Piloting Diversity and Inclusion Workshops in Artificial Intelligence and Robotics for Children

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***Abstract*—In this paper, we present preliminary work from a pilot workshop that aimed to promote diversity and inclusion in Artificial Intelligence (AI) and Robotics in the context of developing countries to children of an range age between 6 to 12 year old. We pose the challenge of teaching AI and Robotics in developing countries where scarcity of funding and little specialised professionals are available to teach such subjects. In that way, we present resources based on free open-source hardware and software, open educational resources, and alternative education programs to promote diversity and inclusion and to teach AI and Robotics for children. We present the design and the pilot of four lessons of the workshop including: (a) motivation and applications, (b) teaching fundamentals, (c) linking sensor and human body anatomy with robots and (d) applications and showcase presentations. We conclude that participant, instructors, coordinators and parents engaging well in the four lessons of the workshop noting the various challenges of having enough resources to organise workshops with a major number of participants.**

***Index Terms*—Open Educational Resources, Educational robots**

I. Introduction

Accessible and affordable technology in conjunction with open educational resources can promote equal opportunities for childhood education [1]. However, teaching state-of-the-art technologies such as Artificial Intelligence and Robotics, AIR, is a current challenge for low-income and often politically or culturally marginalized countries. Additionally, creating the right environment to promote inclusivity and diversity to teach AIR has been little investigated. Astobiza *et al.* 2019, for instance, reported the need of collaborations between industry and a multidisciplinary group of researchers to address concerns on the paradigm of inclusivity in robotics [2]. In that sense, Astobiza *et al.* suggested that inclusive robotics should be based on two points: "1) they should be easy to use, and 2) they must contribute to making accessibility easier in distinct environments" [2]. Peixoto *et al.* in 2018 reported the use of robots as tool to promote diversity leading to improve competences in communication, teamwork, leadership, problem solving, resilience and entrepreneurship [3], [4]. Recently, Pannier *et al.* in 2020 pointed out the challenges of increasing the participation of women and underrepresented minorities in the areas of Mechatronics and Robotics Engineering as well as the creation of community of educators to promote diversity and inclusion [5]. Similarly, Pannier *et al.* mentioned that the prevalence of free and open-source software and hardware made mechatronics and robotics more accessible to a diverse group of population. Pannier *et al.* also touched on the importance of offering workshops to different range of underrepresented students leading to inspire other programs and to create outreach activities for students, trainers and workshops [5]. In March 2021, we introduced air4children, Artificial Intelligence and Robotics for Children, as a way (a) to address aspects for inclusion accessibility, equity and fairness and (b) to create affordable child-centred materials in AI and Robotics (AIR) in developing countries [6]. That said, in this work, we are addressing the challenges of piloting and organising workshops in the context of communities in developing countries where little to none is known about the demographics, education levels and socio-economical factors that impact on teaching AIR. For instance, considering the town of Xicohtzinco, Tlaxcala México as our case study, where Xicohtzinco has a total population of 14,197 (6762 males and 7435 females) [7] and 19 schools including seven kinder garders (3 publich and 4 private), seven primaries (4 publich and 3 private), four secondaries (2 publich and 2 private) and one publich hight-school [8]. However, neither the census [7] nor the education information site [8] provide further informantion about tehcnological on subjects in AI and Robotics. That said, we hypothesised that piloting workshops of air4chidren in a town such as Xicohtzinco might led us to have better understanding of the needs and challenges of promoting diversity and inclusion of state-of-the-art technologies with open education resources.

This short paper is organised as follows: Section II presents resources to promote diversity and inclusion in AI and Robotics for children. Section III presents the design of workshops for children from 6 to 8 years old. Section IV presents outcomes of a four lessons pilot workshop for 14 children inclucing the engagment of instructors and coordinators. We present results of the workshops and finalise it with conclusions and future work.

II. Resources to promote Diversity and Inclusion in AI and Robotics for children

A. Free and open-source software, open-source hardware and open educational resources

In March 2021, we presented examples to create educational resources aimed to be ”affordable, educational and fun”, such examples are (a) Otto DIY – an educational open source robot and (b) JetBot platform – open source educational robot to create new AI projects [6]. Similarly, considering Open Educational Resources (OER) which aim to provide ”teaching and learning materials that are available without access fees” seems to be a right direction to afford innovation through OER-enabled pedagogy [9]. However, Wiley *et al.* in 2014 constrated positvies and negatives of OERS where for instance of the benefits of OERs is to make course development process quicker and easier but also highlighting the challenges of making OER material for people easier to find but with the challenge of making financially self-sustainable programs among many other difficulties [10]. Hence, in this work, we consider Otto Humanoid as a good option because of its affordability with a cost of 200 EUROS, the block diagram programming interface, the multiple sensors and actuators (servos and LCD matrix display) aligned with open-source software and hardware and OER principles [11].

