

BEYOND THE CHATBOT: TOWARDS A HYBRID FUTURE IN EDUCATION BETWEEN EMOTION AND ALGORITHMS

OLTRE IL CHATBOT: VERSO UN FUTURO IBRIDO NELL'EDUCAZIONE TRA EMOZIONE E ALGORITMI



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ABSTRACT

Artificial intelligence and algorithms are assuming an increasingly pervasive role in various fields. This study aims to promote the use of this technology to support teaching/learning processes with the aim of balancing tradition and innovation, between the massive potential of AI and the importance of human interaction. Generative AI can be used to develop a Virtual Tutor that is equipped with a personalized narrative design that takes into account the different cognitive styles and needs.

L'intelligenza artificiale e gli algoritmi stanno assumendo un ruolo sempre più pervasivo in vari campi. Questo studio mira a promuovere l'uso di questa tecnologia a supporto dei processi di insegnamento/apprendimento, con l'obiettivo di bilanciare tradizione e innovazione, tra l'enorme potenziale dell'IA e l'importanza dell'interazione umana. L'AI generativa può essere utilizzata per sviluppare un Virtual Tutor dotato di un design narrativo personalizzato che tenga conto dei diversi stili ed esigenze cognitive.

KEYWORDS

Artificial Intelligence; Narrative Design; Virtual Tutor; Inclusion; Sustainability.
Intelligenza Artificiale; Design Narrativo; Virtual Tutor; Inclusione; Sostenibilità

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Introduction¹

In today's scenario, Artificial Intelligence (AI) and Emotional Intelligence (EI) stand as two distinct but deeply intertwined concepts, catalyzing attention and debate. Although often opposed, these two areas of knowledge converge toward a common goal: shaping our future and improving our experience in the world. Simplifying greatly, we can argue that AI is configured as the ability of machines to replicate typically human abilities such as reasoning, learning, planning and creativity, while EI focuses on identifying, understanding and handling emotions, both one's own and those of others. While AI boasts the power to automate processes and generate innovative solutions, EI offers the ability to build deep relationships, master interpersonal challenges, and make thoughtful decisions.

As early as 1956, John McCarthy, an American computer scientist and mathematician who is considered one of the forefathers of artificial intelligence, argued that "if the human being is a thinking machine, no matter how complex, in principle it should be possible to simulate those same mechanisms of thought with a computer," imagining a world where the same machines can think like us, solve complex problems and even understand our emotions, a dream or a nightmare depending on your point of view, in reality, a few decades later, we are now all more or less aware that technological advances have profoundly changed our lifestyles and the way we interact and communicate. From the earliest rudimentary forms of communication, based on gestures and sounds shared in the same space, humans have made an extraordinary journey toward increasingly flexible and inclusive modes of interaction. Today, we can transcend the limits of time and space by sharing information and ideas with distant people through writing, print and the Web.

In the digital age, artificial intelligence and algorithms are taking on an increasingly pervasive role in various fields, including education. Algorithms have enabled us to develop intelligent machines with which we can communicate naturally, but this is possible not because they have learned to think like us, but because we have learned to communicate with them (Esposito, 2022). We try to develop machines that can understand our emotions, adapting to our needs and providing personalized support. At present, while it is true that through the analysis of image, video, and voice data, AI algorithms are able to identify human

¹ The article is the result of the scientific collaboration of the authors. However, the attribution of scientific responsibility is as follows: Fabrizio Schiavo is the author of paragraphs "Introduction" and "Methods and materials"; Alessia Sozio is co-author of "Discussion"; Michele Domenico Todino is co-author of "Conclusions".

emotions with increasing accuracy, it is also true, however, that algorithm-based learning is often impersonal and lacks the human interaction that is essential for the social and emotional development of individuals. The strategic integration of AI and EI opens up a range of exciting possibilities, especially in the educational field. Think of educational systems that leverage AI to personalize learning, powering each student's passion and talent. The priority for creating meaningful connections between AI and Education is precisely to make the interdisciplinary fields of study contaminate each other in a synchronous and mutual way by finding a space for comparison and project through a joint negotiation of models, intents, actions, practices, as well as outcomes that are both effective and ethical to enforce more participatory and concrete ways (Panciroli et al., 2020).

