Briefing paper: chatbots in education

R&I

eLearn Center

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About this briefing paper

One of the functions of the UOC eLearn Center is to research and innovate to improve the quality of teaching inside and outside the UOC and to analyse trends in online education. To fulfil these aims, we keep lines of exploration open that go beyond more established methodologies or tools and we work to look into the possibilities using of tools such as chatbots in education. In this case, we work on the basis of the exploration of the possibilities of chatbots becoming agents in online universities such as the UOC, in coordination and cooperation with the teaching staff. There are many questions about the potential, the limits and the doubts that chatbots offer when they are designed and applied in an educational context beyond higher education. We at the eLearn Center are working to explore these possibilities. Our ultimate goal is to serve the learning process and adapt it to every individual's specific needs. This informative document is aimed at professionals in the educational sector in all stages and spheres, both academic managers and those in a position within the education system to incorporate chatbots institutionally as well as professionals with an interest in extending their knowledge and driving plans for small-scale implementation forward. It is also aimed at anyone involved in the educational sphere who is interested in learning more about chatbots and seeing them as an educational agent of the future.

Lluís Pastor, director of the UOC eLearn Center
Barcelona, September 2018

About us

The UOC (www.uoc.edu) is an innovative university that is rooted in Catalonia and open to the world. As well as carrying out research in the knowledge society, the UOC offers people lifelong learning to help them, and society, advance Its educational model is based on personalization and accompanying students using e-learning.
The eLearn Center (elc.uoc.edu) is the unit by which the UOC facilitates applied research in e-learning, promotes innovation in this field and conveys the value of virtual learning as a fundamental element of the University's identity, both inside and outside the institution.

Keywords

Chatbots, education, artificial Intelligence, automation

01

Introduction

Chatbots are programs that integrate artificial intelligence, which allows them to simulate and maintain a certain level of conversation with real people. They are currently becoming popular because they are based on natural language and user conversation interfaces that are very common in messaging apps on smartphones. They are being introduced everywhere, albeit timidly in the field of education, not so much to replace the teaching role as to take on repetitive and low cognitive level tasks. In the educational environment, there are chatbots that act as virtual assistants to improve productivity or to answer FAQs, but there are also chatbots with a specifically educational intentionality that can act as tutors in the learning process.

01

Introduction

Knowing which classroom the next lesson is in, understanding the difference between two concepts and practising language through a chat on a mobile phone are just some examples of how chatbots can be used in education to support students.

For decades, a system capable of of emulating human tutors and automating some of their tasks has been sought. In the 1980s, intelligent tutoring systems (ITS) emerged. These are systems that incorporate artificial intelligence and that support the student's learning process, offering them expert guidance. However, they are environments that are limited to specific knowledge domains.

Unlike intelligent tutoring systems (ITS), chatbots focus on conversation. Their aim is to achieve an interaction following similar patterns to those of humans. Through conversation, these bots have to be able to analyse the environment and propose solutions to problems, interpret our emotions and act accordingly or help us in our learning process.

One of the barriers to achieving this aim is the difference that we establish in interaction with a person and with a machine: we do not talk the same way to the former as we do to the latter. For instance, we do not answer in the same way to a person who asks "How are you?" as we do to a stuffed toy with a pre-recorded message (Wegerif, 2004). Among other aspects, this difference concerns the attribution of subject vs. object. In light of advances in artificial intelligence and natural language, this distinction is increasingly blurred when we refer to chatbots. This type of program has an ambivalent status and the human speaker might even feel it has a certain degree of agency and moral responsibility. It is no longer easy to distinguish whether we are talking to a machine or a person. This situation occurs because chatbots use language, which is such a human-specific skill, and due to the incorporation and development of artificial intelligence techniques.

Artificial intelligence (AI) is a central issue in research and innovation. It has enabled the development of relevant advances, although it is still probable that some decades will pass before the most advanced AI become popular and present in people's everyday lives. In terms of nomenclature, we should distinguish between weak artificial intelligence (weak AI) and artificial general intelligence (AGI). The first refers to computer programs that include artificial intelligence techniques, such as machine learning and deep learning, and which are designed to solve a specific problem, from playing chess to detecting pedestrians and obstacles in the street. The second, AGI, refers to machines with the ability to solve different problems, in an almost human-like way. To date, the advances that have been made refer to weak AI, whereas AGI continues to be in a very initial stage of development. However, recent years have seen some very significant advances in AI techniques that allow us to consider a viable AGI in the next two decades (Hornigold, 2018). Perhaps in twenty years' time, our teacher will be a chatbot based on artificial intelligence.

01

Introduction

In light of this scenario, questions arise about the possible use of AGI in education that require considerations not only of an ethical and functional nature, but also of an educational nature. What should an AGI-based learning assistant be like? Is it feasible to think of a program that is not strictly directive and offers more variable options that allow the student to keep control over the computer and not vice versa?

