Discover BBC micro:bit board as part of a dynamic and experimental AI learning process

Constant technological progress is a key challenge for Education and Society in the 21st century. This fact reflects the need of educational communities to stay updated in relation to technological tools and new pedagogies. This article describes experiences in the use of micro:bit programmable boards as part of a dynamic and experimental process of Artificial Intelligence (AI) educational projects. Micro:bit's design allows users without prior knowledge to develop their first programming skills, use AI platforms while creating models that can respond intelligently to different stimuli, and using data entered during training.

The experiences presented here are based on the TeachableMachine platform, and they create a functional machine learning model for the classroom. These experiences are recorded in pedagogical sheets that ensure the applicability of these concepts and tools to work on different types of curricular content in diverse educational contexts.

Keywords: Micro:bit; machine learning; pedagogical sheets; education technologies.

1. INTRODUCTION

Although the first concepts of AI were generated in the mid-20th century, its massive emergence began in recent years. Hundreds of companies, platforms and universities worldwide develop applications and tools that involve AI user experiences. The possibilities offered by this new technology are endless. However, exploring these possibilities requires a basic understanding of the operational processes necessary for the models to work[1].

Within this context, it is important to highlight that machine learning is a subfield of artificial intelligence. Lasse Rouhiainen (2018) defines Artificial Intelligence as “the ability of computers to do things that normally require human intelligence” (Rouhiainen 2018: 17). More specifically, the author refers to the ability of machines to use algorithms, learn from data, and use what they have learned in decision-making just as a human would.

On the other hand, the concept of machine learning refers to one of the main approaches to artificial intelligence. According to Rouhiainen, this concept refers to an aspect of computing in which computers or machines have the ability to learn without being explicitly programmed to do so. A typical outcome would be suggestions or predictions for a specific situation.

This paper focuses on the development of pedagogical worksheets that explain AI projects combining micro:bit boards and the TeachableMachine platform. In this case, the sheets present activities involving the generation of supervised learning models as the most popular application of machine learning. In supervised learning, a model is trained on a labeled data set and then attempts to predict an output or label that has not been seen before.

In supervised learning, machine learning algorithms are trained on labeled training data. In other words, the training data has been labeled by a human expert to indicate which examples are positive and which examples are negative. For example, a supervised learning algorithm may be trained on a set of labeled

[1]In this regard, Pereiro et. al. (2022) state: *“Although the discipline began in the mid-twentieth century, today is the most effervescent historical moment of this field. There are at least two large companies that are working towards achieving a general artificial intelligence, this refers to being able to emulate a human intelligence with all its complexity”* (E. Pereiro, et. al. 2022:6).

images of a certain disease to determine whether a new image is a positive example of the disease or a negative example of the disease. Supervised learning is often used to create a classifier that can be used to determine whether new examples are positive or negative examples of the concept in question (Pereiro et. al. 2022:7).

This project is part of several educational proposals developed by Ceibal in Uruguay and has two fundamental antecedents: On the one hand, the development of the micro:bit project, as a program for massive distribution of programmable boards in the one-to-one model for Uruguayan students and teachers. On the other hand, the implementation of the Computational Thinking program as a large-scale intervention program in computational thinking in primary education. In this line, for the present work, pedagogical contents developed by both programs were used as a basis to investigate possible applications of automatic learning with the micro:bit programmable board. As explained by Pereiro, et. al. (2022), there are some incipient proposals in artificial intelligence for educational systems that would allow theorizing that work in digital education generates the necessary conditions for the incorporation of AI in educational projects[2].

To learn with AI, learn about AI and prepare for AI, teachers must play and have a central role. The process by which both tools and platforms are incorporated and used and the way these topics are integrated into the curriculum depend to a large extent on the empowerment of teachers, and therefore the real impact of AI in education. Working on computational thinking, computer science, robotics and programming has a transitional effect towards the incorporation of AI, that it is the next stage in the development of these competencies, and it can serve as a milestone to follow this path (Pereiro, E. et. al. 2022:22).

2. MACHINE LEARNING AND SUPERVISED LEARNING: AN OPPORTUNITY FOR STUDENTS AND TEACHERS TO WORK ON ARTIFICIAL INTELLIGENCE

The main objective of the learning sheets on AI applications that use micro:bit is to disseminate elementary concepts so that students and teachers can further their knowledge.

As explained above, an elementary concept closely linked to the TeachableMachine platform is the so-called machine learning and its different types. In addition to a generic definition of machine learning, it is made explicit that supervised learning is the technique to be used with the TeachableMachine platform. This means that our model will receive a large sample of tagged data for each of the categories set. From that initial data series, the model will recognize a new category element. It is important to note that data used should be images or sounds.

A simple example is a machine learning model that, based on photos, can identify 3 different types of birds. Initially, tagged photos with the name of each species must be uploaded. In general, the larger the amount of tagged data, the more robust the system becomes. In addition, if the photos are different from each other, the system will probably have a greater chance of success when shown a new image. In parallel, an audio model can be made using the birds' songs.

Another fundamental concept is that, once the model is generated, a confidence threshold should be defined to validate predictions. More specifically, if our model indicates that a new piece of data (image or audio) reaches a certain percentage of coincidence with any of the categories, that piece will be considered valid. The trust threshold is determined by the user.

It is stated that models are not infallible and therefore can make mistakes. Much of the learning lies in understanding the sources of error and how to improve our machine learning models.