Certainly European documents on artificial intelligence regulation or digital competencies, such as the AI Act and the Digital Competence Framework for Citizens (DigComp 2.2), are a very important benchmark to ensure democracy, protect the fundamental rights of citizens, and establish the standards and competencies essential to successfully address the challenges and opportunities presented by this new technology, but as argued in the report produced by UNESCO's Unit for Technology and Artificial Intelligence in Education, regulations on their own are insufficient to ensure AI as a common good for education and humanity. All citizens need to be equipped with some level of AI literacy covering the values, knowledge, and skills related to AI in order to enhance and achieve SDG 4 of the 2030 Agenda for Sustainable Development (UNESCO, 2022). Obviously, in order to achieve these goals and ensure AI literacy, it is crucial to make sure that technological development is guided by human values that take into account issues related to ethics, data treatment and privacy, and the digital divide, so as to capitalize the potential associated with its use and build a more prosperous, equal, and fulfilling future for all.

This study aims to promote the use of this technology to support teaching/learning processes with the aim of balancing tradition and innovation, between the massive potential of AI and the importance of human interaction. It becomes clear, then, that technology can be used to support the teacher, not to replace them. The teacher remains the focus of learning, able to provide students with the guidance, support and empathy they need.

In general, we know that chatbots, conversational agents that can simulate a dialogue with humans, are becoming increasingly sophisticated and widespread, so much so that they are revolutionizing the way we interact with computers. However, the capacity of chatbots to understand and reply to human emotions is

still a matter of debate. Several studies have explored the capacity of chatbots to understand and reply to human emotions (for a review, see Bilquise et al., 2022). Some researchers argue that chatbots can learn to understand and respond to human emotions through machine learning and natural language processing. Others, however, argue that chatbots are unable to truly feel or understand emotions because machine answers are based on pre-programmed rules and have no real understanding of the emotional meaning of words and phrases. A common approach to integrating EI into AI is the use of emotion detection and analysis algorithms. For e.g., sentiment analysis is widely used to evaluate emotions associated with text (Pang & Lee, 2008). Other approaches focus on multimodal processing, which integrates visual, auditory, and textual signals to better understand users' emotional state (Baltrušaitis et al., 2017). However, understanding human emotions remains complex due to their subjective and contextual nature (Picard, 2003). Despite progress, there are several challenges and limitations to integrating EI into AI. A key challenge is the lack of labeled data and coherent models to represent human emotions (Calvo & D'Mello, 2010). In addition, emotion interpretation requires cultural and situational context, which can be difficult to capture through traditional algorithms (Kanjo et al., 2015). Finally, there is a risk of perpetuating stereotypes and discrimination through AI systems that do not take into account human emotional diversity (Noble, 2018).

Based on these studies and shifting the focus to the educational field, we believe that it is possible to combine these two concepts. The use of algorithms in education can be a powerful tool for improving learning, but it is crucial that it be integrated with the human experience and the emotional component. A hybrid future of education, one that enhances both emotions and algorithms, can make it possible to create a fuller, more engaging and effective learning experience and guarantee quality education for all students. Moving beyond the simple chatbot, with the appropriate teacher training, generative AI can be used to develop a Virtual Tutor that is equipped with a personalized narrative design that takes into account different cognitive styles and individual specific needs.

1. Methods and materials

1.1 Virtual Tutor

The ongoing environmental crisis requires innovative approaches to engage and educate future generations on sustainable development issues. It becomes necessary to rethink the educational system to create new pedagogical models

that can capitalize on the potential related to the use of technologies and foster "experiential learning" (Kolb, 1984) that enhances the active participation of each student. The purpose of this project is to present a Virtual Tutor (VT) that can be used in every grade level as an interactive guide that provides real-time information, tips and resources on the topic. Through an intuitive conversational interface, GAIA, a name chosen specifically because, in addition to recalling the goddess of the Earth in Greek mythology, it also represents the acronym for Generative Artificial Intelligence Assistant, thus emphasizing the connection between our research and respect for the natural world, engages users in personalized conversations about sustainability, offering practical solutions for reducing environmental impact and adopting sustainable lifestyles.