To provide an answer to these and other questions, throughout this report, we will be defining chatbots and the elements that comprise them, we will identify the uses that they might have in education, including various real examples, and we will consider their nature and the educational, design and ethical implications for their introduction in education.

1.1 What is a chatbot?

Chatbots are computer programs that are able to interact with people using language-based interfaces. Generally speaking, their purpose is to simulate an intelligent human conversation so that the speaker has as similar an experience as possible to a conversation with another person (Allison, 2011). Searching for information, processing it and adapting it to the user's needs; answering an email following voice orders; making a booking at a restaurant, or simply holding a conversation are some examples of the types of interaction that can occur between a person and a chatbot.

Chatbots generally function based on the use of natural language, although this may be defined flow conversations based on structured interactions that, despite being limited, create few ambiguities of meaning. The alternative are chatbots based on decision trees or driven by artificial intelligence. They have an interface based on the human conversation form through natural language processing (NLP) and, in the most advanced cases, they can have the ability to learn from conversations (mensajea.net, 2018).

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Introduction

The term *chatbot* comes from *chat*, meaning to converse, and *bot*, the contraction of robot or a program that can run actions or tasks, for example: "Alexa, turn on the light" or "OK, Google, what's the weather forecast for tomorrow?" Some are also known as "conversational agents", when they can interpret beyond reality. For example, if you want to know your bank balance, it is possibly because you are planning an expense. They are also known as "virtual agents" or "personal agents" when they allow detailed interaction that attends to the specific needs of each user (Holak, 2018).

If chatbots have become widespread, it is basically for two reasons: the extensive use of instant messaging programs and the apps-based model (Carayannopoulos, 2018). Chatbots have become tools that are present in our everyday lives in the form of help tools, information retrieval, automatic telephone answering systems, in the field of e-commerce or to provide support to learning processes (Hsieh, 2011). This is why they are being introduced into public services such as e-commerce (Coniam, 2014), banking services (imaginBank), personnel selection (Unilever), entertainment (Second Life) and education (Deakin University, Georgia Institute of Technology).

Elements that comprise a chatbot

Chatbots must have the following essential components in order for there to be a conversation (Nieves, 2018):

ELEMENTS OF A CHATBOT
Conversational artificial intelligence, the basic source of chatbots, thanks to which all management and natural language processing (NLP) occurs. The first chatbots focused on the interpretation and recognition of patterns and rules. The more advanced chatbots implement deep learning processes to analyse the human input, learn from conversations and generate as suitable a response as possible.
User experience (UX), which allows a natural, intelligent and coherent conversation to be established.
User interface (UI), whereby the user can see or hear the conversations with the chatbot.
Conversational design, which allows an artificial interaction to be equipped with human logic.

U1

Introduction

To maintain a conversation with a human or with another chatbot, the software must be designed and trained to interpret the reason or the intention of the conversation, understand the questions and decide what to answer. This ability is possible thanks to natural language processing, comprehension and generation technologies as well as artificial intelligence (Futurizable, 2017).

Interfaces and platforms

The interaction process between the person and the chatbot can occur in different ways depending on the communication interface. We can distinguish three main types of chatbot (Cerdas, 2017):

- Based on chatterboxes: the interaction occurs through text inputs and outputs or voice inputs and outputs. With natural language processing, written text can become oral and vice versa, which opens up communicative possibilities in the interaction between person and chatbot (Clark, 2018).

- Embodied conversational agents: the interface is represented by the shape of a body, or a face in the form of an avatar, which interacts with the user and which may contain audio, text and other audiovisual and multimedia representation resources (example 1, example 2) (Allison, 2011).

- Physical: there is a third type of chatbot that is in the form of a physical robot, be it humanoid or otherwise.

Originally, chatbots were only represented through written text, but they have evolved and now include recognition and oral expression possibilities, as well as detection of emotional states (Van Rosmalen, Eikelboom, Bloemers, Van Winzum & Spronck, 2012).

01

Introduction

The following are some of the most significant examples of chatbot development platforms, operational virtual agents and instant messaging apps that integrate chatbots:

PLATFORMS, VIRTUAL ASSISTANTS AND INSTANT MESSAGING APPS THAT INTEGRATE CHATBOTS	
Chatbot development platforms:	**IBM** offers the Watson conversation service for language processing, which provides the creation of chatbots and virtual agents. It also has specific services for developing a number of conversation functions, such as speech to text and text to speech.
	Microsoft has developed the Azure cloud services platform, which includes different AI and NLP tools to aid chatbot development. It also offers natural language services (language understanding intelligent service or LUIS) that process and analyse language (Yan et al., 2016).
	Google offers TensorFlow, open software that provides materials and resources for developers. Google also has Cloud AI, a system for using or creating deep learning models. Finally, we have the Cloud Natural Language application programming interface, focused on natural language processing and comprehension.
	Amazon offers tools such as Lex, which enables developers to integrate chatbots in other mobile apps. Alexa is a cloud-based voice service especially designed for the Amazon Echo device.
	Facebook is one of the main platforms where chatbots can work (Messenger and WhatsApp), but it also offers wit.ai, designed for developers to create chatbots.
	Other technologies for developers that enable the creation of chatbots are: Motion, Smooch, Gupshup, Botkit, Rasa (Futurizable, 2017), api.ai, Semantic Machines, Digital Genius, Chatfuel, Pypestream, Pandorabots, AgentBot, ChetterBot and ChatScript (Davydova, 2017).
Main operational virtual agents:	Siri (Apple
	Bixby (Samsung)
	Google Assistant (Google)
	Cortana (Microsoft)
Instant messaging apps that integrate chatbots:	Messenger Facebook, Telegram, Slack, Skype, Twitter, Kik, WeChat, Line, Viber, Snapchat and WhatsApp.

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Introduction

1.2 Chatbot predecessors

Can machines think? In 1950, Alan Turing asked this question, and since then there have been many attempts to answer it from the field of artificial intelligence, and more specifically through chatbots (Lokman & Zain, 2010).

Chatbots began to emerge in the 1960s, when the first chatbot based on artificial intelligence, Eliza, appeared. It simulated a therapist and was designed to reproduce conversations between a psychoanalyst and a patient. The limitations of this first proposal were evident and were basically related to the lack of memory of previous conversations, the simplicity of the database and the limitation of the techniques that enabled keywords to be identified and joined, structuring the chatbot's knowledge through decision trees and prior scripts produced by the developers.

Eliza was created in 1966 by MIT professor, Joseph Weizenbaum, and is still accessible today.

Although Eliza had been in operation for some years, it was not until 1994 that Michael Maulin used the term *chatterbot* to describe conversational programs (Pichponreay, Kim, Choi, Lee & Cho, 2016).

We can distinguish three main phases in the evolution of chatbots (Cerdas, 2017):

U1 During the 1970s and 1980s, a study trend based on natural language interfaces began (Hsieh, 2011), although they were still restricted to simulating conversations between two humans.

U2 The second phase coincides with the popularization of the Internet, when conversations multiplied and it was possible to chat with thousands of users.

U3 The third wave of chatbots combines natural language technologies, speech synthesis and real-time videos.

01

Introduction

Besides Eliza, other worthy examples in these decades of chatbot evolution include Converse (Batacharia, Levy, Krotow & Wilks, 19999), Jabberwacky and Alice (artificial linguistic internet computer entity), created in 1995 by Richard Wallace (di Lecce, Calabrese, Soldo & Giove, 2010). The great contribution of Alice is the use of AIML (artificial intelligence mark-up language), which enables a stimulus-response template to be defined to obtain an automatic process of knowledge extrapolation based on previously processed information, such as FAQs or glossaries (di Lecce et al., 2010).

As data mining techniques, the integration of architectures more complex than AIML based on probabilistic methods (Bentivoglio et al., 2010; di Lecce et al., 2010) and decision trees improve, and as machine learning develops, the skills of chatbots are expanding to make decisions, have a wider corpus of knowledge and give linguistically stronger responses (Ghose & Barua, 2013).

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Chatbots in education

Teaching is a relational act based on communication and interaction, and chatbots have significant educational potential precisely due to their communicative ability through natural language.

One of the reasons for the commitment to use chatbots in different economic activities such as customer care is increased process efficiency, for example, 24-hour care or specific information. This argument is also used in the case of education, as a chatbot can operate as a 24/7 support service, which can allow, for example, teachers and service staff to avoid having to answer repetitive questions that can be easily resolved.

The incorporation of chatbots in education has to be preceded by prior thought, whether its aim is educational or not. An institutional and organizational debate is needed to ensure functionality, feasibility and scalability within the institution. It is important to stress that the inclusion of chatbots will not replace teaching staff or administration and services staff but it can take over some of their tasks to complement and help them out.

It appears to be feasible to think of a future where there is close collaboration between humans and machines, and, in the case of teaching, teacher roles may be distributed between both agents. The teacher of the future could become a sum of the human teacher and the AI teacher, with a complementary division of tasks. For example, the human teacher could take care of the creation of excerpts of learning materials, which could then be complemented or broadened by the AI teacher. The human teacher could take on personalized tutoring tasks, while the AI teacher provides uninterrupted support. The former could act in cases of dispute or in solving assessment appeals, while the AI teacher could answer FAQs, act as a virtual tutor to guide periodical tasks or redirect complaints and demands. This symbiosis would allow the human teacher to stop taking on more mechanical or repetitive tasks – which would be undertaken by the chatbot or AI teacher – and would consequently have greater availability to devote their time to more creative and high cognitive level tasks. We need to know, then, what the affordances of the different types of chatbot are to see how they operate as cognitive colleagues and not as potential threats.

