Teaching AI and Robotics to Children in a Mexican town

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Figure 1: (a) Instructor demonstrating coding activities with open-source educational robot, (b) instructor showing AI and Robotic-based cards for the bingo game, (c) instructors presenting difference concepts of AI and Robotics to children, (d) children interacting in group activities, and (e) showcase activity where instructor helped the group of four children to present projects.

ABSTRACT

In this paper, we present a pilot study aiming to investigate the challenges of teaching AI and Robotics to children in low-income resource countries. Challenges such as teaching bias in AI and inclusive learning with Montessori method were introduced, emphasising the little to none experts to teach AI and Robotics and the limited resources in a Mexican town. For the pilot study, we invited 14 participants of which 10 were able to attend, 6 male and 4 female of (age in years: mean=8 and std=±1.61) and four instructors of different teaching experience levels to young audiences. We reported results of four-lesson curriculum that is both inclusive and engaging with Montessori method and low-cost open source educational robots. We showed the impact on the increase of general agreement of participants on the understanding of what engineers and scientist do in their jobs, with engineering attitudes surveys from the first and the last lesson. We concluded that this pilot study helped participants to understand fundamental concepts of AI and Robotics and provided better understanding to the organisers on financial and logistical challenges to organise a workshop with a major number of participants as potential future work.

HRI '23, March 13–16, 2023, Stockholm, SE

ACM ISBN 978-1-4503-XXXX-X/18/06…$15.00
https://doi.org/XXXXXXX.XXXXXXX

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in HCI**; **Accessibility systems and tools**; • **Applied computing** → *Interactive learning environments*; • **Social and professional topics** → **Children**; • **Computing methodologies** → *Cognitive robotics.*

KEYWORDS

Child-centred AI, Educational Robotics, Child-robot interaction

ACM Reference Format:
Anonymous Author(s). 2023. Teaching AI and Robotics to Children in a Mexican town . In *HRI '23: ACM/IEEE International Conference on Human-Robot Interaction, March 13-16, 2023 Stockholm, SE.* ACM, New York, NY, USA, 5 pages. https://doi.org/XXXXXXX.XXXXXXX

1 INTRODUCTION

Teaching Artificial Intelligence (AI) and Robotics to young learners has been made good progress in the last decade [3, 5]. Educational progress has been possible due to the great investment in AI and Robotics in countries such as U.S.A, Germany, Denmark, and Sweden, making those countries and their communities to define core values in AI and Robotics [5]. These raise the question on how to adapt such core values from the most to the least privileged environments [9]. Recently, it has been few progress on using open-source educational robots and the creation of child-centred programs to teach AI and Robotics in low-income countries [2, 11]. However, there are various challenges on teaching AI and Robotics to young learners. For instance, the barrier of teaching programming skills to those who are still learning writing and reading skills to which visual and auditory programs using sensor, action and logic blocks helped to address such challenges [10, 15]. Other challenge is the little to none experts to teach AI and Robotics and its limited educational material in low-income countries [2, 16]. Hence, the aim of this work is to investigate further challenges of teaching AI and

Robotics to young audiences in a Mexican town where little no experts can teach such subjects with limited resources.

In this paper, we present challenges of teaching AI and Robotics to Children in a Mexican town. In section 3, we present the study design and curriculum design with four lessons. In section 4, we present results and surveys from a pilot experiment. We then conclude the paper and add future work in section 5.

2 CHALLENGES OF TEACHING AI AND ROBOTICS TO CHILDREN

2.1 Teaching bias in AI

Smith et al. pointed out the current challenges of when and how to teach computing ethics to students [14]. Learning ethics in introductory courses help students to think ethically about their computation topics [8]. Payne et al. have shown great progress on making pilots and beta test teaching ethical AI to young audiences [12]. For instance, on summer 2021 a pilot to teach ethical AI to young audiences were organised with 28 kids at the Media Lab with a cost of $150 for the week, leading to a beta test with 250 students in autumn 2021. Such pilots considered question related to the everyday life of children, such as "What's is the best algorithm to make a peanut-butter sandwich?: is it the algorithm that makes the tastiest sandwich? , is it the prettiest sandwich?, is it the quickest and easiest to make? or the easiest to clean up?". Hence the challenge is to contextualise such questions in a Mexican town where children may know little to none about AI, Robotics end ethics (bias).