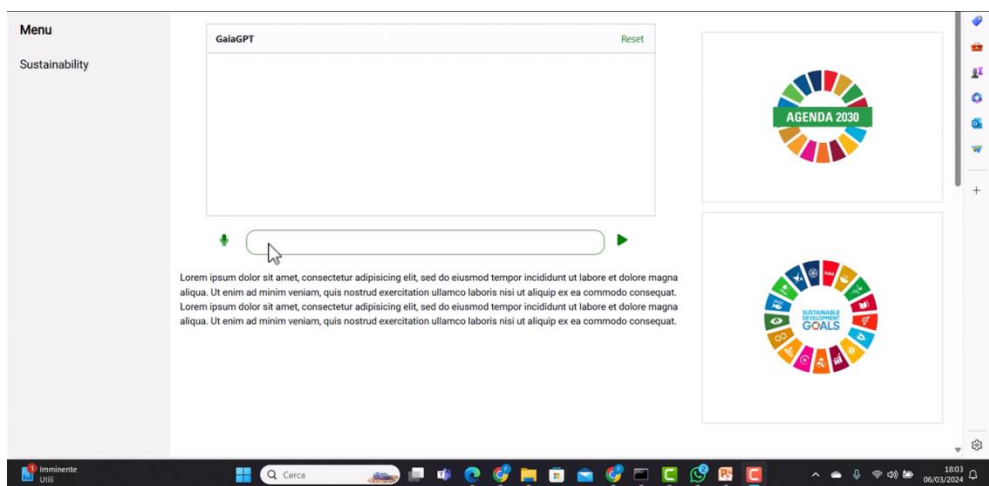


Figure 1 GAIA chatbot interface

The project is currently under development. After conducting appropriate studies, we chose to adopt GPT4All, an open source model based on Meta's LLaMA 7B. This choice is motivated by the reason that it requires less computing power and allows us to train and optimize the general model with smaller amounts of high-quality data. This allows us to make more focused use of our Virtual Tutor (VT). Generally, large language models (LLMs) are trained on large text corpora, but excellent responses have also been given by scaling these models (Brown et al., 2020; Hoffmann et al., 2022). With this solution, we are able to train models using only specific publicly available datasets, avoiding the use of proprietary and inaccessible datasets. Importantly, the creation of a specific dataset can, in theory, contain less bias or toxic and offensive content than a large language model (LLM), but it could still generate errors. It has long been known that

artificial neural networks (ANNs) are usually “black boxes” and that their internal mechanisms are not open to inspection. As a result, ANNs are not “transparent” or “explainable,” and it is not possible to ascertain how their results were determined. If users do not understand how a GenAI system arrived at a specific result, they are less likely to be willing to adopt or use it (Nazaretsky et al., 2022b). For this reason, narrative design and teacher supervision becomes critical to foster the emergence and development of critical thinking by students while using these technologies.

In fact, narrative design has been added to this model, which can support teachers and improve student engagement and learning effectiveness through adaptive algorithms based on: machine learning models to select the most relevant knowledge content; recommendation algorithms to propose additional learning activities; grading algorithms to assess student progress; and real-time feedback mechanisms to adjust learning strategies.

1.2 Narrative Design

We based the implementation of narrative design by pursuing the theoretical principles of narratology and communication theory. According to Bruner (1991), narratives are fundamental to understanding and building the world, as they allow us to attribute meaning to events and experiences. In this context, we have focused on creating interactive and personalized narratives that guide the user through a structured and engaging experience. We believe that this approach is key to creating an emotional connection between the user and the educational chatbot, thus improving the effectiveness of interactions (Anoir et al., 2024).

