ROBOTIC PROCESS AUTOMATION APPLIED TO EDUCATION: A NEW KIND OF ROBOT TEACHER?

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Abstract

The robots, despite being commercially accessible for multiple functionalities and in different modalities, are still an innovative topic and represent great opportunities for the research and development in the education and culture of the society. In this article, the use of RPA (Robotic Process Automation) robots is developed and proposed, as a resource to support teaching processes. The revision starts describing the gradual utilization of robots in the modern educational institution, by means of examples, indicating cases, perceptions, challenges and/or opportunities as the text advances. The role that the AI (artificial intelligence) plays is pointed out, as well as its current situation, different type of robot implementations and their application in education, while going more and more into the RPA option, showing application cases from the private enterprise and highlighting the improvements accomplished.

The method used for the research is explained, which basically consists of the compilation and revision of the related literature, in order to validate the authenticity and innovation of the proposed hypothesis based in RPA, followed by the design of a use case diagram of the robot (operability), the development (software programming) and testing of the specified functionalities, considering different perspectives: in favour and against the project. The work continues with the demonstration of results achieved, including a video of the robot in progress (named Aileen) having an exchange with a student of 11 years old, who interact without interruption for about 10 minutes during a teaching-learning process, in Spanish language (with English subtitles). Before ending, to highlight the widespread opportunity and scope, some of the author experiences about complementary, but pertinent, technology are shared, taking into account emotional factors, through the use of facial expression recognition, eye tracking and the reading of brain's electrical activity with EEG (electroencephalography), among others, and the development potential with the current RPA technology (e.g. an updated version of Aileen). The importance of AI and autonomous systems in the society is emphasized, and the achievements and lessons learned with the RPA robot are reviewed, including the impact and opportunities for governments and educational institutions with its eventual incorporation.

Keywords: Robot, RPA, education, artificial intelligence, teaching, learning.

1 INTRODUCTION

Between the decades of the '80s and '90s, advances in scientific research and development in industrial uses made universities gradually become equipped with laboratories and specialized equipment to offer 'robotics' as a subject of study, which at the same time became common in subjects such as computing, electro and mechanical engineering. Due to the financing and maintenance challenges, robotic education based on computer software had to be considered as an alternative [1].

Paradoxically, the software, which is also one of the most important components of a robot, was considered a 'bottleneck for the proliferation of robotics' for intellectual property reasons of the software offered, until companies began to change their licensing terms [2].

In the 2000s, several robotics toolkits were created with improved and friendly designs, such as LEGO Mindstorms NXT, Arduino and Crickets, among others, which were pioneered in school classes worldwide successfully. For instance, the Robotics class with LEGO Mindstorms NXT at Käthe-Kollwitz-Gymnasium school in Wesseling, Germany. In fact, optimism regarding the development of technology-based learning prevailed in the eyes of experts, as well as leading organizations reported growth in the robot market, but scepticism prevailed in terms of the institutions capabilities and the formal education system to be flexible and keep pace with acceptance and incorporation, along with how the technology evolves in this regard [3].

In 2008, it was published in an OECD (Organisation for Economic Co-operation and Development, p. 2) report, that the technology is '*everywhere, except at school*'. It showed that the speed at which

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technology penetrates the lives of children and young people was reflected in the adoption rates of home computer use, while actual adoption in schools fell short [4]. Similar to the provision of computers and Internet for educational institutions in their laboratories, there are obstacles that hinder the implementation of robots in the regular curriculum of schools, for example: the time consumed by robotic activities, the cost of the required equipment, the teacher training, and the work of keeping the kit parts in the right place and under inventory [3] [5].

On the other hand, robots are often used as the subject of study and not as an instrument to teach, although advances in robotic technology allow additional educational activities [6]. The real contribution of robots in science, technology, engineering and mathematics (STEM) is not obvious, but it has evolved gradually from conventional robotics education, to non-technical learning activities [5].

In a systematic review of studies published in 2012 [6], it was found that most of the papers containing quantitative assessments of student learning, explored topics related to mathematics and physics, including the development of skills in logic, scientific research and problem solving. Although test results (before vs. after), show that there is gain in student learning with the application of robotics, there are also cases with no significant increase in learning. There is an emphasis on the role of the teacher so that the use of robotics kits provides significant benefits, both for the cases of application and dynamics of the participants, as well as the teacher's willingness to program on the computer – situation that also requires an investment in training on the provider’s software, as in the teacher’s skills and competencies.