2.2 Inclusive learning of AI and Robotics with Montessori method

Montessori method is focused in child-centred development where the role of Montessori teachers is to help children individually or in small groups engaging in self-directed activities [1]. The adoption of technological topics (AI and Robotics) into Montessori methods has been experimented and studied in the last 10 years [7]. However, there are other skills that are also required to create inclusive learning of new technologies. For example, "collaborative skills" and "understating concepts" are two main factors to design inclusive AI literary for children in low, medium and high socioeconomic backgrounds [5]. Also, there is evidence on the impact of collaboration and engagement activities on how coding games and robots to enhance computational thinking [13]. Hence, the challenge is how to adapt Montessori method to not only create conditions to develop physical and social requirements but collaborative and literacy skills through hands-on activities.

3 PILOT STUDY: STUDY DESIGN AND CURRICULUM DESIGN

3.1 Participants

In this pilot study, we invited 14 participants between the age of 6 to 9 years old. During the pilot workshop, only 10 participants 6 male and 4 female of (age in years: mean=8 and std=±1.61) were able to join the workshops as remained ones were unable to attend due to personal circumstances. We also invited four instructors with various experiences levels in teaching subjects to young audiences

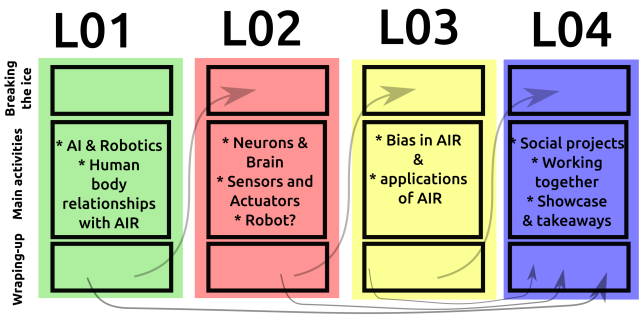

Figure 2: Curriculum design with four lessons of 1 hour and a half (L01, L02, L03 and L04). The arrows illustrate the connection between the first and the last part of each lessons as way to summarise the progress of each lesson and the full curriculum.

(two between 5 to 10 years and two with less than 2 years) and one person to lead the logistics of the event.

3.2 Lessons

Aiming to create inclusive teaching practices for students, we considered a study design based on procedures, instruments, data collection and analysis [6]. Considering the limited human and material resources, we decided to teach four lessons instead of the original ten lessons for the pilot study of this curriculum.

Figure 2 illustrates the curriculum design for the pilot experiment. During the first lesson, we introduced basics concept of human senses and how AI relates to identifying cats and dogs. We were able to use more dynamic activities with protoboards and simple electric circuits so that children can easily learn fundamentals on how a robot works (Figure 1d). For the second lesson, we presented examples on how AI learn to recognize animals or humans with a tangram activity and gave them a mini introduction to the code that they will use for the robot. In the third lesson, we adopted a bingo game with key terms from the previous lessons (Figure 1b). We introduced what is algorithm with an activity of cooking quesadillas where students learnt that everyone can have a different answer given the same instruction. We also organised activities on action/reaction with different sensors, how sensors work, how to program sensors and examples with the protoboards and circuits. During the fourth lesson, we closed the course, starting with an activity in the garden where students program their teammates and practice to give instructions to a robot in order to get the wanted result. Then we show them some real life applications of AI and robotics and we grouped participants in three teams so they could program their robots and design their logo (Figure 1e).

4 RESULTS

Four lessons of the designed curriculum were organised on Mondays and Wednesdays in a Mexican town during two weeks of November 2022. Instructors helped children in the pilot workshop by creating groups of three to four children. In the final lesson groups presented their project with their own robot and children

with the help of the instructor explained the application of the robot (Figure 1).

