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Design of a chatbot as a distance learning assistant

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Abstract

Within the process of progressive digitization of materials and tools for teaching and distance learning of a subject of introduction to Microeconomics (quarterly, in year three of the Degree in Social Work), taught by the authors at the National University of Distance Education (UNED), a virtual assistant in the form of *chatbot*, or conversational robot, called EconBot, has been designed and made available to students from 2017. This paper presents the reasons that led to its adoption, the process of its development, differentiating two phases, its characteristics and functions, the assessment of its usefulness and the role of teachers in the implementation of this type of technological innovation.

Keywords: Distance learning, Online learning, Artificial Intelligence, Chatbot

Introduction

For decades, the face-to-face teaching of Economics, at any of its levels, has slowly incorporated, when it has not rejected, the new communication technologies (Becker & Watts, 1996). This trend began to change in the last decade of the last century, with the generalization of the use of electronic mail and the web (Goffe & Sosin, 2005). However, distance learning, online or any of the modalities of e-learning or m-learning, has become more inclined towards the use of novelties produced in this field, due to the need to make more effective the interaction between students, and between students and teachers.

In recent years we have been witnessing an explosion of developments related to Artificial Intelligence (AI), with applications in all sectors of society: economy, health, work, leisure, security. Besides, very attractive applications have been pointed out in the generic field of education (Seldon, 2018; Holmes, Bialik & Fadel, 2019). Although the expectations of the application of AI are still far from being fulfilled, and its use in teaching and learning activities still generates some skepticism (Sharkey, 2016; Clark, 2018a), some of its materializations are progressively being used. These include the possibility of incorporating robots or virtual assistants that collaborate with teachers – when they do not completely replace them in certain tasks–, and with educational institutions.

The authors teach the subject *Economy: Fundamentals of Microeconomics* during the first four-month period of third year in the Degree in Social Work, an introductory economics course with usually just over six hundred students. The profile of the student of this subject is very varied, although from the experience of the teachers some common characteristics can be pointed out: little or no previous training in Economics; the consideration of the subject as foreign to its formative plan; and the attribution of a degree of complexity that does not correspond to reality (use of mathematics and difficulties in reading graphics, among others). On top of that, the characteristics of the teaching and distance learning processes, which require support or accompaniment for the student, must be added.

To this end, and as part of the process of generating support materials, preferably in digital format, developed by the authors, the creation of a new tool based on AI was tackled in 2017, on an experimental basis, which would serve to increase existing communication and support options: a *chatbot* called EconBot[1].

What a *chatbot* is and how it can be used in education

A *chatbot* or conversational robot is a computer program capable of interacting with people using natural language. Its main function is to simulate a coherent human conversation –Garcia Brustenga, Fuertes-Alpiste & Molas-Castells (2018), expose in detail what chatbots are, and their modalities, along with some experiences of use in education.

Although the first designs of conversational robots date back to the seventies of the past century, the closest antecedents in the use of this type of assistants as learning support elements are found in the early years of this century. It is in recent years, with new developments in IA (Heller, Procter, Mac, Jewell, Lisa & Cheung, 2005), with *chatbots* such as Ada, and Freudbot, (the last one accessible from https://psych.athabascau.ca/html/Freudbot/Freudbot.html), when they have become present in everyday environments with virtual assistants deployed by Apple, Google, Facebook, or Microsoft (Holmes et al., 2019). In this context, Singh (2018) and Clark (2018b) have noted very comprehensively the roles that conversational assistants can play in teaching/learning processes:

- *Intelligent tutoring systems*: a function already available in the eighties of the past century, and which can now be enriched with the possibility of customizing learning environments for each student, based on the analysis of their responses and their browsing trail through the digitized content.
- *Improve student participation*: the aim is to take advantage of the tendency to use instant messaging systems through a *chatbot* that acts as a communication platform.
- *Intelligent feedback*: on the design of the course, the subject, the operation of tutorials, and on information that once collected by the *chatbot* is sent to the teacher or the institution for analysis.
- *Teaching assistants*: a *chatbot* can assist the teacher in performing the most repetitive tasks, follow the student's progress, or provide personalized feedback.
- *Immediate help for the student*: it allows to automate and provide in an immediate way habitual answers, both of administrative character and related to the contents of the subject.
- *Alternative to Learning Management Systems (LMS)*: *chatbot* can perform functions traditionally integrated into LMS more dynamically, by providing access to materials in different formats, external links, doubt sections, messaging, etc.
- *Mentoring functions*: not only providing the students with information, but also guiding them in the search for it, for example through problem solving.
- *Skills practice*: the *chatbot* can assume the role of patient, consumer, client, or citizen with whom students can practice the skills and techniques they have learnt in the subject.

