIC) has developed the free computer program Eduteams[97]. Using different algorithms and based on the personality, gender and skills of the students, it distributes students into teams that have all the skills necessary to develop a task and are also diverse in terms of personality and gender. The

· Rubric: Box that breaks down the different levels of performance to assess student learning.
· Active learning: The student participates in his/her learning by thinking, discussing hypotheses, researching and creating. In class, you practice skills, solve problems, ponder complex questions, make decisions, propose solutions, or explain your ideas in writing or in discussions. Receive feedback from your teachers and peers[207].

goal is for all groups to be equally capable of performing the work and for participants to be able to learn from each other[97,100]. Teams that use AI appear to perform better than those assembled using traditional methods[101,102].

Tools for understanding how learning happens

Learning data collected through various digital tools is analysed and modelled, often with artificial intelligence, to make predictions and facilitate learning.

Some researchers point to the need to collect more data on how people learn, from diverse sources and in an interoperable manner.

Researchers in the field of learning analytics obtain data on how students learn so that teachers (or even other stakeholders such as students, parents, institutions, etc.) can make decisions that facilitate learning[19,103]. For example, the results of the analysis can lead to modifying the design of a course, influencing how students review the content, recognising aspects that they find difficult, identifying people at risk of dropping out of the course, knowing how they are doing in other subjects, predicting the final grade, having an impression of the performance of the entire class or allowing the student to know how their classmates are progressing, etc.[62,104–111].

Data collected through various digital tools is analysed and modelled, often with AI to make predictions[112,113]. For example, the data source could be adaptive learning platforms that inform the teacher of their students' progress and difficulties with homework, so that they can adapt their classes accordingly[114,115].

Teachers are often not involved in research on how people learn, which makes it difficult to interpret the results, which are highly context-dependent[116]. Some researchers propose that part of the teaching staff should specialise in obtaining data in order to collaborate with them. They also point out that in order to scale the results of analytical learning, they need to integrate data from various sources and for these to be interoperable.[116,117].

Tools to automate routine tasks

Educational staff can use AI tools to reduce their administrative workload and focus their efforts on students.

Teachers could use AI tools to track attendance and reduce their administrative workload[79].

These tools could also assist administrative and institutional services, for example, by supporting admission processes or through monitored chatbots that provide continuous assistance to applicants, answering their queries at any time.[19,64,118,119]. Likewise, they can be used to create schedules, assign spaces, write reminders for families or to plan the exam calendar[93,120].

Risks of using AI in education

There is not yet enough solid, independent evidence on the effects of introducing AI into education.

Like other technologies, AI is a social product that can be oriented toward certain values or others. The expert community urges the opening of a public debate, including among technologists, sociologists and educational personnel, to decide how AI fits into the educational system and limit its risks.

AI, although it has its own specificities, falls within educational technology[13]. Although there is not as much evidence about its use in education, there is more about educational technology in general[19,57]. In the scientific literature, it has been observed that there are two parameters that influence the success of interventions: the dedication and training of the implementer and the sample size[121]. Regarding the latter, most experiences are investigated on a small scale and are a test of efficacy rather than effectiveness under less controlled conditions. The positive effect is often diluted by scaling, although successful interventions with millions of students are also known[10,121].

· Analytical learning: Techniques for collecting and measuring data about students and their contexts, with the aim of understanding and supporting the assimilation of knowledge and optimizing the environment in which it occurs[57,208].
· Interoperable: Data interchangeable between different systems.

An experiment with educational technology on a large scale was education during the recent pandemic when, due to the sudden closure of educational centers, classes were taught remotely using digital media[122]. Although these decisions allowed many students to continue the course, others were excluded[122]. In countries such as Spain, it is estimated that 35% of learning was lost compared to a normal year and that these losses were even greater for children from disadvantaged backgrounds[122,123]. In this difficult context, mental and physical health also worsened, and human relationships were replaced by those mediated by machines[122]. In these extreme circumstances, studies indicate that technology was not able to replace schools[122].

Regarding AI, there is still not enough solid and independent evidence on the effects of introducing it into education and its effectiveness in improving learning[19,57,120], so claims that vindicate its transformative power in this area are still aspirational[19].