In this manner, in fact, Narrative Design offers an innovative approach that combines artificial intelligence with a narrative framework, enabling the Virtual Tutor (VT) to adapt to users' needs and preferences and be more inclusive. Through interactive storytelling, contextual dialogues and personalized feedback, the VT becomes a virtual buddy that not only delivers information, but also stimulates deep thinking and promotes sustainable behaviors, opening up new possibilities for learning and education on critical issues such as sustainable development.

The Virtual Tutor, pre-trained on a database of knowledge about sustainability issues, is equipped with a narrative framework that guides students to discover the topic through the use of triggers (events, actions or conditions that start or

initiate a particular narrative sequence or interaction within a structured experience) designed to guide them through the story or experience in a fluid and engaging manner, prompting them to act, react or explore further. The database used to train the machine was sourced from the web by collecting official sources such as the UN's Agenda 2030, which were analyzed in advance to ensure reliability and accuracy. It was only after this time-consuming and complex operation that the narrative structure was designed with the prompts and guided path being created. In a nutshell, based on the type of query (prompt) it receives (input), the machine uses a repetitive pattern of steps that is typical of any pre-trained generative transformer (GPT): breaking down into smaller units (tokens); statistical pattern-based processing and identification of words or phrases that could form a coherent response, estimating the probability of specific words or phrases appearing in a given context and predicting the next likely word or phrase to be included in its response; post-processing by applying formatting and punctuation to improve readability; and generating the final response (output).