In the field of education, chatbots are used experimentally, making the most of the user interfaces (it is now no longer necessary to have programming knowledge to set up your own chatbot) and the boom in their popularity in different economic sectors for the promise of their benefits. However, it remains to be seen how they adapt to every context and how they are understood and rated by students, teachers, and administration and services staff.

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Chatbots in education

An example of an app that enables the creation of chatbots for education is **SnatchBot.** It is a free tool and has an interface that does not require programming knowledge. Its function will be determined by its creator's intention: either to answer informative queries (FAQ-type) or to act as a tutor to teach concepts and procedures.

Anne G. Neering is a chatbot designed by engineering students. The process of designing and creating the software allowed the students to reflect on the course's main ideas, combining learning and fun. The experience enabled the students to collate the main questions and provide an answer to them, expressing the course contents in their own words (Crown et al, 2010).

The student-chatbot interaction

Thanks to their conversation-based user interface (UI), chatbots can become very much present in students' interactions with information and contents, acting as intermediaries. In online learning environments, chatbots provide the element of interactivity (Bii, 2013).

Although there are some chatbots that base their UI on menus and buttons, there are others that enable the person-machine relationship to be based on search keywords. A student or teacher can ask for anything they need by asking a simple query using natural language. This turns the chatbot into a new UI/UX by enabling, providing and streamlining access to information. For example, by asking the chatbot, students can access information that is difficult to find in a learning management system (LMS) environment (Clark, 2018). Additionally, interactions can occur at any time and in any context, which enhances ubiquitous learning.

Otto, developed by Learning Pool (Clark, 2018), is a chatbot that is integrated in an LMS and that aims to enhance the student-content interaction.

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Chatbots in education

This presence of chatbots will also depend on the number and type of interactions that they can have with other chatbots or tools, either incorporating functions that are currently carried out by different apps or converging data so as to enable integrated actions. We are referring, for example, to the chatbot's ability to gather information from an individual's personal email, combine it with the calendar and the information available on a university's website, put the data together and be able to confirm a tutorial on the university's virtual campus.

As has happened with other tools, chatbots may in the future undertake some assistant functions that have been done until now by specific apps. These affordances allow users to worry less about tasks closely related to memory (calendars, reminders, submission deadlines, instructions, etc). New advances in voice and emotional state recognition will end up smoothing these interactions.

The problem with voice messages: using the voice is preferred because it is quicker and easier to speak than to chat through text. However, it is not always easy to retrieve information or listen to it in audio files and it is not useful for all environments, such as a classroom with other people or a library.

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Chatbots in education

2.1 Chatbots and educational intentionality

Depending on their nature, we can generally distinguish two types of chatbot in education: those that do not have an educational intentionality and those that do.

TYPES OF CHATBOTS IN EDUCATION
Without educational intentionality: these are chatbots that are incorporated into teaching tasks of an administrative nature (student guidance and personal assistance) and of a support nature (to answer FAQs).
With educational intentionality: these are designed to foster teaching and learning directly. They are basically of two types:
Tutors that provide scaffolding for the learning process: they can adapt, select and sequence contents according to the student's needs and pace, aid reflection and metacognition processes and provide learning motivation.
Exercise and practice programs for skills acquisition: these present a stimulus in the form of a question or problem, and the student gives an answer. This is automatically assessed by the chatbot, which gives immediate feedback to the student.

Within the group of chatbots with educational intentionality, tutors are teaching agents that work as a learning companion, providing dialogue, collaboration and reflection. They enable a socio-constructivist teaching and learning scenario (John-Steiner & Mahn, 1996). Conversely, exercise and practice chatbots are based on behaviourist and cognitivist approaches to learning, where there is the presence of stimulus-cognition-response and reinforcement.

The difference between chatbots and intelligent tutoring systems

Chatbots as tutors or as teaching agents are very similar to intelligent tutoring systems (ITS). Both are based on the student-machine interaction and use artificial intelligence. However, while the latter are systems for teaching a specific and demarcated corpus of knowledge with an interaction that is also strongly limited to sub-steps, chatbots base interaction on natural language conversation. This makes them more flexible and, therefore, less tied down to a limited corpus like ITS might be.

These programs, come from the 1960s behaviourist tradition known as computer-aided instruction (CAI), and were then improved by cognitivist

psychology perspectives (Kulik & Fletcher, 2015). To be able to guide the student, they need expert knowledge to act as the model. This serves two purposes: it establishes the knowledge that the student has to learn and it works as a standard to assess the student's execution (Wenger, 1987).