For some, technology is not ideologically neutral, but it carries values that cannot be separated from the social and political context in which it operates.[22,32,124,125]. As a social product, its effects and impacts cannot be separated from the objectives of educational policies, which may prioritize greater equity and social justice, or greater excellence and differentiation[22,124,126]. Deciding how AI fits into the education system and limiting its risks and unwanted impacts requires the involvement of technologists, educational policy makers, social scientists and the educational community to open and diversify the public debate[124]. This involves knowing how people use this technology, what resources are needed to produce it, what actors develop and market the applications and what forms of educational organization they entail[124]. In the educational context, this means involving teachers, students, managers and education experts, as well as assessing whether the objective pursued by the introduction of AI promotes their well-being and inclusive, equitable and quality education[127].

Below are a number of risks associated with the use of AI in education, some of which are common to other educational technologies.

Privacy and data protection

AI tools that process personal data, profile individuals or make decisions about them will have to comply with the General Data Protection Regulation.

Some educational technology tools lack information on data processing and there is a certain lack of transparency in verifying whether they comply with the GDPR. Some algorithms may infer true or false information that violates user privacy or results in discrimination.

The General Data Protection Regulation (GDPR) protects the fundamental rights and freedoms of natural persons in relation to personal data processing activities[96].

Processing that includes operations implemented with AI systems that process personal data, generate profiles of natural persons or make decisions about them will have to be subject to the GDPR[128]. In this sense, it must be subject to the principles of: legality, loyalty and transparency (that the data is processed only if supported by a legal basis, without misleading or deceiving the interested party, who must be informed in a clear and concise manner), limitation of purpose (that it is collected for specific explicit and legitimate purposes), data minimisation (collecting the minimum necessary for the purpose of the activity), accuracy, limitation of the conservation period (that the interested party can be identified only for the time necessary for the agreed purposes) and security and confidentiality (that the security of the data is guaranteed) and proactive responsibility[96].

However, the reality is different. On the one hand, some learning tools lack information about data processing, such as what data is collected (it may be personal, academic, attendance or other more invisible data such as student clicks, time on the page, answers that are rewritten, etc.), where it is stored, for how long, how the quality of the data generated is guaranteed, which participants are involved in the processing or for what purposes it will be used[19,76,129]. There is also a certain opacity that makes it difficult to validate whether the aforementioned principles are actually met[19].

· Accountability : The controller must implement appropriate technical and organisational measures to ensure and demonstrate that processing is carried out in accordance with the GDPR (Article 24).

On the other hand, systems that include AI can increase the risks to the rights and freedoms of students, teachers and family members, as well as security[130] or present some specific ones[128]. Furthermore, machine learning-based models often work better with more data than strictly necessary, making it difficult to establish the limit of the minimisation principle[130].

Along the same lines, in addition to the data provided, some algorithms can infer information, true or false, that violates the privacy of users and may even result in discrimination[15,19].

It is important to note that data processing for the use of AI in classrooms cannot be based on the consent of a minor under 14 years old and, in general, cannot rely on consent, as it is not appropriate in situations where there is a power imbalance between the parties and can be withdrawn at any time[86,131]. As with all processing of personal data, if it is not based on consent, it may only be carried out if it is necessary to fulfil certain purposes: to execute or perfect a contract, to serve the public interest or to comply with a legal obligation[86,96]. In the two latter cases, this purpose must be established in a law[86,96].

There are mechanisms to mitigate risk, such as running applications on the device itself rather than on a web server, using versions that do not continue to learn, making data less readable, aggregating it, or anonymising it[128,130].

If the processing using AI involves a high risk, it is mandatory that it be truly suitable (it objectively fulfils its purpose), necessary (there is no other less harmful way of achieving the purpose) and proportional (the benefits to society and the data subject outweigh the intrusion into rights and freedoms)[96].

Furthermore, the determination of the quality and reliability of products that use AI cannot be based solely on the statements of manufacturers and distributors: it is essential that, like any other technological development, they pass prior examinations carried out by third parties and that reference frameworks are developed to accredit compliance with the GDPR[128].

Surveillance

Students may feel watched and change their behaviours.

If AI applications constantly collect data on their academic performance, students may feel monitored, exposed, and change their behaviours, inhibit themselves, self-censor, or act as they believe is expected of them[76,86]. Some studies warn that having so much data can lead to relationships in the classroom based on distrust, control and supervision[23,132].