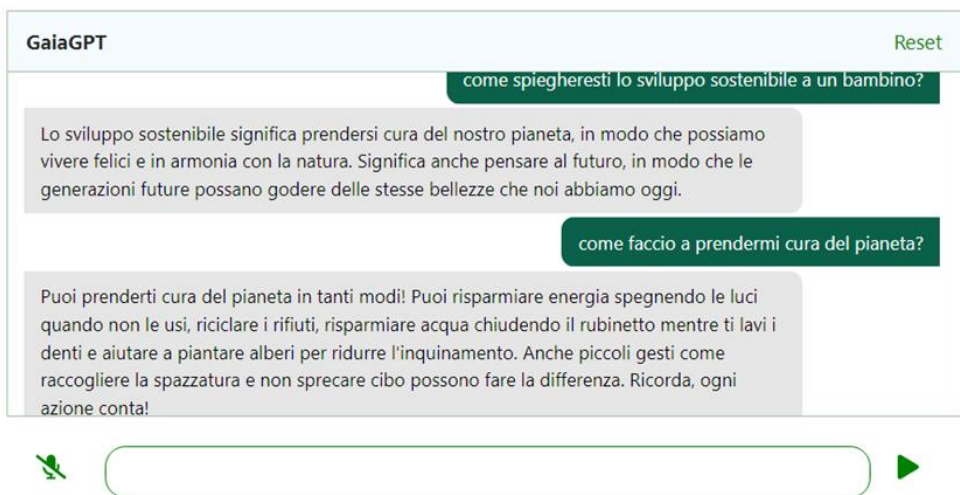


Figure 2 Sample Answer

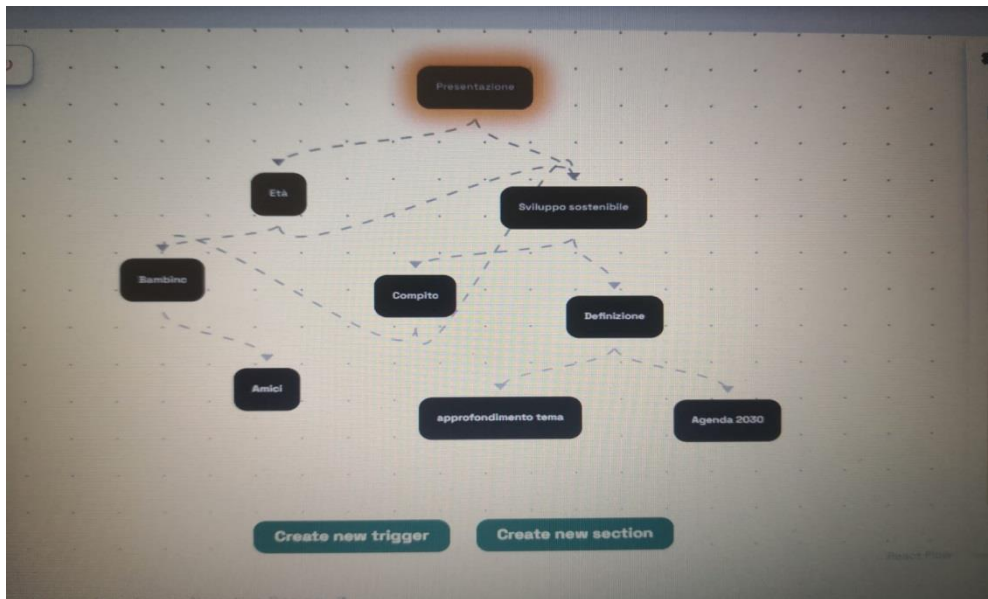


Figure 3 Example of Narrative Design Development

As can be observed in Figure 3, the particularity of narrative design is in the possibility of determining and influencing the type of answer based on the trigger and the dataset one has chosen to upload. In education, this mechanism can become successful and be a key element in the design of effective and engaging educational chatbots. The teacher has the possibility to upload relevant information, e.g., textbooks, notes and explanations recorded during lectures, and allow students to go home and interact in a more knowledgeable safe manner with the Virtual Tutor, getting answers similar to those of the teacher and certainly more reliable and coherent with the topic than a general model. It is easy to understand that this tool, if wisely designed, becomes a meaningful support and certainly not a substitute for the teacher, ensuring the quality of learning and that emotional support that students need. . From an inclusive perspective, moreover, this Tutor also offers us the possibility of breaking down language barriers, as it can be programmed to answer in different languages as can be seen in the following figures.

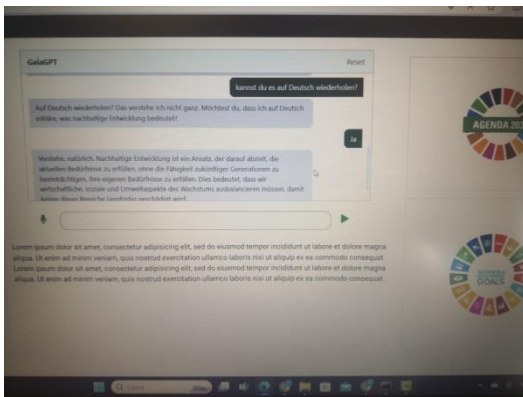
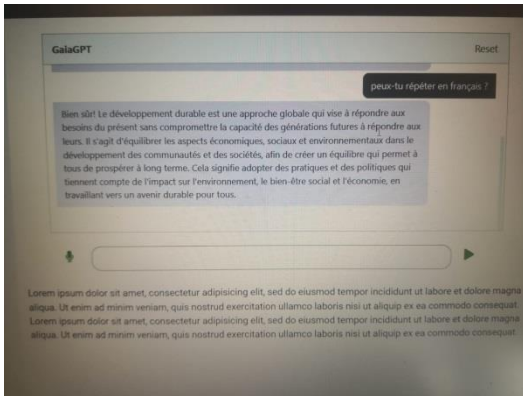
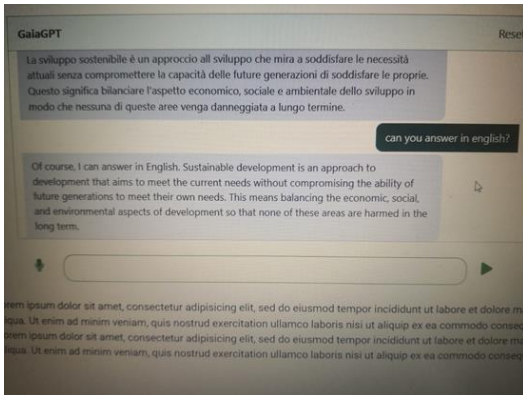


Figure 4, 5, 6 Multilingual interaction example

2. Discussion

Discussing a new and evolving field, the use of a Virtual Tutor and, more generally, algorithms in education inevitably presents both potential advantages and challenges and concerns to overcome. Following Di Tore's (2023) work, during the initial training phases without the introduction of narrative design we asked ourselves some questions and asked the educational chatbot to provide answers.