Reasons to design EconBot

The context that explains the decision to design and implement a conversational robot in the teaching and learning of an introductory subject to Economics, was determined by four simultaneous circumstances: the previous work of the teaching team providing students educational technologies

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[1] To use EconBot you need to have a Facebook account. EconBot can be accessed from its Facebook page https://www.facebook.com/econbotUNED/ There you can scan the code on the cover with the Messenger application for mobile, or start chatting with the chatbot from the chat option included on the same page.

that link them more actively in their learning process; the persistence in the National University of Distance Education (UNED) of recovery exams in September (*extraordinary call*, in the terminology of the University), without attention to the student during the month of August; the observed prevalence of the use of mobile instant messaging applications by students, to the detriment of those available within LMS; and the emergence and popularization of new options for the design and implementation of *chatbots*, fundamentally from 2016.

September exams are still being held

The UNED maintains the realization of recovery tests in the month of September of each academic year. During the period between the end of the teaching activity –which includes attention to the student through the communication tools of the LMS implanted in the UNED–, and the implementation of those tests, there is no scheme of attention to the student. During August, the time students spend preparing the recovery tests, faculty are no longer available to solve their doubts, or to support and reinforce their learning. This is the longest period of time in which there is no type of relationship with the teaching team of the subject.

Prevalence of the use of instant messaging applications

The decision to experiment with the design of a virtual assistant was reinforced by the authors' experience of the new communication habits observed in the students. In most recent academic years, the progressive abandonment of the communication tools that form part of the LMS –fundamentally the forums of doubts and discussion boards– has been verified. Simultaneously, students are showing an increasing use of instant messaging applications available for smartphones, mainly WhatsApp, Telegram and Messenger, to create study or support groups for each subject.

This consideration from the experience of the authors is consistent with available data on mobile device usage. According to the report *Digital Society in Spain 2017* (Fundación Telefónica, 2018), 86% of young people have a mobile device with network access (smartphone), and use it for: instant messaging (81.7%), access to social networks (77.5%), music consumption (65.2%), and streaming video consumption (52.2%). The forecast is that 50% of young people will be *mobile first, i.*e. between 90% and 100% of their network consumption will take place on a mobile screen.

This pattern of use of messaging applications is not exclusive to the youngest, a profile that is not the majority in the UNED. According to the same report, in the 30-39 age group, the use to send and receive messages instantly amounts 80.6%. For users between the ages of 40 and 55, this application accounts for 73.3% of their use.

This trend has continued in the last year, according to the report *Digital Society in Spain 2018* (Fundación Telefónica, 2019): instant messaging represented 94.3% of the use of smart mobile phones.

Technical possibilities for the development of a chatbot

In 2016, *chatbots* or conversational robots broke in, largely driven by Facebook's decision to allow the incorporation of such functionality into its Messenger messaging platform. From that moment on, specific commercial applications and platforms began to be developed in order to design and implement *chatbots*, both for the main instant messaging applications and for websites.

Although their initial capacities were directed towards commerce, their possibilities for other environments such as education were soon discovered, especially within programs that are taught in the form of *e-learning*. That same year, Ashok Goel, a professor at the Georgia Institute of Technology, reported that

he had been using a *chatbot* based on IBM's Watson tool (Goel et al., 2016) as an assistant in his course on artificial intelligence without students perceiving that it was not human (TEDx Talks, 2016).

Design and use of EconBot

The process of creating the chatbot and putting it into operation has gone through two stages which, although cumulative in nature, differ in terms of the objectives pursued and the type of content provided in each of them. The first one, in which it was decided to experiment with this type of interaction tools, had the main objective of accompanying the student in the preparation of the exam of the subject in the call of September 2017. At this stage, the secondary objective was to begin a process of reviewing the contents of the course, as well as evaluating the materials used for teaching, an objective that was postponed until the next academic year.

