Towards the Use of Personal Robots to Improve the Online Learning Experience

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Abstract. All changes are difficult and moving from face-to-face to online learning is not an exception. Nowadays, online students have many supports to ease their learning process due to the evolution of Virtual Learning Environments (VLE), the maturity of the pedagogical models used, and the vast experience of online teachers who design, create and deploy successful learning activities and accompany students through these activities. However, these supports are mainly centralized within the contexts of the VLE or the virtual classrooms. Therefore, new online learners should get the necessary habits to enter the VLE and the classrooms frequently. In this research we present an ongoing study in which robots are used as personalized companions of new students. Robots provide personal feedback to each student with the aim of promoting behavioral changes that facilitate the learning experience of new students and potentially reduce their dropout.

Keywords: Assistive robot · Persuasive technology · Motivation · Learning experience

1 Introduction

Until now, the role of robots as personal assistants for learning has been investigated, fundamentally, in children, less in adolescents, and very little with university students. In fact, the research with university students is mainly limited to learning programming or robotics content [1]. However, robots can be used also for other non-content related purposes, such as the promotion of student motivation and the acquisition of the necessary habits to perform the learning activities successfully.

Online learning takes place in a virtual learning environment (VLE) where learning processes take place and many mechanisms to help students are provided. Online learning is usually provided together with a pedagogical model that promote the work of academic and competence aspects in the classroom, but also other aspects of an emotional nature thanks to the effort of teachers and technicians who accompany, help, guide and support the student, both from an academic and a motivational point of view. However, all

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this guidance and support is useless when students do not access the classroom, do it unfrequently or do not work continuously. Hence, it is important to help new students to get the right habits to promote frequent access to the classroom and regular and continuous work.

In this work we propose to use robots for motivating novel students, promoting behavioral change, and improving their experience of use in an e-learning university context. In particular, the paper presents the experience of the Universitat Oberta de Catalunya (UOC) in the use of robots for promoting behavioral change of the novel students. The problem faced and the lessons learned may be useful and applicable for other distance learning organizations.

The paper is organized as follows. Section 2 presents a background of the work, describing the environment where the experience has been performed and the different psychological theories considered. Section 3 briefly presents the proposed system, the robots used, the way they have been used and integrated within both, the learning process and the UOC's digital learning environment and finally, the pilot study being conducted. Section 4 outlines the main conclusions and provides on-going and future directions of research.

2 Background

With the aim of individualizing and personalizing the accompaniment of the newly incorporated students and streamlining their training process, our research is based on different psychological theories that aim to ensure that a robot, who will be called *Botter* in our case, establishes persuasive and motivating communication with the student. This section introduces these theories and presents context of the UOC, which has been the motivational context and the place where *Botter* will be used.

2.1 The UOC Context

The Universitat Oberta de Catalunya (UOC), was created in 1995 as a completely online university [2], with an educational model adapted to the needs of students that promotes ubiquitous and self-directed learning [3]. Students can personalize the virtual campus according to their needs and likes. In addition, a personal tutor assists students in their educational experience with personalized feedback and answers. The communication nowadays involves several channels, such as tweet, mail, the typical support service and a community of interest for the whole university. Formative feedback may be provided to students from teachers, tutors but also their classmates. Basically, students learn with and from others.

The UOC campus (the Campus from now on), and its virtual classrooms, provides many mechanisms to help students; furthermore, the pedagogical model used promotes students work from an academic and a motivational point of view. It also provides specific guidance and support to new students. However, the dropout of novel students, in their first year, is still high [4]. Therefore, it would be beneficial to provide personalized support to new students in getting the necessary habits and dynamics to be successful virtual learners.

2.2 Habit Theory

Since the last century, psychology has been pointing out that people's lives are influenced by something non-reflective, such as habit. Furthermore, its conceptualization has gone from a purely neuronal level to a macro construct of a cultural nature [5]. Whatever dimension we adopt for its analysis, Andrews's classic definition [6] can help us understand how we work with habit with *Botter*; habit is a way of thinking, a custom, which is established through the repetition of a behavior based on a previous mental scheme. These are behaviors that we emit without too much conscious control, and that is what we want to achieve from our students, who acquire the habit of entering the campus. If this habit is not established, the chances of motivating them are slim.

The classic scheme to establish habits is to emit a trigger (acoustic signal from the robot, or a light signal, for example) to generate a behavior (in our case, it could be entering the classroom to read a message from the teacher) and, then get a reward (a green light signal, or a movement of joy, for example). As this scheme repeats itself, the behavior will end up becoming a habit.

