

# PERCEPTIONS OF THE EDUCATIONAL POTENTIAL OF ROBOTICS AND CODING IN INCLUSIVE SETTINGS

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## Abstract

In recent years, the potential of educational robotics (ER) and coding has been highlighted in studies and research on teaching strategies for children with special needs. Integrating ER and coding in school activities allows for learning based on solving real problems as well as the inclusion of children with special needs since these resources have relevant learning potential by promoting the development of socio-emotional and personal skills, key factors in the learning and inclusion process. However, one of the great difficulties is understanding how teachers recognize the potential of educational resources and their differences, as well as whether they feel prepared to make use of ER and coding in inclusive settings. This study aimed to verify the conceptions about the use of ER and coding in inclusive settings of a group of students in the curricular unit of Information and Communication Technologies and Special Educational Needs of the master's in Special Education in the cognitive-motor domain of the Polytechnic Institute of Viseu, Portugal, in the 2nd semester of the 2021/2022 school year. The relevance of the study lies in the need to train education professionals for the effective integration of robotics and coding activities in inclusive educational settings. This is initial research, with an exploratory interpretive character approach, supported by an assessment of acquired knowledge applied after the class on "Computational Thinking, Robotics, and Coding in Inclusive Learning Contexts". The class consists of 25 students, with 20 having the opportunity to attend the class and 19 responding to the assessment. The results show that most participants recognize the potential of ER and coding in promoting learning contexts with children with special needs and are aware of the importance of their continuing professional development and training in this area. From this initial research, which is now of an exploratory nature, it is intended to do further research that may result in scientific knowledge for future training contexts in ER and coding in inclusive settings.

Keywords: Educational Robotics, Inclusion, Educational Needs, Teacher Training.

## 1 INTRODUCTION

Integrating educational robotics (ER) and coding in school activities enables learning based on real problem solving as well as the inclusion of children with special educational needs since these resources have a relevant potential for learning and promote the development of socio-emotional and personal skills, key factors in the learning and inclusion process [1],[2],[3],[4].

Learning to program a robot has become an increasingly important part of educational and training programs for educational professionals. We want to believe that this is not a matter of trends but of seeking innovation in methodologies and new ways to involve children in learning processes. Everything can start in early childhood [5] and continue throughout the remaining school years in a quest to approach knowledge from diverse curricular areas and, whenever possible, in a transversal and playful way. We believe that educational settings are the ideal scenarios for the effective integration of ER and coding in an inclusive way because we know that our educational institutions integrate children and young people with different specific needs in their classrooms and that they can also take advantage of this learning.

Numerous studies carried out more than thirty years ago at the international level [6] and consequently [7],[8],[9],[10],[11] have shown us the potential for children's motivation by working with these educational resources that are always interconnected with the curricular contents and not isolated from them. In fact, it is a search for meaningful learning for children and young people associated with real life, allowing them to develop the necessary skills for the digital world that awaits them in the near future.

This reality is evident in an inclusive education that aims to be of equal access for all children and young people attending pre-school or elementary school. More recent research has tried to recognize how this integration occurs in Portugal without neglecting to integrate these activities in an equitable way for all children, regardless of their specific difficulties or needs [12],[13],[14],[15],[16]. In recent years, we have

experienced a great movement of national and international projects of great reference that influence and define new ways of working in educational contexts [17],[18]. On the other hand, these projects show us the differences between possible educational resources that can be used to integrate and work with ER in educational contexts [19].

It should be recognized that the concepts of computational thinking [20],[21],[22] and programming are fundamental pillars for ER work, supporting the activities that can be developed with the help of robots. Preparing a curriculum integration context for ER and coding in an inclusive way always requires adaptation to the ages of children and young people, as well as to the curriculum and developmental areas that are intended to be worked on. It is essential that before the integration of ER activities, the child has the opportunity to experience computational thinking activities without technologies [21] and with technologies, such as ScratchJr, to learn how to code an age-appropriate application, whether in preschool or elementary education [22].