Following the principles of instructional design, they segmented what had to be learnt into short pieces and had an assessment system offering immediate feedback.

To appreciate the difference between CAI and ITS programs, the former required a single response from the student and immediate feedback was given. For example, faced with an arithmetical operation, the student entered the final result and the environment gave positive or negative feedback. By contrast, the latter allow an elaborate response by the student, giving room to represent each step in the answer in a way that the system can compare it with the expert model and so give feedback in each step (Van Lehn, 2011).

Chatbots and dialogic learning

As chatbots are based on communicative exchange, they can be very useful for enhancing dialogue-based learning. According to Wegerif (2004), the student-program interaction consists of three elements: initiation, response and feedback (IRF). The program asks a question (initiation), and depending on the student's response, gives some form of feedback.

There is also the possibility of a group of students discussing a program question amongst themselves. In this case, there is a discussion stage, i.e. an exchange of ideas and reflection, and we therefore no longer speak of IRF, but IDRF, where D is discussion. This is an ingredient for learning by discovery and the active construction of knowledge based on Vygotsky's zone of proximal development.

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Chatbots in education

There are studies that say that the student-computer interaction is good in cases in which students have autism disorders, such as Asperger's syndrome (Rajendran and Mitchell, 2000). They are safe environments, with no expectations or judgments, where students can have a sensation of being in control (Wegerif, 2004).

In the 1990s, O'Neill and McMahon, from Ulster University, designed the Bubble Dialogue tool, software that was used so that primary school students could practise written dialogue based on a given situation. Faced with a standard situation based on the establishment of a context and a prologue, the students had to fill in dialogue bubbles and thought bubbles for two characters or for themselves (as if they were a comic), respecting turn-taking in conversation. These dialogues enabled two objectives to be reached: first, to help students' reflection and understanding of given situations and, second, as an ethnographic tool that helped educators and researchers to capture, classify and analyse students' dialogues (O'Neill & McMahon, 1991).

Chatbots today can serve two purposes. On one hand, with an adequate educational design, chatbots can provide the scaffolding that allows students to tackle different subjects and reflect amongst themselves on the basis of starting questions posed by the chatbot and that open up a chatbot-student debate (IRF) or chatbot-group of students debate (IDRF). On the other, although it does not allow participants' internal dialogue to be shown (the typical thought bubbles of the comic format), a chatbot lets the conversation be captured for analysis or for cognitive and affective exploration, and to see the students' perceptions of a specific subject, interaction, situation or context.

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Chatbots in education

2.2 Classification of chatbots in education according to tasks

Depending on the functions carried out by chatbots in education, we can classify them on the basis of the following tasks:

U1 **Administrative and management tasks to foster personal productivity:** they provide personal assistance to students, aiding onboarding (Farkash, 2018) and personal productivity. Tasks include schedule or email management and task, submission deadline or assessment reminders. This uninterrupted personalization involves giving each student a rapid and personalized service, which takes pressure off academic services administration.

U2 **Taking care of FAQs:** they provide a response to student FAQs regarding administration or learning concepts and contents. Unlike the first, they do not include personalization elements but student services in the form of FAQs. Tasks include information about admissions and enrolment, financial services, technical problems (email, virtual campus, etc) or frequent queries relating to study content.

U3 **Student mentoring**: they allow student mentoring during the learning process. They are able to respond emotionally (they include non-verbal communication gestures and expressions), they monitor the student's understanding (cognitive control) and they can provide support and make suggestions to the student when needed. One of the main tasks is the provision and adaptation of contents. In this case, they are chatbots that enable educational programme contents to be generated and adapted, which are then sent straight to the user, taking their preferences into account.

U4 **Motivation:** they contribute to exercising behavioural control by providing positive motivational reinforcement. This process means that students' retention is increased, which is especially relevant in online learning environments.

U5 **Practice of specific skills and abilities:** they enable dialogues to be practised in language learning, simulating conversations in contexts organized by level and with different roles and discourses.

Chatbots in education

U6 **Simulations**: they simulate specific professional situations and can provide support for reflection or therapy. For example, in the field of healthcare, they can simulate patient treatment; in psychological care, they can simulate patient care; and in formal or social education, they can simulate the understanding of different school learning situations.

***Spaced-interval learning*:** they can predict when the student is about to forget what they have memorized and refresh their memory by maintaining knowledge recall. **SuperMemo** allows users to revise and ultimately remember more about the subjects studied. Its aim is to minimize content revision time. Using an algorithm, the app monitors learning and, in different frequency modes, repeats subjects already covered (Griol, García-Herrero, & Molina, 2011).