Biases

Biases can result in algorithm malfunction or even discrimination against students. They can be in the training data, in the algorithms, or in the physical appearance of the system.

Selecting data appropriately for AI training is a key step for its ethical operation: if they are not balanced, the tool can reproduce these biases during its operation[64,76,133,134]. For example, if it has been trained mostly on white male faces, it will not be as efficient at recognising women's faces, especially non-white women[135]. What's more, if a group is overrepresented, AI may recognise patterns or establish erroneous causal relationships to its advantage. For example, scoring men's resumes higher by inferring that being a man is preferable for certain positions[135].

The dataset used to train the main language models has not been made public, although it is known to include a majority of uncurated content collected directly from the Internet[136]. One of these datasets, the so-called *Common Crawl*, has been used to train the main models and contains a non-negligible percentage of unwanted content, including hate speech and explicit sexual content even after having been filtered[136]. Biases have been detected in the texts and images produced by these models that lead to the generation of sexist or racist content or to the perpetuation and replication of certain stereotypes[15,57,76].

Prejudices can also be found in algorithms and in the physical appearance, voice or name that the system adopts. For example, the majority of virtual assistants for students at different Spanish universities have a woman's name and appearance[135].

In addition to the recommendation to use quality data, there are human-centered design techniques to promote the ethical development of software products[137,138]. These include, for example, protocols for designing more gender-inclusive products[139], specific instructions for neutralising discriminatory variables[135] , or using AI as a tool to anonymise profiles in selection processes or eliminate information that allows personal identification[133].

Filter effect

Due to their training, tools may not have access to all available knowledge on a topic and may offer a biased view of reality.

Generative AI is not a search engine, but rather acts as a filter based on the data with which it has been trained[57,74]. You may not have access to all knowledge of a topic (for example, including articles by some authors and not others or excluding non-digitised knowledge), which impoverishes reality for users and biases knowledge[57,74].

For these reasons, some experts point out the convenience of universities and other public entities developing more transparent and reliable, open and non-profit models[74,140].

Social disconnection

AI tools, like other technologies, can promote student isolation or foster collabourative learning, depending on how they are designed.

The school, in addition to being an academic space, is an irreplaceable space for socialisation where one learns with and from others and where the link with the teaching staff is central to educational success[141,142]. As with other technologies, students' use of AI devices may lead to less interaction with their peers. and teachers[120,122,143]. Prioritise the relationship between students with technology can weaken the social aspect of learning[85,122,144] and impoverish the educational experience by increasing isolation, loneliness and disconnection[143].

However, some experts advocate the design of AI applications aligned with social values, which allow students to benefit from technology without replacing human interaction[144]. This trend suggests that AI tools are an opportunity to plan activities in which students can set their own goals and work as a team on open projects[144].

Effects on human capabilities

The impact that using these technologies can have on the neurological, cognitive and emotional development of schoolchildren is still unknown. There is concern, for example, about the effect that generative AI may have on certain skills such as creativity. The expert community recommends using it to enhance human skills and create with it, rather than letting AI create for humans.

Beyond the effects of using AI in the educational experience, its impact on the neurological, cognitive and emotional development of schoolchildren is still unknown[19,145]. There is concern, for example, about the effect that generative AI can have on skills such as creativity, curiosity, critical thinking or the ability to solve problems, as well as the possibility of generating technological dependence[57,120,146]. In some cases, it can be used to skip the learning process and directly obtain the final product[73]. There is also the possibility that AI will undermine the functions of teachers, and they will be relegated to facilitators of technology and student behaviour monitors[57,120].

However, a study conducted with university students revealed that generative AI facilitates and accelerates idea generation and other aspects of creativity.[147]. As a counterpoint, some of the participants were unable to provide alternatives to those proposed by AI and felt that the technology was doing the work for them[147]. Moreover, some did not see the AI's suggestions as original, but rather as a rehash of other people's ideas, underscoring the need for oversight and refinement of the results[147]. Despite its usefulness, other research indicates that students tend to rely on AI rather than learn from it, underscoring the need to balance its use[148].