When we talk about learning to code at an early age, we know that for preschool children, ScratchJr [23] is a visual block-based application that allows the child to learn to code by building simple stories, games, or animations. This learning can be linked to many everyday life situations or preschool curriculum areas [22] and can be extended to the first two years of elementary school while the child is learning to read and write. On the other hand, we have Scratch (<https://scratch.mit.edu/>), a coding language that continues ScratchJr and can be used in elementary school from the time a child can already read and write.

The gradual integration of ER and coding through the basic concepts of computational thinking and programming will allow children and young people, with or without special educational needs, to explore working with robots at a deeper and more complex level, understanding the intentionality of this educational resource for learning content or curriculum areas.

However, a major challenge is to understand how teachers recognize the potential of educational resources and their differences, as well as whether they feel prepared to use ER and coding in inclusive settings. We know that for this learning experience to take place in an educational context, educational professionals need training and to feel able to effectively integrate coding activities in educational settings in a way that is inclusive for all children and young people.

This study aimed to identify the conceptions of ER and coding in inclusive settings among a group of students who are future special education professionals. We assume that from this initial research, which is now of an exploratory interpretive nature, we intend to carry out further research that may result in scientific knowledge for future training contexts in the field of ER and coding in inclusive settings.

## **2 METHODOLOGY**

We used an exploratory interpretative approach supported by an assessment of acquired knowledge as a data collection technique for this initial investigation. The evaluation, in questionnaire format, was designed by the authors of this research and divided into three dimensions: (i) Personal data; (ii) Perception of Robotics and Coding in inclusive settings; (iii) Relevance of Robotics and Coding in inclusive settings. The learning objectives, the purpose of the data collection, and the term "informed consent" were presented at the beginning of the test.

The questionnaire was made available online after a 4-hour class on "Computational thinking, robotics, and coding in inclusive learning contexts", of the Information and Communication Technologies and Special Educational Needs Curricular Unit of the master's degree in Special Education, in the cognitive-motor domain, in the 2021/2022 school year, in the 2nd semester. The class is composed of 25 students, of whom 20 had the opportunity to attend the class and from whom we obtained a total of 19 answers on the test. To maintain scientific rigor in this research and ensure the anonymity of the participants, we coded everyone as (A = Students + Number) so that we could cite some relevant information from the open-ended questions in the questionnaire.

The students in this master's program, during their participation in the ICT and special educational needs classes, referred to their lack of experience in using technologies in inclusive education settings. This lesson on educational robotics came after several lessons on computational thinking, programming, and other types of technologies. Although they were aware of the existence of some of these resources for use in educational settings, few had explored their potential in inclusive settings. The lesson on this topic was motivating, and they mentioned that it was fundamental as a starting point for their future training in this area.

### 3 RESULTS

This paper aims to present an initial investigation into the pedagogical potential of ER and coding in inclusive settings. Our aim was to understand the conceptions of a group of educational professionals, master's students in Special Education, about the use of ER and coding in inclusive settings. Interpretive exploratory research supported by an assessment of acquired knowledge enabled us to identify the conceptions of ER and coding in inclusive settings in a group of students. The results obtained from the application of this assessment were categorized into: (i) personal data; (ii) perception of robotics and coding in inclusive settings; (iii) relevance of robotics and coding in inclusive settings.

#### 3.1 Personal data

As demographic data, we found that most of the participants were women (14). Considering their age, we found that 6 participants were between 20 and 30 years old; the same number, 6, were in the age group above 50 years old, followed by 4 participants between 41 and 50 years old and 3 between 31 and 40 years old. In terms of academic level, we found a higher number of participants with a bachelor's degree (14), and all of them are master's students at the Polytechnic Institute of Viseu. Once the demographic analysis of the participants was performed, we moved on to the analysis of the perception of robotics and coding in contexts of inclusion, which is one of the focuses of our study.

#### 3.2 Robotics perception and coding in inclusive settings

This category had 10 questions that the participants answered according to their knowledge of the subject. Table 1 presents the data collected from the questions "1: Do you know what robotics is?", "3: Do you know the works that can be developed in the field of robotics in inclusion contexts?", "6: Do you know what coding is?" and "8: Do you know the works that can be developed in the field of coding in inclusion contexts?", which aimed to verify the participants' knowledge in the fields of robotics and coding in inclusion contexts.

