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LABORATORY OF TECHNOLOGIES AND LEARNING OF PROGRAMMING AND ROBOTICS FOR PRE AND PRIMARY SCHOOL

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Abstract

This research intends to study how to integrate programming and robotics in kindergartens and primary schools, through a transversal intervention in all the areas of knowledge. This will allow the development of a theoretical framework based on research, able to support the formulation of a proposal of intervention extended to the Portuguese national context. For this project, we will be designing a physical and a mobile laboratory, equipped with tablets and robots, which will facilitate, on the one hand, the initial, postgraduate and continuous training of teachers and, on the other hand, the accomplishment of several case studies throughout Portugal. In addition, the training of teachers and also the participation of the children in the expected activities of this project will enable the designing a theoretical framework about the development of a competences profile for education professionals in this area.

Keywords: Computational Thinking; Learning Programming and Robotics; Teacher Training; Technologies in Education.

1 INTRODUCTION

The present project, Technology and Programming Learning Laboratory for pre and primary school (<https://www.nonio.uminho.pt/kml2>), contemplates the creation of a physical space in the Universidade do Minho (UMinho), for programming and robotics learning by future education professionals (undergraduate and postgraduate students at this institution), as well as education professionals seeking lifelong learning.

This project also includes a mobile laboratory intended for higher education institutions that support the project: ESESetúbal, ESEViseu, ESELisboa, ESEBragança and Universidade Nova de Lisboa (UNL). These institutions will also work as consultants in the development of a national framework, with the goals of studying and reformulating the programs of curricular units of educational technology in Education and Teacher Education courses and degrees. There is also the possibility of extension to other higher education institutions that showing interest in joining.

Besides that we seek to distribute a resource that includes the distribution of mobile laboratories across the country's institutions at a national level to implement programming and robotics activities. Thus, we will encompass explicitly allowing for the reduction of existing inequalities between the interior and the coast. This may also enable these institutions, which already carry out activities autonomously, to collaborate in the joint construction of a framework that may contribute to the formative needs of all. Equipping higher education institutions' laboratories with robotic kits will assist in optimizing existing resources, and thus offering the possibility of undergraduate and postgraduate student teachers to experiment with programming and robotics.

To amortize expenses and to take advantage of the knowledge and resources developed in schools, we will have the support of the Mira Schools Group, through the Club of Technology and Innovation - Informatics and Robotics, and its students of vocational courses, for the development of some robots to be used during this project.

Through a mixed methods approach, with a perspective of social analysis of a real problem within the educational context, we will study the formative needs of the educators of pre and primary schools, regarding the technologies, programming and robotics, to later build a theoretical framework. We will have the partnership of the Universidade de Évora (UÉvora) to survey the training needs at a national level. The design of the referential will be carried out by the Universidade do Minho (UMinho), together with associated consultants, in the aforementioned institutes and also in the Special Education Needs

area. We also count with the partnership of Universidade Aberta (UAb), a Portuguese open university (the only public higher education institution exclusively at a distance) to build a prototype of a MOOC (Massive Open Online Course) for the training of trainers. We will also have close consultation of two invited scientists: Professor Marina Bers (Tufts University – TU, USA) for her knowledge in programming and robotics in preschool and Claudia Urrea (Massachusetts Institute of Technology – MIT, USA), programming and robotics specialist at the primary school level.

2 THEORETICAL BACKGROUND

This project pays particular attention to the transition from kindergarten to primary school, in order to give continuity to learnings that we consider as fundamental. Currently, programming activities in Portugal occur as a pilot project experience lead by the Ministry of Education from the 3rd grade of primary school education and only in schools that propose themselves for this activities [1]. This research assumes a distinct approach. On the one hand, it advocates a comprehensive curricular integration from preschool to all levels of the primary school education. On the other hand, it will have a significant and much needed contribution to initial and continuing teacher education. As Papert [2] states, the use of technologies in the classroom enhances the construction of new and stimulating dynamics guided by the analysis, criticism and sharing of ideas or discoveries in order to make learning more meaningful [3]. In this way, children develop fundamental skills (e. g. problem solving, critical and reflective thinking) through ludic actions that seek to improve the interest and motivation for learning.