On the other hand, a study on how PhD students use generative AI found that those who used AI to improve their texts wrote better. than those who did not use it or used it only as a source of supplementary information[149]. Along these lines, the expert community recommends developing and using tools that improve human skills, rather than using it as a search engine[79]. They propose creating with AI rather than letting AI create for humans[150].

Inaccuracies, errors and overconfidence

Generative AI often provides incorrect information that can go unnoticed. The criteria it uses in its decisions can be difficult to ignore, indicating the need for regulation and establishing high quality standards in the systems that can condition human decisions.

Generative AI invents information that may appear true[76]. This can lead to low-quality educational materials or incorrect responses from students[120]. A recent study of programming questions found that ChatGPT provided incorrect information in 52% of responses[151]. This inaccuracy is one of the main concerns of teachers[152]. However, in another survey, only 56% of students felt that it can sometimes provide false information[11,32]. Furthermore, misinformation can often go unnoticed[151].

It has also been observed that it can negatively impact decision-making because people tend to trust the algorithm's judgment and do not ignore it when it is wrong[153,154], even if the user has information about how the algorithm decides[153].

These data underscore the need for regulation and high quality standards in systems that may influence human decisions (for example, in academic guidance). At the same time, it is key to develop students' critical thinking and encourage their curiosity to know more[76,153].

Copyright and plagiarism

There are still no clear guidelines on whether users can post content that has been partly generated by AI as their own, nor is it clearly established who is responsible for it if the content is protected by copyright.

The data used to train the large language models is public, but it is known that they can also access copyrighted content and summarise it or use fragments of watermarked photographs to compose a new image[57,155]. Also, some copyright licenses allow the use of content if the original source is cited, something that models may or may not do[57]. Normally, AI does not reproduce texts literally, but rather generates them from sources[155]. It can reproduce common phrases that do not generate copyright. However, it may be the case that during training some protected content is repeated a lot, because it is very frequent, and the AI considers that it is a natural response and reproduces it without modifying it[156]. Thus, in theory the student could incur plagiarism or violate copyright if they use texts or images from unmodified AI, which are originally protected, without accreditation[74]. Some large companies have reported the reproduction of their content without permission, but there are still no rulings on the matter[155,157,158].

In this sense, Royal Decree 24/2021 indicates that it is lawful to use content protected by intellectual property rights for data mining as long as the purpose is research or commercial uses, unless the owner explicitly rejects that their content be used for this purpose[159]. Still, according to experts, there is still uncertainty about how these assumptions will be interpreted with respect to generative AI.

Currently, work generated solely by AI is not copyrightable, since by law only humans can be authors[160]. However, there are still no clear guidelines on how much content needs to be modified in order to be able to claim any rights[57,161]. Furthermore, since generative AI can take texts from other people, authorship and plagiarism are no longer as simple to define as before (someone was an author or not, a source was used or not) [74,162]. It is debated, for example, whether generative AI could generate rights such as sui generis database rights.[163].

· Sui generis right on databases: Right of the manufacturer of a database to prohibit the extraction or use of its contents in whole or in part.

Commercialisation of education

If AI applications become widely used in education, it could be a form of hidden privatisation, as most of them are commercial products. The concentration of technologies in a few companies can lead to homogenizing what is studied in different countries.

AI research was mostly conducted in universities until 2014, when collaborations with companies increased[164]. However, the rise of deep learning is tipping the balance towards the corporate domain, which has plenty of funding, computing power, large data sets and highly trained researchers[41,165]. If the use of AI applications in education becomes widespread, it could be a case of hidden privatisation, since most are commercial products[19].

On the other hand, the pioneering and most successful companies are concentrated in a few countries, mostly English-speaking, which makes cultural diversity difficult and can lead to these companies determining and homogenising the content that is studied[19,57]. In addition to the influence that these companies can have on the future societies of user countries, there is also a gap between countries with access to this technology and the rest[1,19,57].

On another level, some also point to the need to safeguard the academic freedom of teachers who use educational platforms at the university and the intellectual property over the content they upload[129].

As a solution, the expert community proposes promoting open educational resources and the development of public tools that allow independence from companies[19,140].

Widening the digital divide

Access to digital infrastructure is unequal. In addition, most apps eventually require a paid subscription, which could widen the gap.