Robots are also being used, not only from the classical perspective of robotic education (educational robotics), but also, when some of these are equipped, with the ability to interact with human beings (HRI – Human-Robot Interaction). In these cases, there are other important factors that should be considered. The social aspects and/or capabilities about and from those that will play a relevant role in the perception of satisfaction, acceptance and even the user’s attitude. From this point of view, some authors [7] have classified them as ‘utilitarian factors’, where aspects such as: utility, ease of use, and the adaptability or ability of the robot to adjust to the changing needs of the user, predominate; and the ‘hedonic factors’, which consider, among others: enjoyment, visual attractiveness, sociability, and the companionship or perception of the possibility of developing a relationship with the robot.

It is pertinent to introduce the artificial intelligence (AI) concept, which, even though is a very broad term, with multiple areas of study and definitions older than half a century, usually have in common, among others: the automation or solution of tasks by computational means, which, depending on the progress to date, are associated with intelligent behaviour. A definition accepted by different authors is: ‘*the study on how to make computers do things which, at the moment, people do better*’ [8, p. 3].

The AI, which lately aims to replace teachers or professors, in practice takes the form of a package or program of 'software', which can be online, based on a desktop computer or installed in a mechanical body, to perform the activities that a teacher does [9]. ‘Robot teacher’, or ‘ robot instructor’, is a term commonly used to refer to social robots in classrooms to act as teachers. As examples of mechanical robots used, some for more than a decade, are: Saya, Pepper, NAO, Rubi, Robovie, and for education at home: iRobi, Robosem, among others. These have no lower cost than the kits used for educational robotics. Another form of robots for teaching are those of telepresence, operated remotely as a replacement for videoconferencing means such as Skype [10].

The term robot, when related to RPA, should be seen less threatening, since it does not depend on electromechanical machines or specialized hardware around, but mainly on the software for the execution of services [11].

Distance education, or e-learning specifically, despite not being the focus of this research, is a subject worth mentioning, since it is easy to find similarities in opportunities or associate the concept of teaching through RPA (outcome of this document), to the training in open universities, for example. Even more, these can resemble, when considering those services that count with Intelligent Tutoring Systems (ITS) and their capabilities, which have been recently promoted by constant research on functionalities to support learning, such as incarnated virtual characters or pedagogical agents and their appearance, the student perception and the impact on motivation to learn [12] [13]. Fields of education supported by digital means, such as virtual learning, virtual laboratories, virtual reality or virtual worlds, avatars, virtual systems based on dynamics, or the concept of immersive education - generally have the common possibility of access through networks such as Internet, for remote education, and the potential to incorporate AI for a more effective learning experience, but also with the disadvantage of not being able to replace, for example: a science laboratory with real equipment for the acquisition of skills and experimentation of first hand [14].

The general objective of this research work is to plan and develop an RPA robot that allows supporting the student's teaching-learning process. Specific objectives include: to review the state of the art and use of this nature and robot properties in education; to design and develop a version of the RPA robot; to test and validate the implemented functionalities of the prototype robot interacting with a student.

1.1 Artificial Intelligence and Robotic Process Automation: Approximation View

It is a lost cause for a human to try to compete against AI in any of its strengths: speed, accuracy and consistency, however, in soft skills such as: innovation, critical thinking, socialization, and leadership, among others, it is still possible to do it [15].

A recent study with participants from Sweden, the United Kingdom and Portugal [16], demonstrated ambivalence from teachers about having robots in classrooms, suggesting that it is due to the emotional obligation and moral responsibility to care for and defend the rights of the youth. Of concern are issues such as data privacy (especially affective data); the responsibility given to robots and the limits in comparison to teachers; long-term risks, which could outweigh the possible benefits; and uncertainty regarding the responsibility for a robot, and any other negative consequence that may arise for a student.

AI tools have proved capable of replacing teachers in some training tasks, just as they have managed to organize educational processes, answer questions correctly, and carry out oral and written communication, although it can take a lot of time and effort to prepare a system to be able to respond to multiple scenarios, so the work is only rewarding if the AI tool will be used at large-scale [17].