The second stage, which is still in process, began in 2018. Now it is a question of not only having a way of interacting with students during the time in which the other ways cease to be used, but also of having a virtual and permanent assistant of the subject. After evaluating the use of *chatbot* in August 2017, and presenting it in some internal seminars dedicated to innovation in educational technology, work continues to be done in order to complete and enrich the knowledge module dedicated to the basic contents of the subject.

First stage: EconBot to support the preparation of "catch-up" exams

The chatbot design options were largely limited by the technical capabilities and skills of the teaching team, with little experience in the programming languages usually used to create *bots*, and none in the Natural Language Processing on which these tools are based. For these reasons, it was decided to use some of the existing commercial applications for the creation and deployment of conversational robots. After reviewing the options available, and analyzing the degree of difficulty for amateur users, the free option of a commercial platform was chosen.

It was at this stage when the different support options that the *chatbot* should have in order to help students were decided. Thus, the content that was provided to the *chatbot* in the first stage was the following:

- *Trivial conversation module (small talk)*: the *chatbot* was provided with a minimum content that would allow it to maintain a basic level of occasional or trivial conversation, such as greeting, responding to the greeting, saying goodbye, and recognizing its lack of knowledge, among other possibilities. It is in this module that the *personality* of the bot is most clearly constructed.
- *Subscription form to the notifications planned for August 2017*: in his first conversation with the *chatbot*, and permanently in its main menu, the student could subscribe through a simple menu of two options (accept the subscription, or leave it for later), to receive messages of support and review the content of the subject scheduled for the month of August. In turn, the student could cancel such a subscription at any time, through the main *chatbot* menu.
- *Support and review content for the month of August 2017*: through the programming options available on the platform used, review messages to be sent to previously subscribed students were prepared in different formats (multiple choice exercises, see Figure 1; reminder of the importance of some concepts and relationships, see Figure 2; messages of encouragement to the student), as well as messages with explanatory content to be received by students who did not respond correctly to the proposed exercises.
- *Links to digital content of the subject*: the student was offered a menu of options, limited by the possibilities of the platform used, with links to digital format learning tools existing in the subject that, in the opinion of the teaching team, could be particularly useful in that period of study.

More specifically, it was linked to the Course available in iTunes, to the subject's *webapp*, and to the dedicated channel on YouTube.

In EconBot's design, and especially regarding its personality expressed through the answers provided for the terms integrated in its conversational modules, one of the principles of multimedia design proposed by Mayer (2009; 2014) has been applied, suggesting the use of an informal and friendly tone, without falling into exaggeration. For example, the user is addressed by the name under which she participates in Facebook.

The availability of the *chatbot*, and the way to access it, was communicated to the students by means of an email message. It informed them of what EconBot was, how it would be used during August 2017, and the functionalities it had at that time. Basically, they were explained that those who subscribed would receive periodic notifications prepared by the teaching team specifically to guide their study during that month, and would also receive support during that time.

From August 2th, the day on which the first message was sent, until the last message was sent on September 11th, coinciding with the end of the extraordinary period of examinations, twenty-four messages were sent at an approximate interval of one every two days (Figure 3). Besides, students received a final message after the subject exam had already been taken in September, in which they were informed on the availability of the most correct answers for the different examination models used. When the content of the message was a multiple choice question, a second explanatory message about the most correct answer was sent to students who had incorrectly answered the former one.
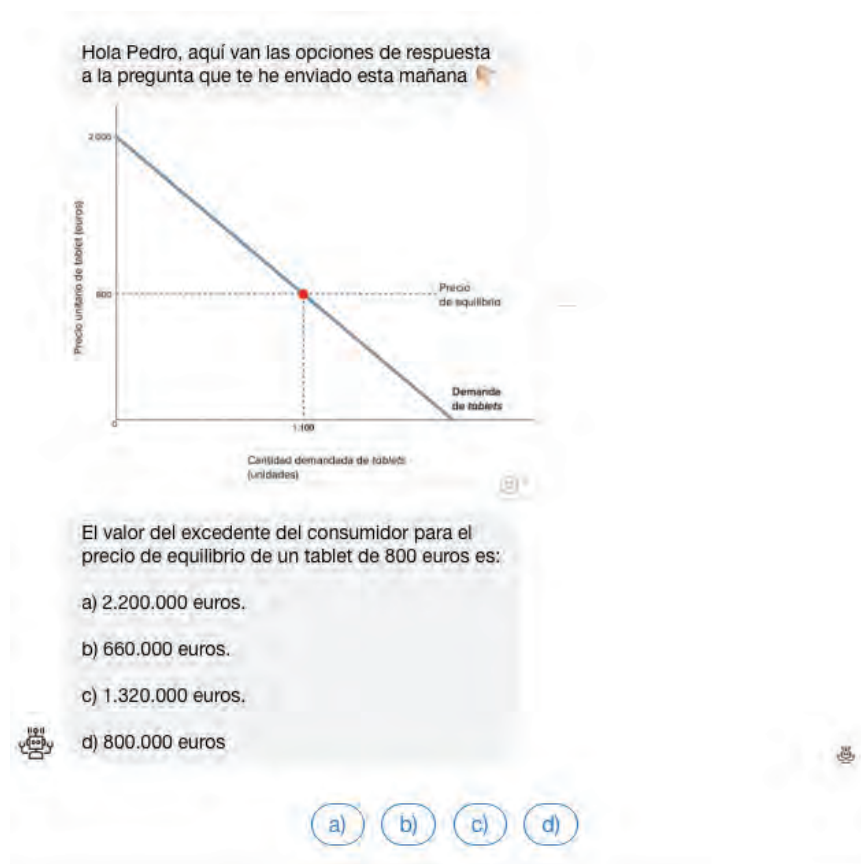