[2] There are different backgrounds of pedagogical worksheets for AI project work in the classroom. You can find some examples on the following websites:
https://ec.europa.eu/futurium/en/system/files/ged/mit_ai_ethics_education_curriculum.pdf (last access 4/8/203).
https://pensamientocomputacional.ceibal.edu.uy/wp-content/uploads/2023/06/Guia-Maquinas-que-aprenden-Inicial.docx.pdf (last access 4/8/203).

3. PEDAGOGICAL SHEETS: A GUIDE TO CLASSROOM WORK

The pedagogical sheets begin with a general introduction to basic concepts of AI and Machine learning. Next, they delve into fundamental aspects of the different platforms that will be used to create the AI project with micro:bit. Finally, they recommend steps to follow to continue deepening and creating models.

The first sheet also describes the main differences between traditional programming and machine learning. In addition, they also explain essential features of the Teachable Machine platform and give the user a detailed guideline to create a new model. The step by step guide describes the whole model creation process. This could be summarized in three steps:

- **Data collection:** the stage in which the data set is charged to the model. Possible data types include images, sounds and postures.
- **Model training:** the stage in which the Teachable Machine platform processes the information and generates the model. Once this stage is complete, the model can be tested and edited if necessary.
- **Model exportation:** the final stage to export your model, it can be downloaded or hosted online. The model created in this stage is the main pillar of the final project.

The second sheet focuses on the final linking process between the Teachable Machine model and the micro:bit board. The series of steps required could be summarized as follows:

- **MakeCode programming:** the stage in which the user creates the micro:bit code that will allow the board to receive and interpret the information from the Teachable Machine model. This code sets the configuration that allows serial communication between the micro:bit board and the computer. At the same time, the user determines the actions the micro:bit will execute based on the information received from the Teachable Machine model. The code must be flashed to the board using USB connection.
- **Linking platform:** the stage that explains the user how to configure ai-training.glitch.me. This website is the online platform that makes possible the link between micro:bit board and the Teachable Machine model created previously. The micro:bit board must be paired through a USB connection. Then, the user uploads the Teachable Machine model created to this platform.
- **Final result:** the platform displays an interface that shows the data that is being received by the machine learning model, and at the same time it displays the coincidence percentages of the different classes established. When percentages of coincidence are high, a string is sent to the micro:bit board through USB connection. The possible strings are exactly the same as the classes names established in the Teachable Machine model. The micro:bit receives the string and takes actions based on the program that the user created previously.

It is important to note that a computer with a microphone, webcam and Internet connection is required to carry out the projects presented in these worksheets.

Based on the content of these two pedagogical sheets, new activities and in-depth projects are under development. The application of these sheets for classroom work opens up great possibilities for working on curriculum content related to different disciplines, while different skills such as computational thinking, creativity, critical thinking and programming are put into practice. Autonomous recognising systems, pictures or postures classifiers, automatic counters, gesture or voice controlled micro:bit applications are some examples of what can be created using these tools.

4. PRELIMINARY CONSIDERATIONS

The following preliminary considerations are based on this first approach to working with micro:bit and AI to generate educational content.

Firstly, the educational material generated allows teachers and students to discover a new area of knowledge. Those who complete their learning through the different sheets will have more tools and confidence to delve in the world of AI.

Secondly, when using different resources that combine and complement each other, it is necessary to develop the ability to work in stages and see the whole picture once the project is finished. This mechanism promotes

the development of computational thinking and it also highlights the importance of working processes and their different stages to achieve the ultimate goal.

Thirdly, claiming the elaboration process as a path to learning, one of the great values of the maker movement where learning by doing becomes an essential concept.

Fourthly, it is vital to highlight the link between a powerful existing technology such as the micro:bit programmable board and the new and emerging universe of AI. These learning sheets encourage users to discover and create an unlimited universe of new applications. As Pereiro et. al. state the development of artificial intelligence in education can have a great impact on the teaching, learning and evaluation process. Fourth, it is vital to highlight the link between an existing powerful technology such as the micro:bit programmable board and the new and emerging AI universe. These learning chips encourage users to discover and create an unlimited universe of new applications. As Pereiro et. al. state, the development of artificial intelligence in education can have a great impact on the teaching, learning and assessment process. Moreover, the use of AI in education can be a way to achieve different learning objectives and can provide students with technical and conceptual elements to understand and reflect on the changes that Artificial Intelligence will bring in the near future (Pereiro, E. et. al. 2022).

Finally, the fact of making content available through various open networks is an invitation to discover these tools in the most diverse spaces and contexts. This invitation also seeks to promote peer exchange as a way to motivate support among teachers, students and users interested in the subject. Open audiovisual materials have been developed to be used together with the sheets, but it is important to take into account that there is a very wide range of possibilities to discover and generate new pedagogical contents[3].

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Webs sites:

- Ceibal Computational Thinking website: https://pensamientocomputacional.ceibal.edu.uy/ (Last access: 2/8/2023).
- Ceibal micro:bit (AI pedagogical sheets with micro:bit) : https://microbit.ceibal.edu.uy/ (last access: 2/8/2023).
- Ceibal's website: https://ceibal.edu.uy/ (Last access: 2/8/2023).
- Ceibal STEAM Youtube: https://www.youtube.com/@CeibalSTEAM_Uy

[3] For further information see: CeibalSTEAM Machine Learning y micro:bit (Last access: 2/8/2023).