Project “Algorithmic Thinking Skills through Play-Based Learning for Future's Code Literates”

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***Abstract* - Project “Algorithmic Thinking Skills Through Play-Based Learning for Future’s Code Literates” (ALGO-LITTLE) is funded by the Erasmus+ program KA2. The project coordinator is the İzmir Demokrasi University with a project team of experts in the fields of robotics, developers for interactive learning platforms, and preschool education experts from Turkey, Portugal, Italy, Slovenia, and Croatia. The main goal of the project is to prepare a program and teaching material to teach undergraduate students how to develop algorithmic thinking skills in all areas of preschool education so they can integrate them into music, art, mathematic, drama, science, and all activities included in early childhood living and learning. This project aims to offer the opportunity to acquire ICT-oriented skills and thus directly influence the modern skills of undergraduate students of Early and Preschool Education. The emphasis is on teaching children through play about the new “literacy of the future” in which algorithmic thinking is predominantly expressed. The paper describes the context and reasons for initiating the project, planned intellectual results, project activities, and its expected impact. The most important activities include preparing and developing curricula, interactive animated presentations, and workshops, and piloting the implementation of courses in the spring semester of 2022.**

Keywords - project ALGO-LITTLE; algorithmic thinking; programming; play-based learning; undergraduate students; preschool education

I. INTRODUCTION

An algorithm is defined as “a set of actions involving the understanding of objectives of further activities and undertaking a series of steps to solve practical and educational problems" [1]. Algorithm comprehension enables the transfer of problem-solving methods to similar tasks in consideration of algorithmic thinking to reach a solution by defining the steps clearly [2]. Not only is algorithmic thinking the foundation of understanding and learning to code, but a necessary life skill considering that by using this skill, one can create and follow simple sequences to perform a task. A good procurement of algorithmic thinking skills provides future generations with the most appropriate steps to reach the eligible goal.

In the ICT sector, the main interest that sector representatives invest not in computer programs but algorithms included in those programs. It is necessary to understand the operation of these algorithms encountered in every moment in every aspect of life and to organize life accordingly, to solve the problems encountered by deconstructing them into simple parts, to reach the desired results by following the most appropriate ways, and to be able to act systematically. The correct understanding of an algorithm also allows it to be expressed in different ways. If one can apply and follow an algorithm easily every time one comes across it, and if one can design more effective versions of that algorithm, this may prove that algorithmic thinking skills and learning have been acquired. “As computational thinking, coding, and educational robotics are entering European schools as tools for thought, teachers and curriculum developers offer to foster algorithmic thinking skills starting from the preschool period so that children could interpret data more easily and develop thinking strategies for understanding and solving problems” [3].

One of the projects with this topic is the project “*Algorithmic Thinking Skills Through Play-Based Learning for Future’s Code Literates“* (ALGO-LITTLE), funded by Erasmus+ program KA203 – Strategic Partnerships for higher education. The project's goal is to encourage the inclusion of coding and algorithmic thinking in the field of Early and Preschool Education and integrate this kind of thinking into everyday children’s activities. The project covers three topics: early childhood education and care, ICT - new technologies - digital competencies, and the development of new innovative curricula/educational methods/development of training courses.

In this project, a project consortium brings together its expertise, dynamism, and the European perspective into the planned course content, including diversity of culture and experience. University professors and educators whose expertise are preschool teaching, play-based learning, didactic of informatics, e-learning, ICT in education curriculum development, robotics, and coding, with diverse backgrounds and views from different regions of Europe facilitate and develop more creative and innovative course content with an exchange of know-how among the partners. The project coordinator is the İzmir Democracy University (Turkey), and the partners are: University of Maribor (Slovenia), Instituto Politecnico de Viseu (Portugal), Scuola di Robotica (Italy), and the Faculty of Teacher Education University of Rijeka (UFRI; Croatia). UFRI carried out a similar project (acronym GLAT; Erasmus+ KA201) [4], related to fostering algorithmic skills in elementary schools. This experience was important for the project practice since the quality information exchange and the transfer of know-how would be ensured among the partners.

The project started in September 2020 and will last for two years. The main activity is to prepare and develop a course program and teaching materials to teach undergraduate students of Early and Preschool Education how to reflect the algorithmic thinking skill in all areas of preschool education and integrate it into Early Childhood Education.

Algorithmic thinking skills are one of the most important steps of computational thinking skills, one of the most urgent educational needs today, with the acquisition of algorithmic thinking skills being recommended starting from the preschool period. Prospective kindergarten teachers who will graduate from this department will also learn how to integrate

algorithmic thinking skills into all learning processes included in preschool education through these project outcomes.

The project provides new insights into the research area of algorithmic thinking from different aspects, specifically for the Early Childhood Education process. Furthermore, as the main result, project partners will be able to carry out the proposed teaching approach a step further by conducting further studies on the subject matter, including all project outputs to be available to use in courses for students. All interested Early Childhood Education departments will be able to use the developed teaching materials under the Creative Commons license (CC BY-SA). Additionally, the project practice will directly impact the undergraduate study of Early and Preschool Education, upskilling the teaching of different areas of Early Childhood Education, supporting children to see the happenings from different angles, create algorithms, apply them, and observe if they can reach the objective or not, and verify their steps, choose different solutions, anticipate the problematic issues, and correct them.

