proceedings

MDPI

Proceedings

Use of Arduino Microcontroller in Education: Creation of "The Musical Stairs" †

Felpeto-Guerrero Abraham, Vázquez-Sánchez Rubén, Chao-Fernández Rocío * and Chao-Fernández Aurelio

IMETIC Methodological Innovation through TIC, Faculty of Education, University of A Coruña, 15071 Elviña, Spain; a.felpeto@udc.es (F.-G.A.); ruben.vazquez.sanchez@udc.es (V.-S.R.); aurelio.chao@udc.es (C.-F.A.)

* Correspondence: rocio.chao@udc.es

† Presented at the 3rd XoveTIC Conference, A Coruña, Spain, 8–9 October 2020.

Published: 18 August 2020

Abstract: In the last few years, the introduction and use of Information and Communication Technology (onwards ICT) in the classroom has been gradually increased, especially in Science, Technology, Engineering, and Mathematics (onwards STEM) areas. However, the use of ICT technology within the music classroom seems to have stalled in most cases, being relegated to making sound recordings and listening to music fragments. Thanks to the rise of the Maker movement, more and more teachers are interested in introducing new types of ICT in the classroom. In our case, we will show how we developed "The Musical Stairs" to teach the musical concept of pitch, through the creation of a project based in Arduino.

Keywords: ICT in music classroom; educational technology; educational innovation; Arduino microcontroller; maker movement

1. Introduction

The role of teachers is increasingly bound to the use and integration of ICT within the teaching–learning process. Originally, the use of ICT in the classroom was mainly focused towards the introduction of computers, digital boards and the internet, where depending on their level of integration, the displacement of traditional or analogue audio–visual materials towards digital ones was, to some extent, noticeable [1]. However, thanks to the rise of the Maker movement, we are witnessing the inclusion of new types of technology and tools addressed to the classroom, as well as the proliferation of a new teacher profile, usually bound to STEM subjects, which rely on making as a way to reflect on the educational practice through research [2].

With regard to the musical education field, several studies show that a high percentage of teachers, although they think that ICT strengthens the teaching–learning process, still lack initial and permanent training regarding their use, therefore, although they have enough ICT resources in the classroom, they lack the necessary skills to use and to adapt them to their teaching methodology [3].

In this paper, we will show the creation process of "The Musical Stairs", under the assumption that, despite a teacher´s low ICT literacy rate, and thanks to the proliferation of the Maker movement as well as all its related features—user communities, development platforms, low cost hardware components, etc.—the music teacher will, up to a reasonable point, be able to be immersed within the Educative Robotics (ER) environment, allowing students to acquire musical competences and skills—in relation to other curricula subjects—from the perspective that the ER environment provides support and learning means [4], without underestimating the ludic, collaborative and motivational aspects inherent to the ER methodology.

2. Mounting Process and Materials

The "Musical Stairs" had to show the musical concept of pitch, therefore, through ascending or descending steps will show a simile with the ascending or descending pitch of a musical scale. In this way, the already said concept could be easily interiorized, among others [5].

The "Musical Stairs" principle of operation has been based on the reflection produced when a sonic burst triggered from an ultrasonic sensor collides with an object and returns to the sensor whenever the object is within the sensor range. In this case, it used the well-known 4-pin HC-SR04 sensor—power (VCC), ground (GND), trigger (Trig) and receptor (Echo)—.

To assemble the "Musical Stairs", first we covered each step with black and white vinyl as if it were a piano keyboard. Next, the sensors were placed along the stairs, disposing 12 or 7 sensors depending on if the preference was to represent a natural or chromatic scale, serially connected for both VCC and GND pins. The remaining pins were connected individually to an Arduino Mega microcontroller, to be able to control independently each sensor's input (Trig) and output (Echo). After that, the Arduino Mega microcontroller was programmed in a way that every 60 milliseconds a sonic burst is triggered and reflected. Once the data from the elapsed time between the sent and the received pulse—expressed in milliseconds—are received, it is time to calculate the distance of the object on which the burst collides, being in this case either a foot or a wall. For this, the formula S = d/t, where the resulting formula to know the distance in centimetres would be d(cm) = t(µs)/58. After that, the value resulting from the calculation of each sensor is serially sent to a laptop.