2.3 Self-determination Theory

Motivation has been a constantly present theme in psychology, and for this theory it is also a fundamental concept. Based on the distinction between intrinsic and extrinsic motivation, [7] that postulates the existence of three innate psychological needs: competence, autonomy and relatedness.

Intrinsic motivation is the intention to act, spontaneous interest, without external rewards, doing an activity for the satisfaction inherent in the activity itself, and that leads us to act or emit behavior. Extrinsic motivation is more determined by social pressure, for example, a child who does homework because of the control that her parents are exercising over her schoolwork. The value of behavior does not reside in itself, but in its instrumental value, and regulation is no longer internal, but external.

Intrinsic motivation aims to promote the autonomous regulation of behavior, beyond extrinsic motivation. Initially, people behave in a certain way because such behavior is modeled or valued by other significant people for us with whom we feel or want to relate. This is how the basic need for relatedness, the need to feel belonging or connected with others, is very important for the internalization of motivation. Furthermore, context can promote intrinsic motivation by supporting the basic needs mentioned, since intrinsic motivation is intimately related to satisfying the needs of autonomy and competence (clearly) and also to that of relationships, although to a lesser degree.

This theory can be very significant for the field of education, since what we want, ultimately, is to motivate students to commit, strive and have the best possible performance [7]. If the social context in which our students are immersed is responsive to their basic psychological needs, we will achieve an optimal development of their abilities, while taking an active, responsible and initiative role in their learning process. From this point of view, it is vital to design the robot in a way that adequately displays responsive behavior that supports the psychological needs of our students [8].

2.4 Persuasive Design

Systems and technologies have been developed in recent years to change people's attitudes or behaviors, and that is where persuasive design and evaluation systems play a very important role. Nowadays technologies create opportunities for persuasive interaction because users can be accessed quickly [9], fosters students' motivation and thus provide a better learning experience.

Persuasive systems can be defined as computerized software or information systems designed to reinforce, change or shape attitudes or behaviors without using coercion or deception [9]. In our case, with *Botter*, it is us, the humans, and not the robots, who have the objective of influencing the attitudes or behaviors of our students, and we will design *Botter* for this purpose.

In this context, the most developed frame of reference is the one provided by Fogg [10] and the work of the Stanford Persuasive Tech Lab[1]. In his model, the author points out that the behavior is the product of three factors: motivation, ability, and triggers, each of which has subcomponents. The Fogg Behavior Model (FBM) states that for a person to perform a behavior, the person must (1) be motivated enough, (2) have the ability to perform the behavior, and (3) be activated to perform the behavior. These three factors must occur at the same time, since if this is not the case, the behavior will not take place.

As this model is useful for the analysis and design of persuasive technologies, we have adopted it to design *Botter*. Specifically, we use the gaze to make *Botter* more persuasive, at the same time that it emits gestures such as walking, shaking his head or clapping [11].

3 Proposed Approach

The proposed solution is innovative, not only for designing a personal assistant who accompanies students in their first contact with online learning, but also for doing so within a university context. Our robot, whose name is *Botter*, is like a co-pilot for the new students training itinerary during their first semester. The robot has been designed and programmed for this purpose, keeping synchronized with the UOC VLE in real-time and providing personalized and updated information on different aspects of the Campus and, above all, from the students subjects and classrooms from a persuasive perspective.

3.1 Goals

Based on the theoretical foundation that we have briefly described, we have specified the general objectives as follows:

– Dynamize the training process, broadening the interaction with the new UOC student and the information we offer her about her integration into the Campus and in the classrooms.

[1] https://captology.stanford.edu.

- Achieve a more continuous, more enriched accompaniment and beyond the virtual limits of the Campus, complementing, in the initial stages, the work that the tutors do throughout the student's academic life.
- Promote personalization and individualization in accompaniment, adapting it to the needs and characteristics of each student.
- Increase adherence to training at the UOC, reducing dropout.

To do this, *Botter* should be able to:

- Get the student's attention and keep it.
- Present the student with significant information about their learning process, such as deadlines, whether to download documentation for the study, whether they have read a message posted by the teacher, etc. These bits of information will allow students to establish tiny goals, which will stimulate their motivation more than a single, more far-reaching, and longer-term goal.
- Propose a good reinforcement system, so that students receive a reward (gamification) for each action that is appropriate for their learning.
- Offer trustworthy information, which allows students to stay on their learning objective and increase their perception of self-efficacy. To do this, *Botter* must be able to offer updated information in real time, such as inviting the student to enter into the Campus when the student has not done so in days. The bond between *Botter* and the student is based precisely on this trust.
- Show different expressions, either with "body" movements or with "facial" expressions.
- Value the satisfaction of the student's own learning process. Learning is very satisfying, but the most important thing is not that it is, but that the student realizes that it is. That is why *Botter* can, for example, give information about the qualifications of his continuous evaluation with a certain degree of gamification.