When asked what are the best practices for integrating artificial intelligence in education in a way that enhances both emotions and algorithms, the chatbot answers:

“Integrating artificial intelligence in education in a way that enhances both emotions and algorithms requires a balanced approach that takes into account the emotional needs of students and the capabilities of AI in optimizing learning. Here are some best practices:

1. **User-centered pedagogical design:** Develop educational systems that put students' needs and emotions at the center, using artificial intelligence to personalize the learning experience according to individual preferences and abilities.
2. **Use of emotional feedback:** Integrate AI to detect and respond to students' emotions during learning, providing appropriate emotional feedback to support their emotional well-being and maintain engagement in learning.
3. **Development of empathetic AI systems:** Create virtual agents with empathetic capabilities to interact with students in a sensitive and understanding manner, providing emotional support when needed and encouraging a positive relationship between students and technology.
4. **Incorporation of narrative elements:** Use engaging stories and narratives to convey complex educational concepts and stimulate students' imagination and empathy, combining AI to tailor the story to students' individual needs.
5. **Development of advanced virtual tutoring systems:** Implement intelligent virtual tutors that use AI to monitor students' progress, identify areas of difficulty, and provide personalized suggestions and resources to support their emotional and cognitive learning.
6. **Teacher training:** Provide training for teachers on the effective use of AI in education, including methods for integrating technology in meaningful ways to support students' emotional and cognitive development.

7. **Ongoing Research:** Conduct interdisciplinary research to explore the effectiveness of strategies for integrating AI in education to enhance both emotions and algorithms, identifying best practices and continually adapting approaches based on survey results”.

When asked what skills teachers of the future will need to possess to work effectively with artificial intelligence, we get this answer:

“Teachers of the future will need to develop a set of skills to work effectively with artificial intelligence. Here are some key competencies:

1. **Advanced digital skills:** Teachers should be proficient in the use of digital tools and educational technologies, including online learning platforms and artificial intelligence applications.
2. **Understanding of artificial intelligence:** It is important for teachers to gain a basic understanding of artificial intelligence and its applications in education, including its benefits and limitations.
3. **Data utilization skills:** Teachers should be able to use data generated by artificial intelligence to monitor student progress, identify student needs, and adapt lessons accordingly.
4. **Skill in technology integration:** Teachers will need to be able to effectively integrate artificial intelligence into their teaching practices, using technology tools and resources to enrich student learning.
5. **Ability to adapt and continuous learning:** Given the rapid evolution of technology, teachers will need to be willing to adapt to changes and continuously learn new skills and knowledge related to artificial intelligence.
6. **Leadership skills and guidance:** Teachers will need to take a leadership role in integrating artificial intelligence into education, guiding colleagues in understanding and effectively using the technology.
7. **Social-emotional skills:** Despite the increasing use of artificial intelligence, it is essential that teachers maintain a strong human presence in the classroom and develop social-emotional skills to support student well-being and cultivate meaningful relationships.
8. **Ethics and accountability:** Teachers should consider the ethical implications of using artificial intelligence in education and ensure that it is used responsibly and equitably, respecting students' privacy and safety.

In summary, teachers of the future will need to be flexible, technologically competent and socially aware, able to use artificial intelligence to enhance student learning responsibly and effectively.”