Figure 1: Image of the message sent by EconBot with graphic to review, and multiple selection exercise (in Spanish).

Figure 2: Image of the first message sent by EconBot with a reminder of important concepts and relationships of the first topic of the course (in Spanish).
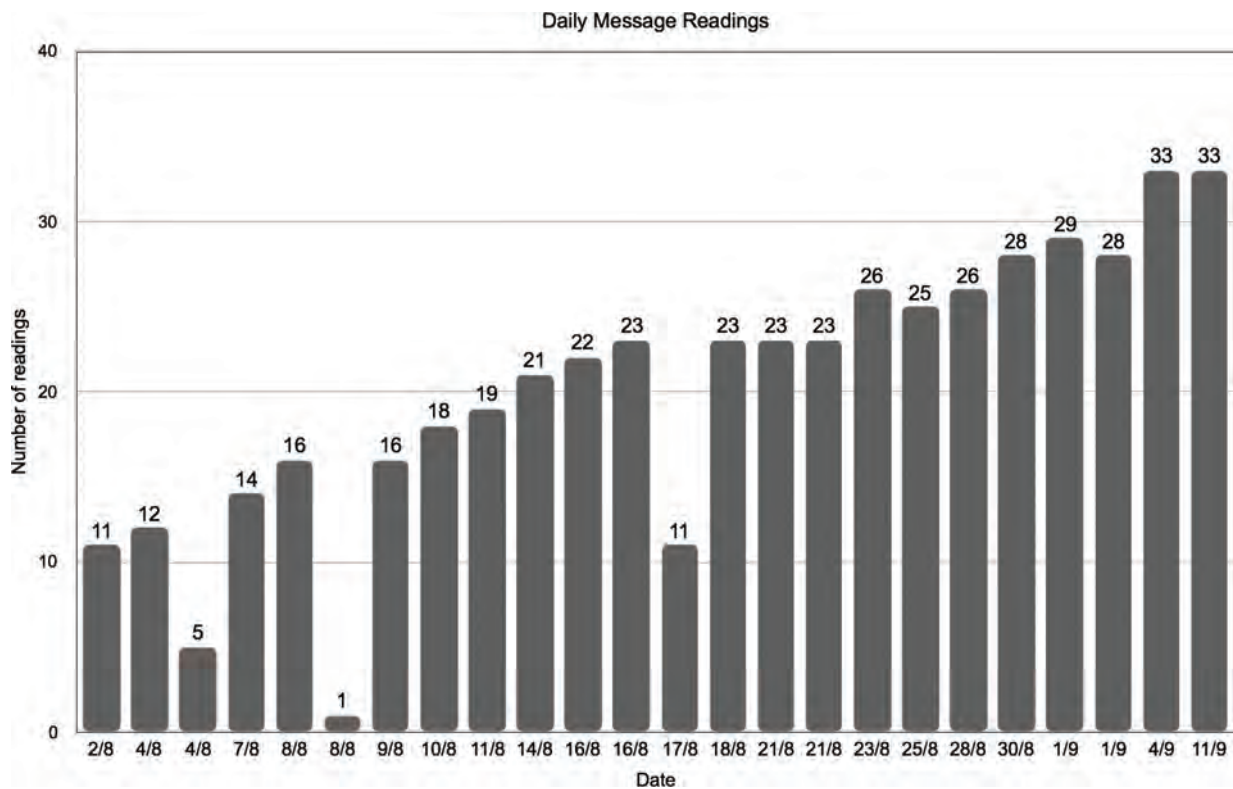

Figure 3: Daily message readings: August 2 - September 11, 2017.