3.2 The Casting of *Botter*: Characteristics of the Chosen Robots

After establishing the general and specific objectives for *Botter*, we have benchmarked to decide which robots could meet the required conditions. The first selection criterion was to achieve a balance between cost, usability (dimensions, skeleton), personalization (system, programming, aesthetics), accessibility (proximity detection, voice recognition, visual/facial recognition), connectivity (WIFI, Bluetooth), autonomy (high, medium, low) and emotional expression. We evaluated this last aspect considering three components: facial expression (light, mouth, eyes, text, graphics), movement (arms, legs, wheels) and audio (sound, voice).

Based on these criteria, we analyzed the following commercial robots: Lego MindStorm EV3, Mbot 2.4G, Aisoy 1, Zenbo, Cozmo, Otto and Zowi; to end up choosing Vector, which is the evolution of Cozmo, and Zowi. We can see the personalized version of the robots chosen in Fig. 1.

The Cozmo/Vector robot has the following characteristics: small, compact, degree of customization of the system only by the owner, limited programming (SDK), low

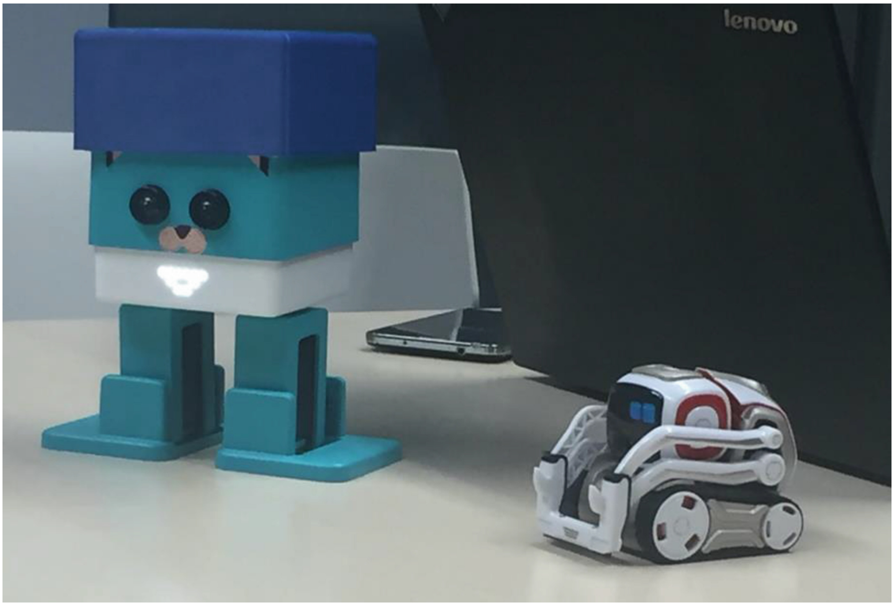

Fig. 1. Robots used for promoting a behavioral change in the novel students of the UOC: Zowi at the left and Vector at the right

autonomy, average cost, with wheels, voice, arms, eyes, text, voice recognition, facial recognition, proximity detection and WIFI.

The Zowi robot has the following characteristics: medium size, compact, open source programming, 3D printing, degree of customization of the system only by the owner, high autonomy, low cost, with legs, sound, mouth, proximity detection and Bluetooth.

3.3 Proposal

In this first stage of this research, some indicators potentially useful for behavioral change of novel students have been proposed. This process has been conducted by defining a first set of over 30 potential indicators that cover the different activities students may perform within the Campus. From these indicators, only 18 were selected, after a collaborative process of prioritization, which involved 6 persons of the team.

Each of the selected indicators (*frequency of connection* for example) were analyzed to find out the expressions it may trigger (*if the frequency states an obsessive conduct then some signal should be performed to let it know to the student*, for example), the habit we would like to promote (*self-regulation* in the example) and the action to be done by the robot (*some humoristic action to make student realize that he is connecting too much*, for example). Note that the possible actions of the selected robots may be acoustic, luminous and of movement. Indicators mainly collect data about student connection to the Campus and classrooms, student access to the different resources within the classroom, and students marks of the different assessment activities. The details about the indicators are out of the scope of this paper.