Table 1. Perception of Robotics and Coding in Inclusive Contexts.

| Question  | Yes | No |
|---|-----|----|
| Do you know what robotics is?   | 19  | 0  |
| Are you aware of the work that can be developed in the field of robotics in inclusive contexts? | 17  | 2  |
| Do you know what coding is?   | 17  | 2  |
| Are you aware of the work that can be done in the field of coding in inclusive contexts?        | 17  | 2  |

It was found that all 19 participants answered that they know what robotics is; however, when asked about the work that can be developed in the field of robotics in inclusive contexts, it was found that 2 said they had no knowledge. The same can be observed in relation to coding. To the questions "do you know what coding is?" and "do you know the work that can be developed in the field of coding?", we obtained that 17 of the participants answered "yes" and 2 answered "no" to both questions. This allowed us to reflect on the planning of the pedagogical actions applied in this classroom and to foresee new actions that would promote practices in which the participants could take ownership of the learning and competencies established.

After the questions "1 - Do you know what robotics is?" and "6 - Do you know what coding is?", it was important to check how much the participants perceived they knew about these topics. Thus, they were asked to self-assess themselves on a Likert-type scale, with an intensity between (1) they know very little and (5) they know a lot, regarding their perceived knowledge (Figure 1).

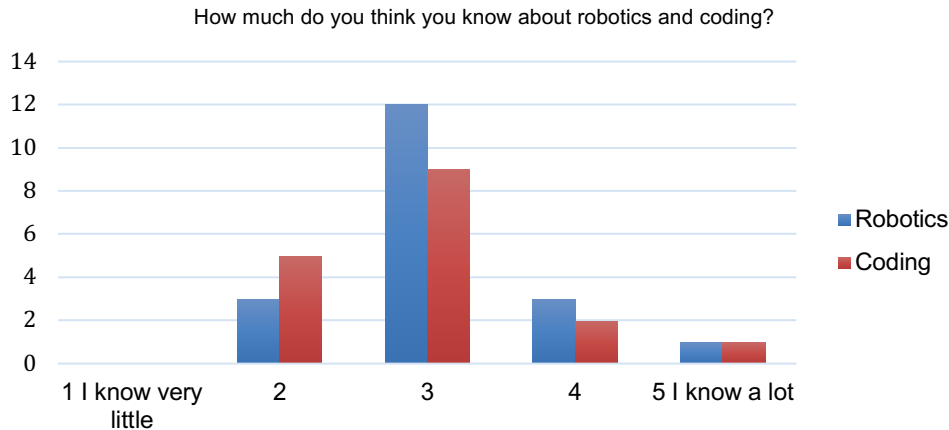


Figure 1. Perception of robotics and coding skills

The data reveals that most participants classified themselves as having an average level of knowledge (scale 3) in both robotics and coding, with 12 and 9 responses, respectively, with 3 being the highest number of responses on the scale, compared to 1 who said they knew a lot and 0 who said they knew nothing about both resources.

Based on the perception of the knowledge and work that can be developed in robotics and coding in inclusive settings, we proposed to test the participants' knowledge about some of the digital resources used in this area.

4. Do you know any educational robot used in inclusion context?

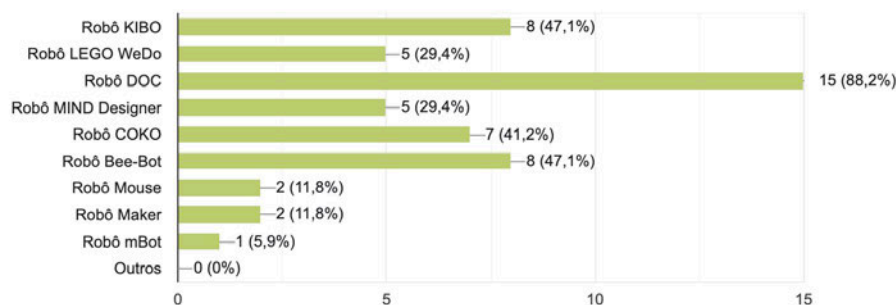


Figure 2. Knowledge of digital resources

Figure 2 shows that the DOC robot was the most popular as known by the participants, followed by the KIBO, Bee-Bot, and COKO robots. It is relevant to note that during the master's classroom, they had contact with the DOC, Super DOC, MIND Designer, KIBO, and COKO robots. The lesser-known robots are the Mouse, Maker, and mBot robots. It should be noted that none of the participants claimed to know "other" robots than the ones presented in this question.