Following "Engineering Attitudes Survey" by [4], we surveyed all participants with two surveys for the first and the last day of the lessons. However, we only considered 9 participants as the remained 5 were either not in one of the days of the surveys or there were not able to be present. Figure 3 illustrates the average values of 20 questions from 9 participants where 1 is totally disagree; 2: not sure, and 3 totally agree. It can be noted that "S17: Scientist help make people's lives better." resulted in the highest average value whereas "S16: Engineers cause problems in the world." is the lowest average value. "S19: I think I know what scientists do for their jobs." and "S20: I think I know what engineers do for their jobs." showed an increase on agreement between participants.

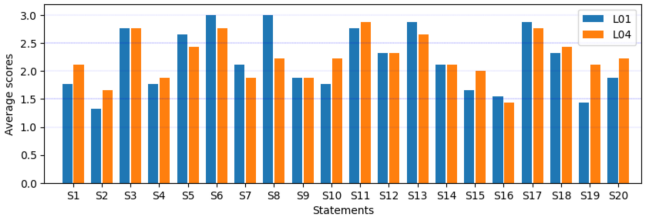

Figure 3: Results of the survey with 20 statements (s1, to s20) of 9 participants of the workshop, showing average values where L01 are for the first lesson and L04 are for the fourth lesson. "S19: I think I know what scientists do for their jobs." and "S20: I think I know what engineers do for their jobs." shows an increase on agreement. Please see appendix A for further references on the statements of the survey.

5 CONCLUSIONS AND FUTURE WORK

In this paper, we investigated the challenges of teaching AI and Robotics to young audiences with a pilot study in a Mexican town. We designed ten lessons but only were able to pilot four lessons due the limited human and material resources. We also surveyed participants using Engineering Attitudes Survey from [4], and showed the impact on the increase of general agreement of understanding what engineers and scientist do in their jobs. However we noted that children were not able to read long sentences and were confused about agreement and disagreement terminology. We can concluded that children and parents had the willingness to join this pilot study by learning new experiences on collaborative and fun activities with low-cost educational robots. However, our limited self-funded budget for this project restricted us to prepare and organised a major number of lessons and reach more participants which hopefully will be addressed in future work.

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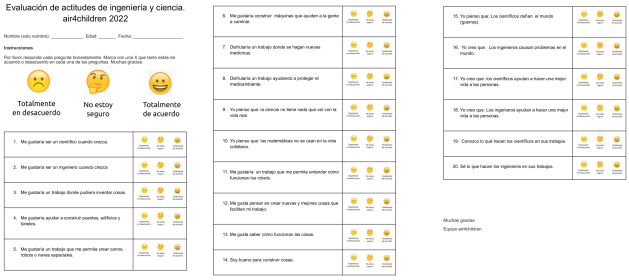

Figure 4: Survey in Spanish with 20 statements. Translation English to Spanish statements from the "Engineering Attitudes Survey" [4].

APPENDICES

SURVEYS

Figure 4 shows survey layout document and table 1 presents 20 statements of the survey.

Table 1: Statements in the survey from "Engineering Attitudes Survey" [4].

Number	Statements
S1	I would enjoy being a scientist when I grow up
S2	I would enjoy being an engineer when I grow up.
S3	I would like a job where I could invent things.
S4	I would like to help to plan bridges, skyscrapers, and tunnels.
S5	I would like a job that lets me design a cars.
S6	I would like to build and test machines that could help people to walk.
S7	I would enjoy a job helping to make new medicines.
S8	I would enjoy a job helping to protect the environment.
S9	Science has nothing to do with real life.
S10	Math has nothing to do with real life.
S11	I would like a job that lets me figure it out how things work.
S12	I like thinking of new and better ways of doing things.
S13	I like knowing how things work.
S14	I am good at putting things together.
S15	Scientist cause problems in the world.
S16	Engineers cause problems in the world.
S17	Scientist help make people's lives better.
S18	Engineers help make people's lives better.
S19	I think I know what scientists do for their jobs.
S20	I think I know what engineers do for their jobs.