National and international research has highlighted the potential of using programming systems, as Scratch or Squeak Etoys, in the development of creativity, multimedia production and the sharing of learning, face-to-face or online, with peers and the surrounding community. The results of the Squeak Etoys used by primary school students, in Portugal, allowed to state that their learning is: guided by the active resolution of significant challenges and problems, improves motivation for learning, increases cooperation, differentiation and diversity of experiences, interaction and sharing among students (e.g. [5]; [4]). Other studies [6] have registered improvements in learning with the Scratch system, especially at the emotional level (e. g. interest, motivation, involvement).

Several researchers [7]; [8], consider that the use of computational thinking in the teaching-learning process is currently a proposal supported by the scientific and educational community that assists in the development of children's ability to solve real problems. In turn, the use of computational thinking associated with robotics allows the development of learning in a more motivated way [9] Ramos e Espadeiro [1] found that most of the students and teachers have positive perceptions regarding the use of programming in schools, assuming behaviours of receptivity and enthusiasm that translated into an increase in the commitment to accomplishing of the tasks. From the perspective of teachers these resources stimulate imagination and creativity. However, teachers are unanimous in considering the need for qualified human resources to develop these actions.

Besides or in accumulation with the above mentioned potential, programming, robotics and computational thinking can contribute for the inclusion of children with special educational needs. As Correia [10] points out, these are "children and youth with sensory, physical and health problems, intellectual and emotional problems, and also specific learning disabilities (process factors/information processing) derived from organic or environmental factors" (p.48). Previous research has already explored and gave evidence of how educational technologies may afford tailored responses to these specific characteristics and needs.

3 RESEARCH METHODOLOGY

3.1 Objectives

This project has two main objectives: (a) to propose a training framework for curricular units of educational technology, in the courses for teacher training in higher education and for continuing training; b) to design a profile of the childhood educator and primary school teacher as mediator in the integration of programming and robotics learning in educational contexts.

As specific research objectives we outlined:

- To propose a model training plan for under and postgraduate training on programming and robotics learning;

- To propose a model training plan for trainers to accredit educational professionals, to develop the training plan and to give it national coverage;
- To build a training framework that will lead to integration in under and postgraduate education in higher education;
- To design a competency profile of the educators as mediators in the use of technologies, programming and robotics in educational contexts;

In terms of resources for the accomplishment of the project, the following objectives apply:

- To equip a laboratory of the Institute of Education of the UMinho with tablets, robots, computers, digital cameras, 3D printer, and other resources, for the learning of programming and robotics by students of the University's education courses and by professionals in continuing education;
- To organize kits with tablets, robots and digital cameras to develop activities within preand primary school educational contexts.

As for data collection and analysis, the objectives are:

- To conduct a national inquiry on training needs in technology, programming and robotics of primary school teachers and educators (construct and validate a questionnaire survey to know the training needs in this area, with a representative national sample);
- To conduct a pilot study on the training of trainers and educators with a representative sample, allowing us to develop the training referential;
- To carry out programming and robotic activities in educational contexts with preschool and primary school children;

3.2 Methodology protocol

Using a mixed methods research approach, we will conduct multiple case studies [11]; [12]; [13]; [14]; [15] to study educational contexts, where the activities with technologies, programming and robotics take place in an integrated manner in curricular guidelines for preschool and in the curriculum of primary school. These activities are going to be replicated in different regions, using pedagogical practices of under or postgraduate students at partner institutes.

The activities to be carried out at UMinho laboratory comprise the training of future educators and continuous education professionals. These activities will constitute a case study to be carried out by the doctoral researcher and its coordinating group.

We will construct and validate a questionnaire survey in technologies, programming and robotics of early childhood educators and primary school teachers, using a representative sample at national level. To accomplish this task, we have the partnership of the UÉvora and a group of researchers associated with the project.

We will seek to respond to the needs of training in the field of ICT for education professionals, valuing their professional growth. To collect data in the various case studies a variety of techniques may be used. Throughout the school year and with the participation of education professionals and children, focus groups [16] will allow us to identify emerging strategies and methodologies for the development of activities.