U7 **Reflection and metacognitive strategies**: they help the students regulate their own metacognitive processes (reflection on their own learning process), they act as an expert classmate and they can provide support to aid learning. There are currently no examples of chatbots (that we know of, at least) that offer this reflective function (Taraban, 2018).

The fact that a student has to teach something means that they have to master what it is they have to teach and reflect in depth on the concepts and processes involved, as well as their connections. Reflecting on what others think helps one think about one's own cognition. Roman Taraban (Texas Tech University, USA) explains how the students on a psycholinguistics course created their own chatbot. After creating it, they had to identify the nature of the language of the bot they had created, which fostered metacognitive reflection based on the analysis of the communication of an intelligent agent.

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Chatbots in education

U8 **Student learning assessment:** they can act as exercise assessors quickly and automatically. One example is automatic essay scoring, which gives feedback on mass courses based on automatic learning capable of analysing thousands of essays and giving an automated score. They also include tasks related to feedback to the student, who receives support thanks to learning feedback and the adaptation of the learning process (contents and activities) at the student's pace and according to their needs (Chatbots Magazine, 2017).

Pedagogical agents: these are embodied conversational agent bots that take on a recognizable human speaker form. They appear in learning environments such as intelligent tutoring systems. They are recognizable animated figures, with their own initiative, that use verbal and non-verbal communication. They can respond emotionally (including non-verbal communication gestures and expressions). Some of the functions of pedagogical agents in intelligent tutoring include monitoring student understanding (cognitive control), behavioural control (keeping learners from playing with the responses, providing them with positive reinforcement), motivational reinforcement, metacognitive control and support and learning feedback when necessary.

Teachable agents: these are embodied conversational agent bots that take on a recognizable human speaker form. Students are able to train and teach them; as they do not come with initial knowledge, it is the user who provides them with it. A sub-type of teachable agents is "troublemakers", which propose problems and solutions to the student, who then has to say whether they agree or not. If they do not agree, the student has to argue why. These agents can increase student motivation and play the role of teaching guide (Silvervarg, Kirkegaard, Nirme, Haake & Gulz, 2014).

2.3 Examples of chatbots in education

Ani: designed for learning and able to replace some tasks of human teachers, its aim is to provide personalized tutoring and mentoring that aids student commitment and involvement. It includes elements of motivation, assessment and immediate feedback as well as the ability to adapt to the user's needs through the use of automatic learning algorithms. It also includes a tutored English-language learning course.

Botter: in its trial phase at the Universitat Oberta de Catalunya, Botter is a physical robot that will provide student support. It is able to interact with students, using light signals, sound messages (motivation and disappointment sounds and phrases) or movements, to help them monitor their learning progress. It implies a new way of communication between campus and student and it works as cognitive technology for learning, especially regarding the promotion of student behavioural change.

CEU Cardenal Herrera University bot: since 2017, a bot based on Microsoft Azure has been used for student mentoring and to answer queries immediately with uninterrupted availability. At present, it acts as a personal assistant to answer administrative queries, but the goal is to make it more proactive in the future, able to predict student behaviour to advise them throughout the learning process.

CourseQ: designed at Cornell University (USA), it can integrate with LMS and virtual learning environments such as Moodle. The chatbot's functions include obtaining information for faculty and students as well as giving reminders regarding submission dates, timetables, material and events. It is based on text messages from the information shared by teaching staff.

Differ: used at BI Norwegian Business School, it is able to create communities that bring together students in similar situations and it publishes relevant messages, as well as reminders, with the aim of increasing commitment and involvement and of creating a space where students do not feel judged because of the questions they ask.

Duolingo: designed for language learning, using conversation along with gamification techniques.

U2

Chatbots in education

Genie: designed by Deakin University (Victoria, Australia). It uses IBM Watson and answers questions relating to everything that students need to know about life on campus.

Hubert: it gathers students' opinions through interviews to find out their degree of satisfaction.

Ivy: designed for higher education, it enables management of admissions, financial services and technological services such as email access, Wi-Fi connection and app installation. It also includes information about the job market, student services and FAQs.

Jill Watson: designed at the Georgia Institute of Technology to answer queries. It is based on IBM Watson and enables FAQs to be answered and helps with students' routine tasks.

MOOCBuddy: is a chatbot created to assist students. It works on Facebook Messenger and, depending on each person's career and interests, it makes recommendations of the most suitable MOOCs.

Otto: developed by Learning Pool (Clark, 2018), Otto is a chatbot that is integrated in an LMS and that aims to enhance the student-content interaction.

Pepper and NAO: Softbank Robotics creates and distributes humanoid robots to deal with the public and that interact with their environment using sensors and video cameras. Pepper is a robot that emerged for customer care but that has been adapted for university education. NAO was created for the educational sphere. It is smaller than Pepper and although it is able to give lessons and encourage and assess activities, it is also programmable with the programming languages, Python and C++, and can therefore be useful for teaching programming to primary, secondary and university students.