As for coding, the participants were asked what programming languages or applications they knew. With this question, it was found that the most well-known language was "ScratchJr", followed by the language "Scratch" (Figure 3). Again, it is important to note that these languages were extensively worked on with the students, participants in this research, during the master's course in other previous classrooms. It was also found, as a common finding, that none of the participants claimed to know "another" programming language other than those presented in this question.

5. Are you familiar with any of these programming languages (coding) used in the context of inclusion?

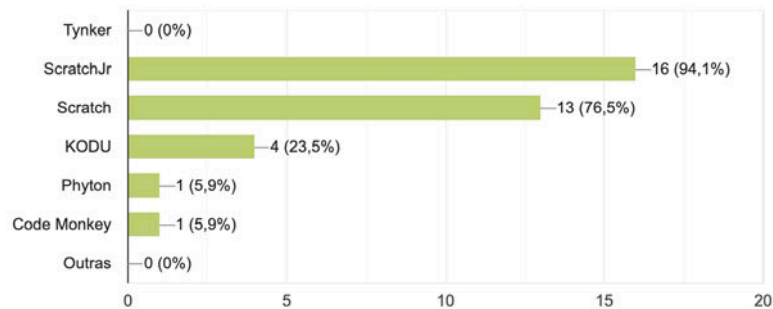


Figure 3. Knowledge of programming or application languages.

### 3.3 Relevance of robotics and coding in inclusive settings

This category aimed to collect data on participants' conceptions of the relevance of robotics and coding in inclusive settings. It contained five objective questions categorized on a Likert-type scale with an intensity ranging from "strongly disagree (1)" to "strongly agree (5)" and an open-ended question "How could you apply robotics and coding in inclusive curriculum settings?", aimed at finding out the participants' level of learning in relation to this topic.

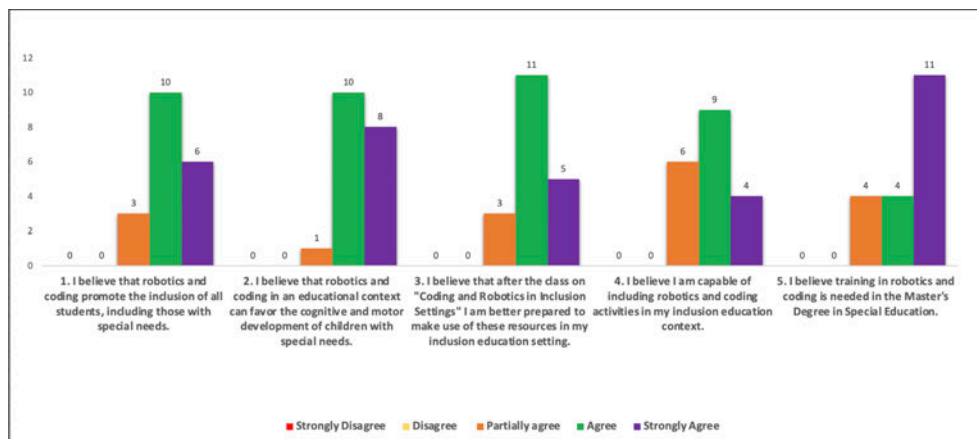


Figure 4: Participants' perceptions of the relevance of robotics and coding in inclusive settings

Regarding question 1, about promoting the inclusion of students, including students with special needs, using robotics and coding, the data shows that 10 participants agree against 0 participants who disagree or strongly disagree with the statement. The same is presented in question 2, on the potential of robotics and coding to promote the cognitive and motor development of children with special needs. It was found that 10 participants responded that they agreed and 0 that they disagreed or strongly disagreed with this statement. These data lead us to interpret that most participants have gained knowledge about the potential of robotics and coding as promoters of student inclusion, including students with special needs.