For its part, RPA refers to the robotic automation of processes traditionally executed by humans, which in practice is achieved through software robots that are assigned with a high volume of repetitive, standardized and rule-based tasks to interact with multiple end user interfaces. Tasks are set by experts in each matter, who define the rules for decision making, including process flows, triggers and activities to complete each process [18].

Nowadays, large corporations tend to pursue the implementation of RPA looking for benefits such as boosting productivity with minimal process changes, since RPA does not require changing the applications that humans use, in order to automate. A robot could replace one worker or five, for example, so that return on investment calculations are also simplified. At the same time, the RPA market counts with a stable portfolio of products and suppliers, with approximately 15 outstanding, which have been competing for many years, and some recently innovating in AI [19]. Among the most outstanding brands, in alphabetical order, are: Automation Anywhere®, Blue Prism®, EdgeVerve®, Kofax®, Kryon®, NICE®, Pegasystems®, Thoughtonomy®, UiPath®, WorkFusion® [20].

So far, the best RPA returns have been identified in business areas such as Finance and Accounting, Human Resources, Supply Chain, Information Technology Services. A great advantage for users is that a background in computer programming is not needed in order to design the processes. RPA tools are generally easy to use and the staff of each department can support to train the robots [21].

In a recent survey involving 150 individuals from companies of all sizes, the main benefits identified were: quality improvement, cost reduction and process acceleration. However, other essential measures of success for companies are: risk reduction and increased compliance, time saving on repetitive tasks, as well as improvements in effectiveness and efficiency [22].

An interesting example of the use of RPA, among several, is that of OpusCapita [23], a company with headquarters in Finland, which offers business process outsourcing with a focus on the procurement area, has a payroll of 2,000 professionals and 8,000 clients in more than 100 countries. It began the implementation of RPA in the year 2014, focusing on automating certain internal processes - which is the usual practice. Since 2016, it has been expanding RPA to different areas of the business, up to achieving to include the offer of ‘RPA as a service’ to its customers with operations in Europe and U.S.

There is enough evidence of successful cases of robot implementation, including RPA, in different commercial sectors. As for the education sector, there are strong opinions that deny the future ability of robots to completely replace human teachers, some researchers study issues such as the personality of robots in terms of how they impart knowledge, the capacity for social interaction and the feelings [24]. Although emulating a human teacher so much may not be necessary. A recent study in Spain [25] that questioned the comfort of students in being with robots that have emotions, revealed that 55.2% of the primary education group responded affirmatively, while 51.3% of the secondary education group said:

not being sure, not knowing, or did not respond – preliminary data, in an environment of rapid changes, which seem to indicate that '*older students do not care much about the emotional part of a robot*'.

According to the UNESCO Institute for Statistics, there is a 'massive teacher shortage at primary and secondary levels', and the projections indicate that by 2030 the countries will have to recruit: 24.4 million teachers for primary schools (21 million will be replacements, 3.4 million will be additional) and 44.3 million teachers for secondary schools (27.6 million replacements and 16.7 million additional), totalling a need for 69 million new teachers [26]. The variation in the difficulty to fill teaching positions varies by educational centres per year. However, this tends to be greater and constant between different subjects. For the United States, as example, the percentage of vacant teaching positions in STEM was more than 200% higher compared to vacancies in Primary, Language and Social Studies according to the 1990 registry until 2012. The challenges for hiring teachers are increasingly higher [27].

The position presented in this article is not intended to replace teachers, but rather to favour their work, under the initial hypothesis that 'RPA robots can be used as a support resource in teaching processes'.

2 METHODOLOGY

First of all, literature was collected with the intention of verifying if a similar hypothesis had been raised previously, or if robotic process automation applied to education with HRI was already a researched and known topic. Finding no evidence to prove either of the two possibilities, it was decided to expand the available documentation with associated topics to base and justify the exercise in this regard.

The absence of an exemplary model provided the opportunity to present the idea through a use case diagram [28], which can be seen in Fig. 1.