Using AI requires a basic digital infrastructure, with computers and stable internet access[15]. However, access to these resources is unequal, as evidenced by the pandemic[15,58], although it could be alleviated with systems for lending, recycling and reconditioning devices in the centres[120]. The digital skills of families are also unequal[120]. Furthermore, most AI applications are free at first, but later require a paid subscription, which is necessary to access at least the most powerful version of the technology[76]. This can result in inequalities between students and schools. On the other hand, free tools base their business on data collected or advertising[19,76,143].

To promote equality, the expert community calls for the development of low-cost, user-friendly programmes that unify the best features and do not require too much technical knowledge for their use[79].

Energy expenditure and environmental cost

AI systems, especially generative AI, are costly to the environment, although there are alternatives to make them less polluting.

AI systems, particularly generative AI, have a significant environmental cost: they require energy and critical raw materials, emit CO□, consume water to cool servers, take up physical space, and generate electronic waste[57,166–168].

A significant portion of the energy expenditure comes from training the models. For example, it is estimated that a person emits about 5 tons of CO_2 (or equivalent gases) per year, while training a large model based on neural networks emitted 284 tons[41].

Using them also leaves a carbon footprint, especially significant in image generation[166,169]. Even when it comes to text, 1000 responses would be equivalent in the most efficient models to 9% of the energy needed to charge a smartphone[166]. Thus, although each response may require a relatively small amount of energy, the total consumption accumulates exponentially when used worldwide millions of times a day[166]. Furthermore, large language models continue to grow in size, multiplying their consumption and requirements[41,168,169]. In this sense, others argue that training models better saves energy in the long term, since they are more efficient and consume less energy each time they are used[170].

Other strategies to make AI less polluting would be to reuse models instead of training them from scratch, use renewable energy sources, and decide in which situations it is needed and with what capacities[41,167,170].

The integration of AI into the educational system

Below, we explore some alternatives for equipping society with the tools and capabilities needed to engage with AI effectively, especially in the educational field.

AI literacy

Alternatives for building an effective and secure relationship with AI are explored below.

Learning the basics of AI is necessary for that students and other actors in the educational system can use it safely, understand the technology and how it affects them. Also to awaken the necessary vocations in this sector.

In Spain, the regulated introduction of AI in pre-university stages is still pending. Computational thinking, programming language and educational robotics are already taught.

Digital literacy is not a matter of the future but of the present, since the digital society already shapes the way we interpret, live and understand the world as well as the experience of being at school for students[171]. However, having technological devices does not guarantee that students acquire the knowledge they will need to study or work. It is not just about learning to use technology, but about understanding it critically and training people to participate in today's digital society[171,172].

Specifically, learning the basics of AI is necessary so that students and other actors in the educational system can use it safely, understand the technology, its risks and benefits and how it affects them[173], as well as to demystify it and avoid conceptual errors (for example, attributing excessive human traits or qualities to it[174]). It is also essential to awaken vocations and fill the specialised jobs that will be required in the coming years[173]. In this regard, in the European Union, the academic offer of master's degrees in AI is led by Germany, the Netherlands and Sweden, with Spain in an intermediate position[175]. However, the number of master's degrees offered, both generic and specialised, has recently increased and various universities have started degrees in AI[175].

Computational thinking, programming language and educational robotics, already present in early childhood, primary and secondary education curricula[176–178], provide a good basis for facilitating the understanding of AI[173,179]. As this is a new field for pre-university education and is constantly changing, at the moment only 15 countries have approved or are developing curricula for teaching at these stages[180]. In Spain, its regulated introduction is still pending[181]. It is necessary to define what students should learn in this context[182]. In this regard, educational scenarios are already being compiled from Europe and the Ministry of Education. and practical examples of its use[120,179]. At the international level, a reference framework for the AI[180]curriculum is being developed.

While in early education, approaches without computers or without using AI can be used to introduce students to the subject, in Spain, a private initiative has developed a platform called LearningML, which enables the teaching of the fundamentals of machine learning and encourages reflection on its responsible use[173,183] (**See Box 4**).

· Computational thinking: A problem-solving approach that is commonly used in computer science and programming but can also be applied to a wide range of non-computer science situations. Develop skills such as abstraction, breaking down problems into simpler ones, pattern identification, and algorithm design.[209].