B. Alternative education programs with new technologies

Alternative education programs such as Montessori, Waldorf and Regio Emilia considers children as active authors of their own development [12]. In the last 5 years such programs are starting to include topics on AI, robotics and computational thinking into their curriculum [13], [14]. For instance, Aljabreen pointed out the adoptions of new technologies and how early child education is re-conceptualised [14]. Elkin et al. in 2014 explored the how robots can be used in the Montessori curriculum [13]. Similarly Elkin et al. posed the question on the revision of new curriculums that include technology should not deviate from the main purpose of the Montessori classroom [13]. Drigas and Gkeka in 2016 reviewed the application of information and communication technologies in the Montessori Method, mentioning the Manipulatives, as objects to develop motor skills or understand mathematical abstractions, are based on cultural areas, language, mathematics and sensoria but little to none on technological areas [15]. Drigas and Gkeka reviewed Montessori materials of the 21st century where interactive systems with sounds and lights, touch application to enhance visual literacy or the development of computational thinking and constructions of the physical world [15]. These indicate that the incorporation of such manipulatives with the use of robotics might led to reach scenarios to explore motor skill development, visualisation and computational thinking. Recently, Scippo and Ardolino reported a longitudinal study of the use of computational thinking in five years participants of primary school in a Montessori school [16] Scippo and Ardolino pointed out the importance of alignment of the Montessori material with the computational thinking activities.

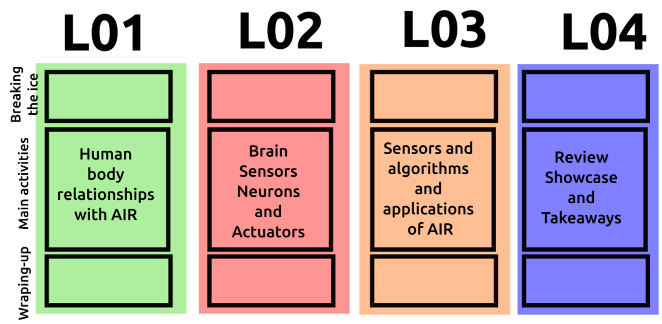

Fig. 1. Curriculum of the pilot workshop with four lessons. Lesson 01 introduce the course (L01), lesson 02 provides the basics of anatomy (L02), lesson 03 covers algorithms (L03), and lesson 04 wrap-up and showcase the project of children (L04).

That said, previous authors stated various challenges on the incorporation of new technologies into their curriculum posing more questions on creating curriculums that should be more accessible to a diverse group of population as it has been done in other areas such as the case of open educational resources.

III. Designing Diversity and Inclusion Workshops

To design diversity and inclusive workshops we were considered the six ideas discussed in ”Ensuring education and Inclusive Learning for Educational Recovery 2021” [17] and ‘Concrete to abstract’ concept within the Montessori philosophy [18]. In one hand, we considered the six ideas to ensuring and inclusive learning summarised as: (1) personalisation of education including the recognition of specific learning expectations and needs, (2) designing inclusive, emphatic and participatory curriculum for an plural and open participation of a diversity of actors and institutions, (3) appropriation of technology as a community resource to strength ties between students, educators, families and communities, (4) empowering knowledge, learning, collaboration, trust and listening among peers, and (5) the visualisation of schools as lifelong learning spaces. On other hand, the workshop were planned to develop concepts and skills using ’concrete’ concept with hands-on learning materials to make abstract concepts clearer as it is taught in Montessori education [18].

That said, with the combination of Open Educational Resources, alternative education programs and the six ideas, we designed a four lesson workshop with two-fold aims: (a) to promote diversity of and inclusion to children to teach AI and Robotics and (b) to encourage children to discover and increase their interest in AI and Robotics. Figure 1 presents four lessons of the workshops.

a) Lesson 01: Breaking the ice and motivations: The educational goal for this lesson was to develop the children’s curiosity about AI and Robotics while emphasizing the importance of interpersonal connections that will evolve into a collaboration work for the following lessons. That said, this lesson started with a recreational activity where each student and teacher introduced themselves with name, favorite food and a superpower or ability that we would like to have and that was related to robots. This lesson also covers basic concepts and examples of AI and Robotics in different fields and daily life, how the brain works and how the human senses and body parts relates to the way a robot is built and how it works and perform activities.

b) Lesson 02: Human senses and coding my first robot: The main purpose of this lesson was to understand fundamentals of Robotics. Children began to work with more abstract concepts, developing problem-solving skills as well as cooperatively working relationships. The first activity, outside of the classroom, was a true or false game, were the teacher told a sentence about AI and Robotics, and the children jumped in front of a rope if the sentence was true, or if the sentence was false, the kids jumped behind of the rope. In the second activity, the instructor explain about the human senses and their relationship with inputs and outputs. After that, instructors explain examples of sequences and codes. In the last activity, participants were asked to sort out tangram in a group in which a leader of the group provide instructions to the team-mates as an analogy of coding a robot with algorithms.

c) Lesson 03: Playing with reaction-action activities: The educational goal of this lesson is to cover the concept of the effect of causes and consequences with daily life examples and the computational thinking of robots. Hence, this lesson start with a match game consisting of figures and shadow's figures where participants develop their comparing skills to match similar or different robots. This lesson covered points on how robot works with sensors, processors, actuators and programming. The "find the effect" activity was also introduced where participants have to relate pictures of cause and consequences, for example "the cause is the rain and the consequently is a rainbow". Afterwards, we worked with the Otto humanoids in which we programmed the sensor presence for that robot moves, dances and that emit texts with the 8x8 matrix.

d) Lesson 04: Develop your own AIR: The four lesson aimed to summaries what was covered in the previous lessons emphasising the relationship of the human body anatomy (brain, neurons and body parts) with humanoid robots (computer, sensors and actuators). This lesson covered real-word application of AI and Robotics including medicine, spacial robotics and smart cities. Three projects were prepared to be introduced to each team in which every participant have a role. Each team prepare a short speech of their application using AI and Robotics.