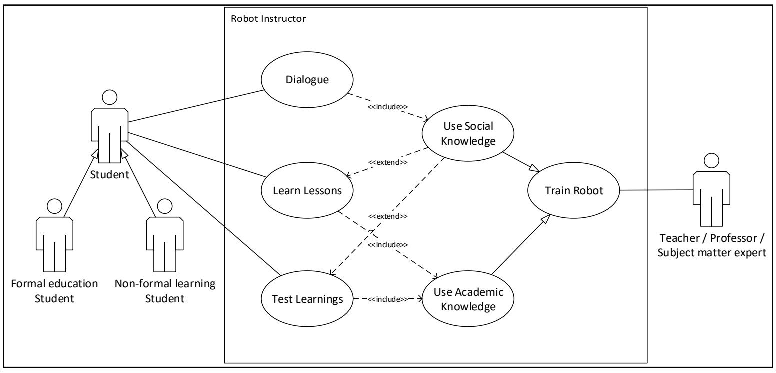


Figure 1. UML diagram with planned use cases for the robot. Source: Own elaboration.

This diagram basically consists of two actors, the student and the teacher. Where the student should be able to interact primarily with the system (robot instructor or robot teacher), as can be seen through association relationships, to dialogue, learn lessons and test learnings. On the other hand, the teacher, with the role of secondary actor, should have the possibility of training the robot, in its two generalized capabilities: use of social knowledge and the use of academic knowledge. These last two at the same time support the student's uses in an inclusive (necessary) and/or extended (optional) manner, depending on the case and/or desired situation.

The desired uses are not part of the software packages offered by RPA providers, yet, so such an idea would call for the development of the functions mentioned in the diagram.

Once the concept and the required functionalities have been established, the design and architecture of the prototype robot is then worked on. For these purposes, UiPath® (www.uipath.com) was chosen as RPA software, due to the flexibility for custom integrations, the large community that supports it and previous positive experiences of one of the authors, among different RPA tools. Microsoft® SQL Server® (www.microsoft.com/sql-server) was used as database and Microsoft® Windows® 10 Pro (www.microsoft.com/windows) as the operating system.

The development and testing took multiple iterations under trial and error, which were reduced as the learning curve progressed in regard to human-robot interaction.

Before starting to show a first version of the product implemented (Aileen v1), it is worth reviewing the following factors, predispositions and/or arguments, which have different points of view:

2.1 Counterarguments

- *Robots pose a threat to the stability of the workforce of any organization, in this case educators, who will reject their potential and possible implementation. In addition, there is an absence of technical knowledge to handle the technology*.

  It is natural that employees feel fear when it is rumoured that the organization's management analyses the possibility of implementing robotic process automation. They think that, by increasing productivity, their jobs will become redundant. The idea that is usually transmitted from top to bottom is that: it will be possible to put aside the repetitive tasks or boring work, and concentrate on more interesting tasks, consequently having an increased satisfaction [23] [11].

  It is the reluctance or reaction by instinct of the human being when encountering new technologies or perceiving that their comfort zone could be at risk, and like other innovation projects, the importance of change management should not be underestimated. The training to operate RPA robots is not as technical as the required for handling robotics kits, nor as exclusive as the case of mechanical robots, but as simple as the use of a desktop application on the computer.

- *When an RPA robot works, it completely occupies the computer and it cannot be operated by a second user at the same time*.

  That's correct! This is one of the characteristics of RPA. The robot takes the place of a person. Its work does not normally manifest in the background as a service of the operating system. This aspect must be perceived positively, and has a cultural connotation. For example: if the robot is moving the mouse pointer and the student moves the mouse too, the second one will change the course of the pointer, entering into a movement dispute. That is, just as a student should allow the teacher to finish speaking, until it is his/her turn to ask questions. Both should not expound at the same time. The opposite is usually considered disrespectful, of bad manners, or a bad habit.

- *The technology was not created for that purpose. There is no evidence that RPA robots can interact with students, which in addition to teaching classes, includes responding to requests!*

  That's right. One of the main challenges of this proposal, and at the same time opportunity due to the innovation factor, is because RPA technologies have been traditionally used to automate processes involving many software applications, such as web forms, desktop tools, remote clients and command consoles, while an education approach demands concurrently mastering HRI.

  The use of many technologies manages to evolve beyond ideas through experimentation. When the light bulb was invented for the purpose of lighting, for example, it was not known that the technology would evolve until the creation of visual projection devices used today in the classrooms, not to mention other intermediate and derived achievements.