When asked what are the risks of using artificial intelligence in education, the chatbot's answer was:

“The use of artificial intelligence in education offers many benefits, but it also comes with some risks and challenges that need to be carefully considered. Here are some of them:

1. **Inequalities in access:** The adoption of artificial intelligence could widen inequalities in access to education, as not all students would have access to the technologies needed to fully benefit from AI-based systems.
2. **Privacy and data security:** The use of AI-based technologies could involve the collection and processing of large amounts of students' personal data, raising concerns about the privacy and security of such information.
3. **Algorithmic Bias:** Algorithms used in AI may be influenced by unconscious biases present in the training data, which could lead to discriminatory or unfair results against certain groups of students.
4. **Depersonalization of learning:** Excessive reliance on AI could lead to depersonalization of learning, reducing human interaction and teachers' ability to respond to students' individual needs.
5. **Job loss:** Automation through AI could lead to job loss for teachers and other education professionals if not properly integrated with the human approach and teacher experience.
6. **Surveillance and monitoring:** The widespread use of AI-based monitoring technologies could lead to increased surveillance of students and a decrease in their freedom and autonomy within the educational environment.
7. **Technology dependence:** Excessive reliance on AI could lead to a decrease in students' critical skills, such as critical thinking and autonomous problem solving, if they are not encouraged to develop them.
8. **Lack of transparency:** Algorithms used in AI often operate as “black boxes,” meaning that the algorithm's decision-making process may not be clear or understandable to users, leading to a lack of transparency and accountability.

In summary, the use of artificial intelligence in education offers multiple benefits, but it is important to carefully consider the associated risks and challenges to ensure that implementation is done in an ethical, equitable and responsible manner”.

It is possible to note how the machine, following the typical steps of the generative models previously described, gives us plausible answers in probabilistic terms not so different from those produced by the human mind. The more we train it and provide specific and detailed prompts, the more it learns, but we can never be sure of the reliability and accuracy of the output generated, so much so that if it does not know the correct answer it still responds and when you point out to it that the answer is wrong it apologizes for the mistake made. ChatGPT itself in its interface states that it can make mistakes and advises you to verify important information. This becomes critical because very often mistakes go undetected unless the user has a solid knowledge of the topic in question.

Although AI can help teachers and students generate useful text and other output to support their work, it is not necessarily a simple process. It may take multiple iterations of a prompt before the desired output is obtained. One problem is that young students, because they are by definition less experienced than teachers, may unwittingly and uncritically accept superficial, inaccurate, or even harmful results. Before significant progress is possible, it is essential that efforts be made to refine the basic models not only by adding knowledge about subject matter and de-biasing, but also by adding knowledge about relevant learning methods and how this might be reflected in algorithm and model design. The challenge is to determine the extent to which models can go beyond subject knowledge to foster student-centered teaching and positive teacher-chatbot-student interaction. The further challenge is to determine the extent to which student and teacher data can be ethically collected and used to train AI (Floridi, 2022; Holmes et al., 2023).

Conclusions

Once the design phase is over, the natural testing phase will be necessary, but it is believed that the possibility of designing a specific Virtual Tutor with the implementation of a narrative design could play a key role in improving teaching/learning practices by co-constructing multidisciplinary pathways (Ilkka,

2018). The Virtual Tutor can be used to provide personalized support and interactive instruction to students in certain contexts, such as for specific exercises or individual learning activities, while preserving the classroom experience and human interaction as a core part of the educational process (VanLehn, 2011).

It would allow teachers to train the machine with their own materials or at least those they deem relevant and reliable, thus ensuring higher quality of the desired output. It would allow 'learning to be tailored to the specific level and needs of each student, identifying the areas where they experience the most difficulty and providing resources and activities tailored to improve their skills (Hwang et al, 2020). Because of its ability to quickly analyze student responses, a virtual tutor could provide immediate feedback, helping students correct errors and improve their performance and offer teachers a tool to constantly monitor their progress.

Because it is available online, it allows students to access learning materials and educational resources anytime and from anywhere, eliminating barriers related to distance and time. It can make learning more engaging and challenging by increasing attention and motivation. It can also increase creativity and stimulate the emergence of critical thinking during interaction with the educational chatbot, making students active and responsible during the development of their educational journey. The lack of human interaction and emotional feedback from the machine could limit students' ability to develop social and interpersonal skills. For this reason, it is believed that the use of algorithms in education can be a powerful tool for enhancing learning, but it is critical that it be integrated with the human experience and emotional component that only the teacher can provide. A hybrid future of education that enhances both emotions and algorithms can make it possible to create a richer, more engaging and effective learning experience, ensuring quality education for all students.

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