We will conduct semi-structured initial, intermediate and final interviews in order to respond to the training needs of education professionals. The researcher in each case study may also assume the role of observer-participant in the project activities, within educational contexts.

Case studies of pedagogical practices developed by researchers at the institutes will contribute to the construction of the referential and training plans for initial training, postgraduate training, continuous training and training of trainers. Each institute assumes the role of consultant and may promote various activities (workshops, lectures, etc.), as well as establish partnerships with the surrounding community to extend the project activities.

It is also essential to provide this training experience in continuous training and for this purpose it is fundamental to build a model of training plan for trainers and teacher training, to be validated by the Pedagogical Scientific Council of Continuing Training. After accomplishing this task, it will be necessary to develop and validate a prototype of a distance training course, a MOOC that integrates

the anticipated needs for the realization of the training. In this process we have the partnership of UAb.

After surveying the training needs and carrying out the case studies, we will proceed to the elaboration of categories for the triangulation of results, in order to delineate a training reference for the curricular units of technologies, for the teacher training courses and continuing education. Finally, we will design a profile of childhood educator and primary school teacher, as a mediator in the integration of learning programming and robotics in their educational contexts. We expect to have a positive impact at the national level in higher education courses and, consequently, in the contexts of pre and primary school education.

3.3 Detailed description

Phase I (January to December 2018)

- Specific bibliographic collection and literature review;
- Establishment of partnerships for the acquisition of resources;
- Acquisition of equipment and resources (robots, tablets, other mobile devices and a 3D printer);
- Creation of a physical laboratory at UMinho;
- Preparation of at least 10 kits with technological resources to be made available to the institutes;
- Construction of a robot, by the Mira Schools Group;
- Construction and validation of a questionnaire survey - UÉvora;
- Apply the questionnaire survey at national level to be answered by educators of childhood and primary school teachers of public educational institutions, IPSS and private - UÉvora;
- Participation in scientific meetings at international or national level;
- Elaboration of the annual activity report.

Phase II (January to December 2019)

- Data analysis, in order to obtain relevant indicators for the construction of the training plans - UÉvora;
- Construction of a MOOC prototype to support training, guided by UAb.
- Training activities in initial, postgraduate and continuing training, with the resources of the mobile laboratory and those existing in partner institutes;
- Conducting workshops, seminars and various activities involving the educational community;
- Dinamisation of the laboratory with the participation of students of under and postgraduate training at UMinho;
- Implementation of training activities for trainers, with the participation of partner consultants;
- Conducting continuing education courses for education professionals (educators, primary school teachers and Special Education Teachers);
- Development of programming and robotics activities in pre and primary school; performing at least 7 case studies at national level, with the possibility of other institutes adhering to the project and also developing case studies.

Phase III (January to December 2020)

- Construction of the training framework for higher education and continuing education and of the skills profile of education professionals.

4 FINAL CONSIDERATIONS

With this research project we are expecting to achieve a cumulative positive impact, working with teacher education in graduate levels and continuing education and, subsequently, reaching pre and primary school education practices.

On a more exhaustive mode, and in an initial phase, this project will implement a physical laboratory in UMinho, equipped with resources that allow the development of programming and robotics activities in initial training, postgraduate courses, training of trainers and continuous training. It will also organize resources for mobile laboratories in order to allow the development of case studies at national level, which will be conducted by higher education institutions (UNL, ESEBragança, ESELisboa, ESESetúbal and ESEViseu), as collaborating consultants in this project.

Prior to conducting training and case studies, a national survey of training needs in the area of technology, programming and robotics will be conducted by partner institution UÉvora, enabling the construction of adequate training plans for preschool educators and primary school teachers. The construction of a prototype MOOC by partner institution UAb, will adjust the outlined training plans to a distance education approach, in order to allow a formative scope at the national level.

The collaborative effort of all the individual and institutional participants in this project will be coordinated by a leading researcher who will provide the consolidation of research, assuring the inclusion of activities such as training, lectures and workshops. Seeking to guarantee the watchful eye of pioneering researchers in this area of research, the project will also ensure an advisory contribution by collaborating researchers of the University of Tufts and the MIT, bearing in mind the ultimate goal of this project: to enable children and their educators to be able to deal with the challenges of complex and unknown times.

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