2.2 Arguments in Favour:

- *Lower cost in comparison to mechanical robots*

  The cost of a mechanical robot, for instance: a humanoid, increases when there are more advanced sensory and mobility functionalities, due to the multiple mechanical parts (hardware) that compose it. The size, quality of the parts, workmanship, and the software that integrates it, also have an impact on the cost of the final product. The commercial value of the equipment can vary, for example, from approximately € 500 for an Alpha 1 Pro package from UBTECH Robotics, Inc., which is mostly promoted as a tool for family entertainment with pre-programmed functions; up to around € 7.500 for a NAO Power V6 robot and € 21.000 for a Pepper, (both from Aldebaran Robotics SA, which belongs to Softbank K.K./ SoftBank Group Corp.), in its academic versions.

  In contrast, an RPA robot resides on any desktop computer, or laptop without demanding specifications. So, the lower hardware cost already represents a great advantage. Software licenses are generally compared to the cost of 'an employee' to the organization (to later make the investment more attractive), although the amount 'per robot' can vary from € 0 (depending on the brand, software package and the type of business in which it will be used) up to approximately € 12.000 per year. Providers offer different licensing models to adjust as appropriate and, some of those who charge, allow up to 12 months of trial at no cost.

  The need to have a body or mechanical object moving in front of the student is questionable, to support teaching-learning processes. The mechanical functionalities of a humanoid robot could currently be considered a waste of resources, if the objective does not involve the manipulation of objects. If it is really necessary for the project to provide a striking visual experience when teaching classes with RPA, the presentation of a virtual character can be considered using, for example, a holographic projection via secondary device.

- *Ease to multiply and spread knowledge*

  Robot cloning is very common when implementing RPA. All the knowledge that is transmitted to the robot, in the end is software and data, which can be transferred from one computer to another, regardless of the distance or multiple desirable instances.

  RPA solutions allow you to manage robots centrally. If a change is applied, for example, in the design of the robot's functionalities or the extension of its knowledge in any course, it can be distributed remotely to all the clones as desired, without much effort: between classrooms, branches of the institution, or different schools.

- *Alternative to improve students' capacity, performance and assessments*

  When a student has a hard time understanding a topic and does not do well with the course literature, he/she usually depends on the willingness and availability of the teacher or professor, classmates, parents, friends or third parties. Sometimes, it is not only about the difficulty to understand of a subject, but simply the desire of a student to learn more about the subject that interests or passionates him/her. Unfortunately, it is common that in the previous scenarios the students face failures, or limitations in learning opportunities. This could be overcomed by counting with RPA for teaching, since robots have the following attributes:

  - they can work 24/7 to provide explanations, exercises and tests that allow learning according to the learner's convenience.
  - provide constant and even improved quality of work, without depending on emotions, health or psychological conditions.
  - they can repeat the explanations numerous times, adjusting to the need of the students.
  - do not discriminate (gender, nationality, religion, sexual orientation, social status, etc.).
  - can operate in diverse environments, meeting minimum requirements for the eventual student.

3 ROBOT: MAIN FUNCTIONALITIES

The general characteristics of teachers' work are suitable for the algorithmic programming of tasks, for example, breaking them down into specific stages, steps, procedures and actions, which facilitate the configuration of robots for behaviour or decision trees. Administrative work, in particular, is much easier than counselling, research or studies, so a complete replacement of human teachers by independent robots should not be expected [9].

Among the functionalities implemented in the programming of this first version of the RPA robot, stand out: 1) Greeting through audio interface; 2) Answers to questions (verbally and with customized screen interfaces); 3) Use of desktop applications; 4) Usage of a stored courses index; 5) Instructions/ recommendations to the student; 6) Data registration, progress tracking and lessons preparation.

Likewise, a training and/or teaching process to the robot has been carried out for a concrete case, to be able to perform later: a practical essay with the preselected student.

4 RESULTS AND DEMONSTRATION

Some functionalities have been already successfully implemented, and their operation has been demonstrated in practice, as designed for the robot since the conceptualization of the project, including dialogue, the teaching of lessons and the verification of student learning through practical knowledge tests. In the recorded video, under Fig. 2, part of the social and academic knowledge that Aileen was taught/trained on during the experimentation, was tested; training or subject matter expert role that, according to the diagram from Fig. 1, would normally be held by a teacher.