On the laptop, a development environment called Processing 3.0 was installed, along with the Minim library—an application programming interface (API) of a Java Sound library that allows for the integration of audio functions to the project. In our case, Processing is used to receive the measures from each of the sensors and associate each of them with a predetermined sound, in this case a musical note pre-recorded expressly for the project. In the giving case of receiving a measurement from a sensor less than 300 cm—which is the distance between each sensor and the wall—Processing plays their related sound until the measurement returns to 300 cm. The latter logic works for a musical natural scale of 7 sounds. If the purpose is to use a chromatic scale of 12 sounds—simulating the black and white keys of the piano—as the black keys are shorter than the white ones, their sound should be played when the detection distance is lesser than 100 cm. For this reason, within the source code it is necessary to differentiate between the black and white keys to be able to evaluate the distances and play the sounds depending on the position of each sensor. Figure 1 shows the operating diagram of all the above descripted.

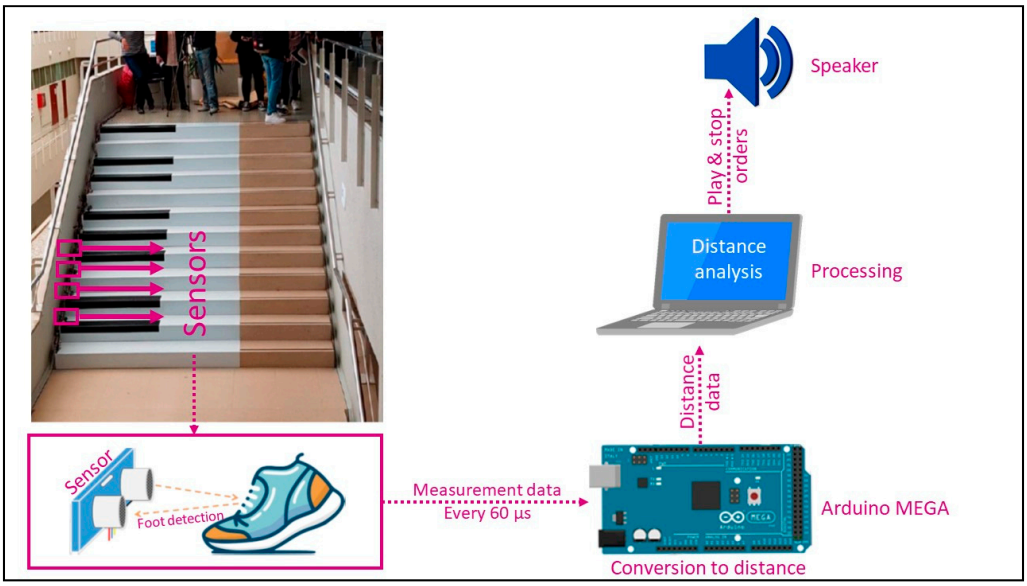

Figure 1. Operating diagram of "The Music Stairs" (source: the authors).

3. Conclusions

After carrying out this experience, we observed a change of mind in the future teachers—the project was developed in an education faculty—so that they are now more inclined and open to perform innovative projects using ICT, in addition to confirming a greater interest in the knowledge and development of their digital skills.

Author Contributions: Organization, C.-F.R. and C.-F.A.; implementation, C.-F.R., C.-F.A., F.-G.A., V.-S.R.; programming, F.-G.A.; writing, F.-G.A.; review and editing, C.-F.R., F.-G.A., V.-S.R. and C.-F.A. All authors have read and agreed to the published version of the manuscript.

Funding: This project was funded by the Faculty of Education from the University of A Coruña through the competitive call of grants for cultural activities.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Area-Moreira, M.; Hernández-Rivero, V.; Sosa-Alonso, J. Modelos de integración didáctica de las TIC en el aula. *Comunicar* **2016**, *24*, 79–87.
2. Vossoughi, S.; Bevan, B. Making and Tinkering: A Review of the Literature. *Natl. Res. Counc. Comm. Out Sch. Time Stem* **2014**, *2014*, 1–55.
3. Colás Bravo, M.P.; Hernández Portero, G. Itinerarios formativos del profesorado de música: sus percepciones sobre el valor didáctico de las TIC. *Fuentes* **2017**, *19*, 39–56.
4. Moreno, I.; Muñoz, L.; Rolando, J.; Quintero, J.; Pitti, K.; Quiel, J. La robótica educativa, una herramienta de enseñanza-aprendizaje de las ciencias y las tecnologías. *Tesi* **2012**, *13*, 74–90.
5. Chao-Fernández, R.; Felpeto-Guerrero, A.; Vázquez-Sánchez, R. Experiencia de creación y puesta en funcionamiento de la "escalera musical" como medio saludable de relacionar áreas de conocimiento. *IV Xornadas de Innovación Docente* **2020**, in press.