LearningML is an open, free and accessible software platform for teaching the basics of machine learning and reflecting on its responsible use.

Key point 4. LearningML: a tool developed in Spain to teach machine learning

LearningML is an open, free and accessible software platform that does not require extensive knowledge to get started, but allows the development of complex projects with different algorithms[173]. Today, it is used by an average of 700 students per day in schools and institutes across the country[184–186]. It consists of two applications, one to develop machine learning models from training data and another to programme creative applications using the generated model[173]. It does not require registration and runs locally on the teacher's computer, without having to resort to the cloud, which guarantees data protection[173]. There is also a desktop version that does not require an internet connection, making it possible to use it in remote areas[187].

LearningML was evaluated in an online workshop with 135 students between 10 and 16 years old during the pandemic with good learning results[183]. In the same vein, it has also proven useful for teachers from various autonomous communities and as a classroom activity in secondary school mathematics (E.S.O.)[184,185]. Other applications to teach machine learning include *Teachable Machine*, *Cognimates* or *Machine Learning for kids*[76,173].

Another relevant aspect is teaching students to understand and analyse data, which is the basis of machine learning applications, as well as statistics, mathematics and computer science[174].

At the moment, international scientific evidence on the teaching experiences of machine learning in pre-university education It is scarce and mainly focused on the high school stage as part of formal education and associated with computer activities, although it is expected that more varied research will be published in the coming years[188]. The studies also showed a lack of preparation of teachers to teach machine learning[188]. This aspect is key, since the success of the experiences seems to depend on the teacher's degree of competence and interest in the subject, which underlines the need to investigate their needs[188].

Furthermore, many studies do not detail the degree of knowledge acquisition of students after the programme[189]. It is appropriate to develop assessment criteria to measure the degree of literacy in AI and what this literacy entails at the different pre-university levels[189].

Teacher training

Some preliminary studies indicate that teachers lack training in AI tools.

Regarding the preparation of teachers, it is important that they have the necessary knowledge to use and adapt AI tools according to their teaching and pedagogical priorities[23].

Some preliminary studies indicate that pre-university teachers in Spain and Latin America have little knowledge of and experience with AI tools[190]. Along these lines and given the speed with which it is advancing, a majority of the teaching staff do not believe themselves prepared to integrate it into their profession and they believe that they need training and cite a lack of time to get up to date or concerns about its risks[62,174,191].

In this sense, according to some ongoing research, opinions regarding the use of AI may become more positive after a training course[192]. The National Institute of Educational Technologies and Teacher Training (INTEF) offers training for teachers in different formats, as a complement that improves digital teaching competence[193]. Teachers need different skills depending on the objective: teaching how to safely interact with AI, approaching AI from a technical perspective, or using it for educational purposes[194]. Additionally, manual work and technological fabrication promote understanding and enhance students' critical thinking skills[171]. For this reason, some experts even suggest that teachers incorporate technology-building activities into their lessons. This means that they can make use of easily adaptable open educational resources or support and advice groups. To do this, they need tools to experiment with AI and time and resources to think individually and collectively about stable projects[79,195].

Regulation for the use of AI

The European Parliament and Council's AI Regulation will largely enter into force in 2026. It bans emotion recognition systems and characterises others as high-risk, meaning they will have to be subject to strict requirements before they can be introduced to the market.

Although there are aspects of AI that are already regulated by other laws, such as data processing by the GDPR, the AI Regulation of the European Parliament and the Council, will largely enter into force in 2026 without the need for transposition. According to this regulation, incorporating AI systems in education is important to promote high-quality digital education and to enable students and teachers to acquire and share the necessary digital skills[95].

With this rule, to avoid violating students' privacy and perpetuating historical patterns of discrimination, emotion recognition systems are prohibited in education, except if they have therapeutic use[95]. In addition, high-risk systems will be considered those that can determine the educational and professional course of a person's life and influence his or her future possibilities[95]. Among them:

- Systems that determine admissions or assign individuals to educational programmes or institutions[95].
- Systems that assess the degree of learning or educational level and influence the degree that students will receive or the educational level to which they have access[95].
- Systems that monitor and detect prohibited behaviour during exams[95].