Pounce: in use at Georgia State University, it gives reminders, implements surveys, automates FAQs and produces tutorials.

Replika: serves to put dialogue-based emotional skills into practice.

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Chatbots in education

The Guardian of History (Silvervarg et al., 2014): is a computer program for teaching history to children aged between ten and twelve. The environment is based on the narrative of the elf, also known as the guardian of the Time Castle, who has been responsible for teaching history and who is now retiring. A young and inexperienced elf replaces him and the user has to teach him the knowledge he needs. It is a teachable agent that enables learning and metacognition processes. There are several studies that show that peer teaching fosters learning (Fiorella & Mayer, 2013).

The following table shows these examples classed according to the tasks they carry out and their educational intentionality:

		According to intentionality			
		Without educational intentionality		With educational intentionality	
		Academic guidance and personal agent	Support (FAQs)	Tutors-support	Exercise and practice
According to tasks	Administrative and management tasks to foster personal productivity	Genie Hubert Ivy Pounce CourseQ Differ MOOCBuddy	Genie Ivy Pounce Otto	Genie	
	Answering administrative queries (FAQs)	Genie Ivy Pounce CourseQ Bot CEU Cardenal Herrera	Genie Pounce Jill Watson Bot CEU Cardenal Herrera		
	Mentoring		Jill Watson	Pounce Jill Watson Differ Ani Botter	Duolingo Pepper NAO
	Motivation			Differ Ani Botter	Duolingo
	Conversations for language learning			Ani	Duolingo
	Reflection and metacognitive strategies			The Guardian of History Replika	
	Student learning assessment			The Guardian of History Ani	Pepper NAO

2.4 Considerations regarding design and configuration

This section poses a number of questions that should be taken into account when it comes to chatbot configuration and format.

U1 Degree of **anthropomorphism** that the teaching agent should have (with anthropomorphism being understood as the tendency to consider non-human realities or elements as though they were human, according to Wikipedia). Should we give them human qualities or characteristics, like a name? How will we decide what they'll look like (not just their physical appearance, but also their voice and accent if they speak)? Will they have a physical body, like a robot, or merely a virtual one? Do they need to be given a back story? In fact, anthropomorphism would probably help with communication and ergonomics. We also have to think about whether there will be just one assistant for everyone, a specific one for each student, or a common one for each subject.

U2 Level of "**humanness**" of the chatbot and its relationship with the student. The range of options refers to the simulation of human personality features, and the degree of imitation of these abilities will have to be looked at. For example, a sense of humour, sensitivity, empathy or assertiveness. It may also be able to detect the student's frame of mind and act accordingly. Besides that, we also need to think about whether it will be time-aware of past sessions.

It may seem rather banal, but we already call Siri and Alexa by their names. At present, we do not talk to a car satnav system by name (maybe some people do), but the boundary is not clear. When the assistant becomes someone we talk to and ceases to be a simple tool, we need to solve these issues.

U3 Degree of **proactivity**, in other words, if the virtual teacher will limit itself to answering queries (like a tool) or if it will be proactive and give advice on how to do the tasks, remind students of submission dates and ensure their success. Will it be like a teaching coach? We may need to place limits on the help it provides to prevent the student from relying on it too much. In any event, we will also have to determine whether all of these options will be configurable or not. Some students may feel happier with a virtual teacher with a specific personality or that uses a certain tone of voice.

U4 Level of "**wisdom**" of the bot. For example, what subject areas will it know about? Just the ones in the official university curriculum? Or will it be open to external resources (like Wikipedia or other internet sources)?

2.5 Ethical considerations

As regards the ethical considerations that need to be placed in the arena for debate when incorporating a chatbot in education, the following are some of the most relevant:

Consideration 1. Honesty and transparency
Is it fair to trick the students and not tell them that the teaching assistant is AI, like Jill Watson, the well-known Georgia Institute of Technology case, or the recent example of Google Duplex, where the hairdresser or the restaurant employee, supposedly (Cranz, 2018), do not know that the customer is a machine? Or is it preferable to say clearly that there is a human-machine interaction?

Consideration 2. Extreme anthropomorphism and the "uncanny valley"
The uncanny valley (*uncanny valley, n.d.*) is a hypothesis about robotics that says that when a robot appears to be human, the emotional response of humans to the robot will become increasingly more positive and empathetic up to a point. Beyond this point, the response changes and turns into repugnance. If we then make the robot even more human like, we return to high levels of empathy. In other words, we have to humanize the robot but only up to a point, making sure it does not create fear or anxiety, or we have to do the opposite – we have to decide to make it virtually indistinguishable from a human.