The developed robot, which has been provisionally named in this project: Aileen, to facilitate the reference to the concept of RPA in education, is then put to the test, under Fig. 2. In fact, and for the moment, it is not a final product, but tentative or preliminary, for the purpose of demonstrating that RPA robots can be used as a resource for improving the teaching-learning (recurring and recursive) processes. As the adage goes ‘an image says more than a thousand words’, the recorded video has been used to expose, together with an 11-year-old student, the robotic functionalities initially proposed.

Figure 2. Testing interaction between RPA robot and student. Source: Own elaboration.

4.1 Further Opportunities: Emotional Factors and Development Potential

Beyond having the ability to teach a course, the ‘empathy’ or ability to perceive the emotions of the student, is an appreciated attribute in a teacher. Combined negative emotions, for example: fear, anger and sadness, have different effects on the behaviour of individuals. Fearful people have relatively pessimistic judgments and avoid risks, those disgusted are more inclined to have stereotyped criteria and focus little on details, while sad individuals prefer to apply systematic methods and deal with more details [29]. From the technological aspect, this area of research is called ‘affective computing’. It covers the study and development of systems and peripherals that can recognize, interpret, process and simulate human emotions. Affective computing was derived from HRI and has since grown to become an interdisciplinary field that encompasses computer science, psychology and cognitive sciences [30].

Depending on the vendor and RPA software package that is selected, it is possible to count with some AI functionalities already included in the product, as well as extend or integrate third-party tools. Here are some examples of the potential exploitable in new versions of Aileen:

4.1.1 Facial Expression Recognition

Facial gestures are probably the most common and notorious medium, additional to the exchange of words, that a teacher usually perceives or feels when communicating with a student. Expressions such as: surprise, smile, concentration, dislike, valence, attention, expressiveness, among others, can also be detected by the robot. Thus, the decision trees can be configured to consider the mood the student reflects in each moment, adjusting to personal needs for the best learning of the individual. For example, if gestures of dislike are detected, the robot can understand that the topic or teaching style is not being appropriate for the student at that time, and immediately take measures such as encouraging the student with motivational phrases and/or trying to explain in a different way, like with real cases; conversely, smiles can be configured as student satisfaction and, therefore, continue tutoring in the same way.

Facial expression recognition functionalities have already been developed by companies such as Affectiva Inc. (see Fig. 3.a), Kairos AR Inc., Noldus Information Technology BV, NVISO SA, Sightcorp BV, among others. Fortunately, for the implementation, it is not necessary to emphasize on the selection of the peripheral, because with a generic webcam of moderate specifications is enough (even the same ones incorporated in laptops). This simplifies as well the comfort aspect of the end user, who will only need to maintain lighting in the work area to allow recognizing his/her face.

4.1.2 Eye Tracking

The capability to detect where the human sight is directed, also represents an opportunity to enrich the perception of the emotions that emanate from the student. Similar to how a teacher can notice when a student is distracted observing through the classroom window, instead of paying attention to the lessons, there is the possibility of enabling the computer or robot to distinguish whether the student is looking towards the monitor, or in another direction. The robot can also have a fairly accurate precision, being able to determine the image, text, button or other object on the screen that captures the student's attention. This ability provides additional opportunities, considering that, for example, when already counting with recognition of facial expressions, it could be deduced if any specific object on the screen is the cause of an unusual gesture from the student.

To detect with precision where the eyes are pointing, when viewing a screen or other object, a webcam is not enough; a specialized device and software that measure the position of the eyes and their movement, are required. There are different technologies and products on the market: from those centred on solutions for medicine and scientific laboratories, to those trying to innovate in the niche of peripherals for video games, with prices ranging from tens of thousands of euros to less than € 100. Some suppliers offering similar proprietary eye tracking technologies are: Tobii AB (see Fig. 3.b.), SensoMotoric Instruments GmbH, SR Research Ltd., Smart Eye AB, Ergoneers GmbH, among others.

4.1.3 Reading of Electrical Activity in the Brain through EEG

The use of EEG (electroencephalography) allows to go beyond the visual. Owing to the fact of being an electrophysiological method, it reveals data that sometimes contradict what is interpreted from body gestures. For example, a student could stare into the teacher's eyes, keeping a serious facial expression, but at the same time the processed brain data could indicate a low level of commitment and interest. In order to apply EEG, a specialized peripheral or system is required, in practice known as BCI (brain-computer interface), or simply ‘neuro-headset’, depending on the solution.