IV. Piloting Diversity and Inclusion Workshops

To pilot the four-lesson workshop, we invited 14 participants (6 female and 8 male) with range of age from 6 to 11 years old (average age of 7.64) (Figure 2). Three instructors with three years of experience in teaching and two coordinators with ten years of teaching experience volunteered to deliver four lessons of 90 minutes in the workshop (as shown in the proposed curriculum Fig 1). During the initial three

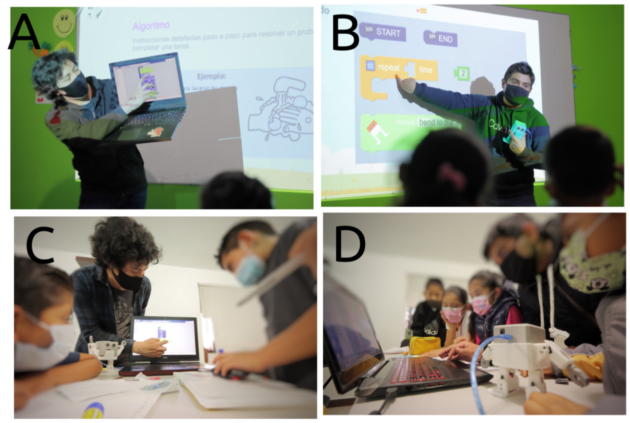

Fig. 2. Instructors demonstrating basics of AI and Robotics (A, and B). Children engaging with robots, classmates and instructors (B, and C).

lessons, children incorporated the gained knowledge to relate fundamental human body anatomy (brain, neurons, body and senses) to robot parts (microcontroller, motors, sensors). In the final lesson, children showcased their final work promoting a sense of achievement in the children working not only with their mind but also with their social emotional well-being.

We however noticed that each lessons was originally planned to be 90 minutes and we did not consider breaks neither perhaps the participant's energy levels to which in the second to four lesson a 15 minutes break was incorporated. Additionally, we pilot surveys to (a) children with ten questions about their understanding and feelings towards different type of robots and (b) to parents with 30 questions about their understanding of AI and robotics and how parents were aware of technological advances in AI and Robotics. Although the aim of the surveys was not to be reported but only to understand how participants and parents feel about being surveyed and how the logistics of surveys would be followed with more participants. That said, we noticed that participants require support as few participants were not familiar with reading surveys and the content of 10 questions was spread into five questions into two sessions. On other hand, parents thought that surveys were lengthy taking more than 60 minutes and we also realised that a paper-based survey require more work as scans and transcripts are required.

V. Conclusions and future work

In this paper, we investigate the challenges of Diversity and Inclusion to teach "Artificial Intelligence and Robotics for Children" with open educational resources and principles of Montessori education. For the design and the pilot of the workshop, we invited 14 children of an average age of 7.64 years old participated of the community of Xicohtzinco Tlaxcala Mexico. The workshops were free of cost as a way encourage participation of anyone. During the pilot workshop, children were enthusiastic about learning the fundamentals for AIR by building, coding, designing and playing with open-sourced robots. The instructors embraced the different set of skills each child had by working in small groups and supporting the students during the process. These lessons intended to remain beyond the learning of a single concept and contribute to develop a skill the children can take and apply to other areas in their life. However, we noted that grouping children of four participants with one instructor was not creating an engaging experience as each group has only one robot and one computer and the space and number of participants was leaving sometimes one participant outside of the reachable robot-computer setup. As a future work, we are planing to organise another workshop in the four quart of the 2022 where we will consider 10 lessons distributed in four weeks with we will invite more participants. For curriculum of the workshops, we will improve the interactivity of the participants and create more engaging and inclusive activities. We will incorporate a similar approach of the synthesis program which aim is to cultivate student voice, strategic thinking and collaborative problem solving [19].

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CONTRIBUTIONS

Antonio Perez-Badillo: Contributing to design and write up of lesson 02. Dago Cruz: Contributing to proofreading, edition and feedback. Diego Coyotzi-Molina: Contributing to design and write up of lesson 03. Donato Perez-Badillo: Contributing to design and write up of lesson 01. Leticia Vazquez: Write up and refinement of the conclusions. Miguel Xochicale: Contributing to create the template, drafting, write-up, edition, and submission of the paper. Rocio Montenegro: Contributing to the write up of designing and piloting workshops.

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