Consideration 3. Bias due to incorrect training of machines
The AI bot's teaching responses may be incorrect because we have trained it with data that may be incorrect, such as previous answers given by other students (in debates), previous interactions with the student or material from the internet that has not been validated. The human expert has to be present in this process to validate the training data. We have to put a "human in the loop" (Bridgwater, 2016) to ensure that there is no bias and that what happened with Tay (Vincent, 2016), the Microsoft chatbot that turned racist, does not happen again.

Consideration 4. The machines ultimate purpose
As is the case with autonomous cars, which, in the hypothetical event of an accident, may decide who lives and who dies (Moral Machine), the final (programmed) purposes of the educational AI bot could be varied and even contradictory:

- The purpose may be for the student to learn (and so run the risk of the AI bot setting difficult and very challenging activities that could lead to the student failing).
- Or it could be for the student to pass (and then there is the danger that the AI bot sets tests that are too easy, suggests the answers and makes passing the course too easy, preventing the student from learning).

- The objective may even be for the student to enrol on a lot of courses (and then perhaps the AI bot does not provide realistic information about the student's ability to take a lot of courses and hides potential difficulties in passing the course).

Each stakeholder in the teaching process (teachers, students, marketing and finance departments, society, the job market, etc) may have opposing aims. In this case, we need to put "society in the loop" (Ito, 2016) and draw up an educational social contract.

At present, the possible functions and tasks that are attributed to chatbots regard a contribution to learning, but we still do not have examples of their application. We are referring to the use of chatbots as simulation agents, such as patients for practising medical or healthcare procedures, children with special educational needs or students who require specific care for carrying out formal or social educational interventions. These chatbots, as tutors, will contribute to the personalization of learning, to a more inclusive education and to more significant learning.

We also need to analyse examples of how their introduction may help make assessments of an educational nature, with personalized and immediate feedback, or that tend to favour students' metacognitive control over their own learning.

U3

Conclusions

Chatbots are computer programs that are able to interact with people, using language-based interfaces. They are able to simulate an intelligent human conversation.

The person-chatbot relationship occurs in the user interface (UI), which is based on (written and oral) language and the user experience (UX), which allows a natural, intelligent and coherent conversation to be established. This happens thanks to their capacity for natural language processing (NLP). Chatbots are based on a currently very popular interface, namely instant messaging apps, and on the human capacity of language. This is why they have such a great potential and are being integrated in various economic sectors (fundamentally customer care), and education is no exception.

In education, we find two types of chatbots: firstly, those that do not have an educational intentionality and that work to help students with management and personal assistance processes and secondly, those that do have a clear educational intentionality and that act as tutors to mentor the student in their learning process or create a more specific environment of exercise and practice.

We find different functions of chatbots in education, such as mentoring the student before they start their course (guidance and enrolment process) and offering them 24/7 support during the educational process, on and off campus. Others enable learning to be adapted to the student's needs and pace, fostering personalization of learning. In general, they have the potential to increase student motivation and involvement, which are highly valued in higher education, even more so in distance universities, where withdrawal rates are more significant than in on-site universities.

Many bots have the ability to provide responses to students' queries, which aids access to information and learning contents. This way, teachers can move away from the more mechanical and repetitive tasks like answering students' recurring questions.

The uses of chatbots in education and their contributions to mentoring in the learning process are numerous. To integrate them into education, we need prior consideration, whether their purpose is educational or not. An analysis needs to be made of what they can offer and of educational, organizational and technical needs.

Chatbots are in education to stay. We can communicate with them as we would with people, and they offer a range of functions. They still have to evolve a great deal and they will steadily improve as they acquire more basic knowledge thanks to mass data and to the application of layers of artificial intelligence related to deep learning (neural networks). In some cases, they are already used for voice and face recognition, for idiomatic translation, for text to speech conversion and for improving natural language processing.

U3

Conclusions

As they become more popular and improve, we need to consider different aspects regarding both design and configuration and the degree of anthropomorphism, humanness and proactivity, without forgetting ethical aspects.

Right now, we do not believe that they should replace the teacher; instead, they have to replace certain low cognitive level and repetitive tasks, which will then allow the teacher, free of such tasks, to devote their time to more critical, strategic and high cognitive level tasks. Chatbots in education will work as a colleague for teachers, administration and services staff and for students. This human-AI machine interaction constitutes a key association where, presumably, no jobs will be lost, only specific tasks such as answering administrative questions relating to work submission dates or correcting exercises. Each one will do the task that they can do more efficiently.

Perhaps we have to wait a little while for it to be possible to have an artificial assistant with all the functions of artificial general intelligence (AGI), but in the meantime it is worth asking ourselves all of these questions. Some of the answers can be implemented right now, given the current state of technology.

And with the gaze focused on the 20-year horizon, we also have to start thinking as a society about the role that AI will play in education and the implications of an AGI.

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