Equipment options to allow the application of EEG in a practical and comfortable way are not yet abundant. In fact, by simply typing the word ‘electroencephalography’ in an Internet search engine, you can see how apprehensive (even invasive) a traditional equipment looks, with several cables directed towards the head. During the experimentation, it was possible to recognize emotional states such as: stress, interest, relaxation, commitment, excitement, and concentration. Providers, such as Emotiv Inc. (see Fig. 3.c.), NeuroSky Inc., OpenBCI, InteraXon Inc., offer solutions in the neuroscience field.

To illustrate, the Fig. 3 shows each one of the previously visited technologies. Hence, in 3.a) how the student can be seen from the robot perspective when integrating Affectiva software; 3.b) Tobii Eye Tracker 4C device for eye tracking; and 3.c) Emotiv Insight neuro-headset for EEG.

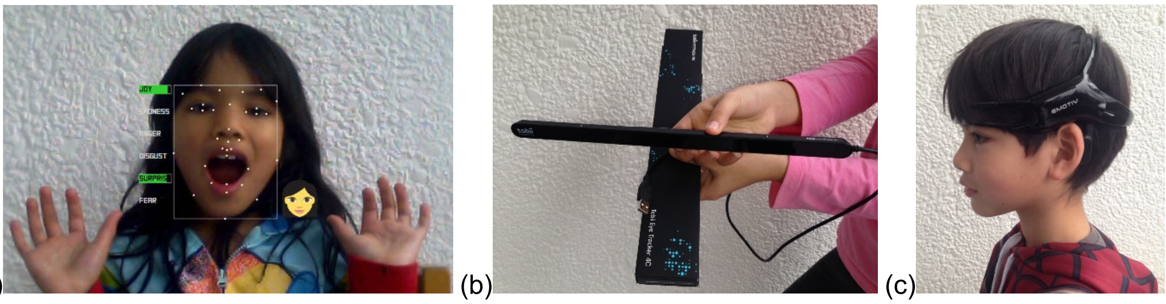
(a) (b) (c)


Figure 3. (a) Affectiva SDK; (b) Tobii Eye Tracker 4C device; (c) Emotiv Insight neuro-headset. Source: Own elaboration.

Other techniques such as MEG (magneto-encephalography), fMRI (functional magnetic resonance imaging), heart rate detection and voice processing, among others, although they are not part of the scope of this work, should not be ruled out for future analysis with focus on RPA robots.

The current state of AI, robotics and autonomous systems, especially when associated with education, is boosted through the investment by organizations, either private or governmental, and their scope (local, regional or global), in these research areas. The advancement level can be perceived, for example, by seeing that the European Union discusses issues related to morality, values, the organization of society and the role that autonomous technologies should play, including proposals for a common framework on legal and ethical subjects in the design, production, use and governance of these technologies. They recognize that there had never been such a push towards automation and autonomy in robotics, AI and mechatronics, as well as that ‘the investments of countries and large companies in these fields is enormous and a leading position in AI research is among the prominent goals of the superpowers in the world’ [31].

5 CONCLUSIONS

The limited literature regarding RPA, specifically applied to education, and even more when it involves HRI, offers a great opportunity for research and development.

Favourable aspects were presented when considering RPA robots for teaching, especially as an alternative to improve students' capacity, performance and evaluations. These factors could be decisive even for initiatives at an educational policy level.

The development of the robot and its programmed functionalities, in addition to the demonstration of the prototype reached, have put on evidence, beyond the text, the capability of RPA robots to support on teaching-learning processes. The possible uses under these profiles represent an attractive opportunity, inclusively for educational institutions, that could benefit greatly by employing their use at different scopes and/or scales.

This first design and experimental work illuminate an interesting horizon and serves as encouragement for future research in the area of RPA, with opportunities for the educational and similar sectors, applying artificial intelligence technologies, as eventual advanced resource.

As next step in the investigation, multiple robot tests will be carried out with students, considering the availability of a governmental entity that has shown interest in the project and offered its support.

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