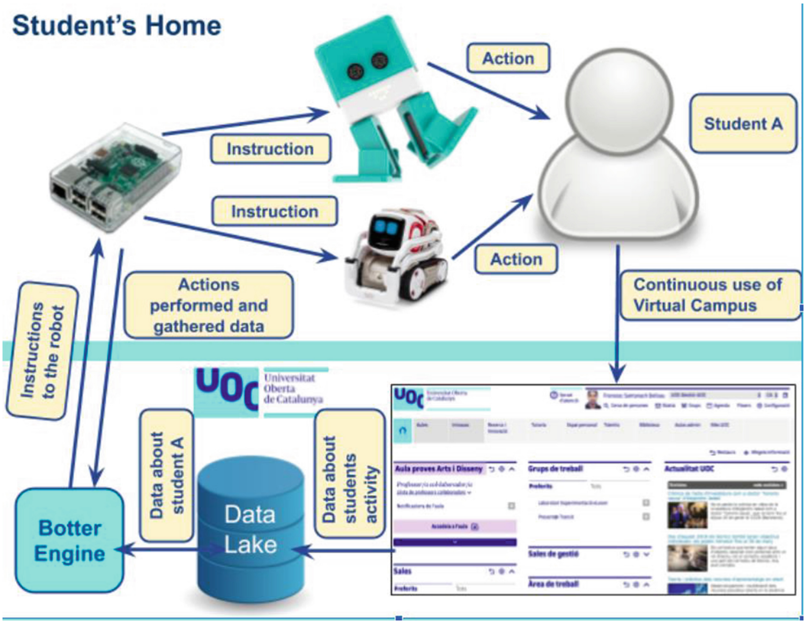

Fig. 2. Architecture of the Botter System. The top of the figure shows the students environment and the bottom the UOC environment.

Unfortunately, the personalization and programming environment of the robots and their performance may make it harder to execute complex processes within them and to connect them to the Campus to get the necessary data about the indicators. In order to make the system as much generalizable and robot agnostic as possible, and reduce the workload within the robots, all the necessary computation is done in a Raspberry Pi (Raspberry from now on). Each robot pairs with a Raspberry that has to be installed at students' home in order to use the robot. The architecture of the system (see Fig. 2) is split in two environments: the university and the students' environment.

In university environment, the fingerprint data of students (data about their interactions within the Campus) are stored in a data lake [12]. There is a Botter Engine that continuously check the data lake to find out new data about the selected indicators and recalculate the indicators (and the corresponding robot actions) as soon as new data arrive. Thereafter, the new actions are sent to the robots.

At student's home, the Raspberry receives the actions to be performed and send them to the robot. Depending on the student the robot may be a vector or a Zowi. The robots perform the actions and inform to the Raspberry about the actions performed and their results (if any). Then the collected data are sent to the Botter Engine at the university and will be potentially used to prioritize and filter new actions.

3.4 Pilot Design

In order to evaluate the system and to analyze the usefulness of the approach, we have designed a pilot study that is currently being performed.

The pilot has begun at February of 2020 and will take one semester to finish. During the semester, 10 new students from the Psychology and Computer Science degrees of the UOC were chosen to use the robot as a companion in their first online learning experience. The inclusion criteria of the students were to belong to Psychology and Computer Science degrees, to be novel students and to have no experience in online learning. Each of the students received one robot and one configured Raspberry (5 Vector and 5 Zowi). A formation for each student was performed when delivering the robots. An infographic showing how the robot communicates was also provided.

Data about the experience will be gathered by using pre-post questionnaires and semi-structured interviews after the experiment.

4 Conclusions and Future Work

Robotics is very likely to occupy a privileged place in people's training and education [13], although this does not necessarily imply the dehumanization of education. The fact of training with robots does not involve delegating the functions of educators to develop relatively autonomous, automatic or depersonalized processes. As long as e-learning professionals lead these changes, robotics can contribute not to dehumanize education, but to broaden its scope as a tool for social change.

In this work we take the challenge of studying how to design robots to be persuasive and cause behavioral change for novel students in online learning environments. From the work done so far with *Botter*, it would be advisable to keep the use of robots low cost to ensure that their use as a support tool can be generalized to as many students as possible. Likewise, we consider that research is necessary on the characteristics of robots that can range from "boots" (operating systems) to anthropomorphic robots, and combine these physical characteristics with other "psychological" ones, such as the type of triggers, the type of messages, the tone and style of these, etc. It is important also to consider that a robot is just a tool to serve educational purposes and, therefore, its incorporation should be driven within the instructional design perspective and a given educational model.

As further work, we plan to finish the experiment and share its findings. From there, the findings obtained will be used to decide whether to continue in this research line and, if so, in what direction.

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