High-risk systems are subject to strict obligations before they can be introduced to the market, such as subjecting them to evaluation, training them with high-quality data sets, or ensuring traceability of results, among others[95].

In parallel, the Council of Europe, made up of 46 countries and open to other accessions, has published the first draft of the Framework Convention on Artificial Intelligence, Human Rights, Democracy and the Rule of Law[196].

At the national level, efforts to strengthen governance and the regulatory framework stand out, with the creation of the first Spanish Agency for the Supervision of Artificial Intelligence, which will ensure adherence to AI standards and facilitate its responsible introduction[197]. A regulatory sandbox has also been established in collaboration with the European Commission to facilitate the implementation of the new legislation[198,199].

The communities of Catalonia and the Canary Islands have published separate guidelines on the use of AI in the educational system[76,200].

Towards responsible AI in education

AI must meet a number of criteria to be considered responsible.

Responsible development and introduction of AI in education requires ensuring that AI is trustworthy. To do so, it must be based on three pillars: complying with the law, adhering to ethical principles and being robust[201–203].

Along with the requirements already mentioned, trustworthy AI supports human control or supervision and is transparent and explainable, allowing the actors involved to understand how it arrives at the result[201]. Algorithms should also be auditable to ensure they are working as expected, and there should be someone responsible if AI causes harm[201,204]. It also has to be beneficial not only for people today but also for future generations, which underlines the need for it to be sustainable[201].

· Emotion recognition systems: AI system to identify or infer emotions or intentions of people based on their biometric data.
· Regulatory sandbox: Framework to bring together AI development companies with regulatory authorities to define what characteristics these systems must have to comply with European regulations.
· AI Robustness: Quality of digital systems that seeks to ensure that they do not cause unintentional harm and are reliable from a technical and social perspective. It consists, for example, in reducing their possible weaknesses so that they are not sensitive to interferences that could alter the result of their analysis.

In the education field, the expert community calls for evaluating IA tools before implementing them and giving teachers time to train so they can develop stable projects. It also advises making decisions that can be adjustable and reversible and using technology without falling into technological solutionism.

In the educational field, the expert community suggests evaluating AI tools before using them based on criteria already used with other educational resources, such as accuracy of content, age-appropriateness, relevance of teaching methods, and cultural and social appropriateness[125].

On the other hand, in order to develop AI responsibly in the educational field, part of the expert community proposes basing its incorporation on the Precautionary Principle. This principle does not imply immobility, but rather acting according to a measured action, which is characterised by being progressive, revocable, taking into account the consequences of the actions and receiving feedback from the opinions and needs of the educational community[171,205]. In short, without denying the transformative potential of technology, some call for avoiding technological solutionism, since transforming and improving education depends especially on educational policy and the social and family context[171]. The changes that technologies can bring about go hand in hand with transformations in other dimensions, such as educational infrastructure, teacher training, establishing new pedagogies, improving assessment, having high-quality content and curriculum, etc.[23].

· Technological solutionism: To consider that complex problems are easily solved by inventing or applying technologies.

Key concepts

- The expert community urges to debate how AI fits into the education system and to decide how to equip institutions with the tools, methodology, human capabilities, ethics and regulatory frameworks to improve education.
- The use of AI in education brings benefits, challenges and risks about which there are still uncertainties, as there are not yet enough systematic and impartial studies on the subject.
- Among the opportunities, students could access tools that personalise learning or assist them in their tasks. Teachers could use AI systems to reduce the time they spend on routine tasks such as planning lessons, organising students into more effective teams, or collecting data about their learning and analysing it to make more informed decisions. Generative AI tools call for a rethinking of how students' abilities are assessed.
- The ethical and responsible use of AI in education covers very different aspects, such as student privacy, the effect on their cognitive abilities, data processing, the risk of social disconnection, or the environmental cost of these technologies.
- There are aspects that favour a safer and more productive relationship with AI: the development of responsible, ethical and proven quality AI, its regulation (although some aspects such as data processing are already regulated by current laws) and AI literacy among students and educational staff.
- Understanding the fundamentals of AI helps not only to use existing technology, but also to understand how it works, assess its risks and benefits, train critical thinking and be innovative and responsible in its development and application.
- The expert community urges the promotion of open educational resources and the development of independent public tools.

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