The chatbot offer was well received by the students, but the impossibility of connecting it to the LMS used by the University did not provide us with usage data. They also did not use in EconBot the same identifier they use as students at the University. This disconnection made it impossible to approach learning analytics, such as those regarding the use of *chatbot* with the score obtained in the September exams.

Second stage: EconBot as a permanent virtual assistant

Once the initial objective of this digitization project had been achieved, it was decided to incorporate it into the virtual course as a permanent virtual assistant, although still under an experimental mode. Now EconBot has been enriched by expanding its content on:

- *Administrative knowledge*: specific modules were built with content on administrative issues, and the operation of the subject: ways to contact the teaching team, office hours, exam dates, ways to file complaints about grades, etc. The aim was to progressively replicate part of the non-teaching content collected on the University's website for the subject, so as to facilitate its search by locating it into a mobile tool such as *chatbot*.
- *Basic concepts of Microeconomics*: at this point, we have chosen to use different formats for the presentation of the contents, once the concepts to be included from the experience of the teachers have been selected. On the one hand, there are links to other materials already available, such as those already collected in the *webapp* of the subject. And on the other hand, specific responses are built, in text or *chatbot* response message format. In order to increase the effectiveness of the presentation of some concepts (Vazquez & Chiang, 2014) considered of special relevance as learning objectives by the teaching team, it was decided to enrich the visual content of the *chatbot* with the elaboration of specific images, and short videos in various formats (mp4, GIF). They were especially adapted to the format of the messaging application, and to the evidence available on the use of mobile devices.

EconBot Usage assessment

The design and implementation of the *chatbot* has served to enrich the teaching and learning environment of the subject, by providing students with a new communication tool adapted to their new habits, based on the use of mobile messaging applications. The experience of its use has proved the great potential that IA-based tools offer for teaching, and more specifically to assist and support the student in autonomous learning modalities, such as that of the University in which the authors develop their activity. The usefulness of conversational bots has been proven to make up for the absence of student care functions in periods such as vacations, as it happens during the month of August, as long as the extraordinary examinations are maintained in the month of September.

This initiative has also acted as a lever to promote the revision of the content of the subject, by having to select the most relevant economic concepts and relationships for inclusion in the content module. Thus, it has forced to adjust the expression of the teaching activity to the requirements of the use of mobile applications, simplifying the explanations. It has also led to an assessment of the need to generate a conceptual map of ideas the teaching and learning of which can be understood as basic in an introductory course to Economics in non-economic Grades. And it has shown the convenience of extending the module of contents with those corresponding to the continuation subject of the one referred to here, *Economy: Macroeconomic Fundamentals*.

On the other hand, it has been proven that the development of this type of tools by instructors without previous experience or training, opens the door to risks inherent to amateur dedication in

terms of design. And has, in any case, a high opportunity cost in terms of the tasks of university professors.

In addition, having to use a commercial application means introducing serious limitations to the project. Although it has served the basic purposes pursued, its commercial nature makes the final product dependent on the changes introduced in the application in terms of data traffic allowed by the company owner, available features, number of users that can be reached, etc.

Together with the above, the use of applications such as the one chosen, disconnected from the LMS of the subject, hinders the availability of usage data that allow an elemental approach from the analytical learning.

Chatbots models such as EconBot have, by their own design, shortcomings that need to be overcome. For example, it does not allow students to customize their learning beyond the feedback possibilities shown. Nor does it allow us to offer contextualized answers. Limitations that could be resolved with a specific programming from the beginning, carried out by professionals. It seems necessary to have a department dedicated to technological development, working together with faculty, specialized in the design and implementation of this type of tools. It would also be necessary to look for programming languages that facilitate a design without the limitations of commercial applications, and to have support to extract valuable information on patterns of use and learning.

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