Questions 3–5 complement each other and aim to verify the participants' perception of the importance of training actions for the effective use of robotics and coding resources in inclusive settings. With the data obtained, it was possible to assess that the participants have a clear perception that training in robotics and coding in the master's degree in Special Education is necessary but not sufficient. This fact is quite significant in the number of answers obtained in question 5: I think that training in robotics and coding in the master's degree in Special Education is necessary, with 11 answers on the "strongly agree" scale. If we compare it with the answers obtained in question 3, whose data show 11 answers on the "I agree" scale, we can conclude that technological training in the field of inclusion is necessary for the development of the digital skills of these teachers.

Still in the interpretation of the data obtained in this section, we have in question 4 a relevant factor to consider. This was the question that obtained the highest number of answers (6) on the "partially agree" scale and the lowest number (4) on the "totally agree" scale.

The open-ended question aimed to collect data from participants' conceptions of their ability to make use of ER and coding in inclusive educational contexts: "How could you apply robotics and coding activities in curriculum inclusion contexts?" The data reveal that participants feel partially prepared. This finding can be seen in responses such as:

- Considering that coding refers to the modification of a message or code and that robotics is the science that studies technologies, I think that I still need more information and to know more mechanisms to be able to formulate a more concrete and conscious answer (A1).
- To work and acquire more knowledge in this area to be able to implement the existing materials as an added value for the inclusion of children with special needs (A10).

## 4 CONCLUSIONS

This study aimed to identify the conceptions about the use of ER and coding in inclusive settings by the students of the master's degree in Special Education, specialization area in the cognitive-motor domain, who attended it in the previous academic year (2021-2022) at the School of Education of Viseu, Portugal. The exploratory interpretative research was based on a qualitative methodological approach and used the questionnaire as a research instrument. As a result, it was found that most participants are women, aged between 41 and 50 years old, graduates, and master's students at the Polytechnic Institute of Viseu.

Through the questionnaire, we were able to find out mainly about the perception and relevance of educational robotics and coding in the context of inclusion. The participants claimed to know what robotics and coding are and to know the work that can be developed with these resources in inclusion contexts. In terms of relevance, the data show that the participants believe that robotics and coding can promote inclusion and the good development of children with special needs and consider themselves partially prepared to integrate activities with these resources in special educational contexts. It is important to note that training was mentioned as a fundamental aspect of this master's program but also during other types of complementary training. Knowledge, on the other hand, of resources and applications allows educational professionals to feel confident in developing ER and coding activities with their students.

If we take into account that working with educational robotics and coding also requires taking into account the knowledge and training needed with the resources to be used, we can realize that, as Miranda-Pinto, Monteiro, and Osório [24] state, when we use different robots, "we can visualize interesting features in all of them, which, if removed and placed in a single robot, could constitute the ideal robot" (p. 26). On the other hand, when we talk about ER in inclusive education, we also recognize that the ideal robot may not exist; "what is ideal for us may not be ideal for children and may not be ideal for different educational contexts." Undoubtedly, other factors influence how a child interacts with a robot" [24, p. 26]. This is the great challenge of inclusive education, and in the activities, we intend to propose through ER.

The perception and relevance of ER and coding in inclusive settings by education and special education professionals still reveal a lack of in-depth training. However, we recognize that interest in this area has been increasing, both through national projects that are disseminated in schools and higher education institutions and through international research that for some years now has brought us relevant contributions in this area. We recognize that much of the inspiration comes from what we believe is possible to develop through research that shows that robotics activities allow youngsters to build fine motor skills and hand-eye coordination while also encouraging collaborative and group work. By constructing tales for their projects, children can learn about engineering ideas as well as storytelling. [7].

We understand that by engaging in such robotics projects, young children play to learn while learning to play in a creative context [25]; therefore, educational robotics becomes a very useful element in creating inclusive environments in education that compensate for students' inequalities while learning through play. In sum, this research allowed us to conduct a study of the training needs of future special education professionals and thus contribute to the perception and relevance of ER and coding in inclusive settings. We recognize that the results of this research, which we hope will be extended to other master's students in this area, are a first contribution to future comparative studies, allowing the improvement of teacher training and, consequently, the integration of ER and coding in inclusive settings. We understand that one of the limitations of the research is that the sample size is not significant, but being a relevant questionnaire, it provides us with information to guide us in validating it and increasing the sample size in future research.

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