II. CONTEXT AND SCOPE OF THE RESEARCH

Algorithmic thinking is the ability to think in terms of clear, simple, and small sequences and repetitive rules to solve a problem or understand a situation [5]. There can be more than one method (algorithm) to solve a problem. For example, a sweater can be folded in several different ways. Alternatively, there may be more than one way to reach a restaurant. The choices can vary according to the set goals when performing these tasks. For example, someone who does not want to get stuck in red lights while driving can choose a direction without traffic lights, or someone who wants to take an economical journey or to reach his destination quickly can choose the shortest route. A person who learns the division process steps (in Math's) divides numbers each time using the same algorithm during various mathematical operations. Therefore, algorithms are used in the ICT sector and in many other non-related sectors, including production, service, education, transportation, etc.

For preschool children, the algorithm skill represents the abilities to work according to rules and models to understand, use, apply, and develop algorithms, and analyze, correct the sequence of actions to reach the results, transfer the acquired methods of action (algorithms) to new situations, and clearly describe their activities to others. As [1] claim, the structure of preschool children's algorithm skills is divided into four parts called procedural, personal, regulatory, and communicative components. The procedural component is responsible for the study of properties, types, and ways of displaying algorithms for their application and preparation; the personal component is for developing awareness of the importance of new knowledge; the regulatory component promotes the development of the ability to plan, monitor, and self-correct their activities; the communicative component stimulates the development of communication skills in preschool children due to their interaction with adults and group mates in the process of an algorithmic activity.

Education received in early childhood plays a vital role in developing life skills, especially learning-by-doing and play-based learning skills for optimal development [6]. One of the most important features of the activities carried out at every moment of life is that they progress step by step, consist of repetitive processes, and include choices and classifications. For example, while folding clothes, the primary task is to classify them, for example, into pants, sweaters, and underwear, then to fold each one in an appropriate way and store them in their right place. Or when going somewhere, before leaving the house, to wear clothes appropriate to the weather condition. The next step is choosing a means of transportation (or walking) based on the distance to the destination and, in the end, reach it by following the road.

Some plugged and unplugged methods for teaching algorithmic thinking in preschool are present for some time now in kindergartens, but most often guided by external expert. In existing programs, one of the key teaching tips is to connect unplugged lessons to the online lessons using "bridging activities", and their other guidelines referring to problem solving activities and play based learning for children such as storytelling and discussing the scenarios, working in pairs with encourage children to help each other [7]. Unplugged activities to develop algorithmic thinking are those activities in which learners do not use digital devices but physical objects to present and understand concepts. For example, children can search for words in a grid and describe their position or solve problems in everyday life (making a sandwich or cup of tea), solve mazes or puzzles, describe an algorithm in storytelling and search for algorithms in dance or gym exercises. On the other hand, activities with digital devices can include different devices such as Bee-Bot or Sphero where coding becomes a playground for solving different movement problems. MIT Media Lab has The Lifelong Kindergarten group with a mission to "develop technologies, activities, and communities to engage young people, from all backgrounds, in creative learning experiences, so they can develop their thinking, their voices, and their identities" with projects and programs such as Creative Learning and Scratch, design to think and act creatively; to program their own stories, animations and games interactively [8].

A. Objectives of the project

The project comprises the following objectives: closing the skills gaps in ICT-oriented teaching/learning activities for an immediate impact on contemporary teaching skills of Early and Preschool Education undergraduates; increasing the acquisition of knowledge and skills of kindergarten teaching undergraduates related to employing algorithmic thinking skills through play-based learning as an innovative teaching approach; upskilling the lecturers of the partner universities related to the integration of algorithmic thinking skills into all subject areas focused in preschool education. Children who gain their algorithmic thinking skills in every moment of their lives will have one of the most necessary skills in the future information industry.

Project target groups are 80 kindergarten teacher undergraduates who will participate in the piloting process in five countries (Italy, Portugal, Slovenia, Turkey, Croatia) and nine lecturers who will take part in the training to gain insight into the application of the developed learning/teaching activities to integrate algorithmic thinking skills into all subject areas addressed in preschool education and monitor the teaching practices through in-classroom observations.

III. INTELECTUAL OUTPUTS AND ACTIVITIES IN THE PROJECT

A. Methodology and activities in the project

Except for the preparation of intellectual outputs, the project aims to test their compliance with project objectives.

The intellectual output preparation process comprises two research methods. The first is mainly descriptive and includes preparation, curriculum development, and interactive animated presentations as teaching material. It includes literature reviews, workshops, individual works, teamwork, and joint work of the project team members to empower all included parties. The second method is more experimental and consists of piloting the process taking place after preparing the curriculum and teaching materials. By providing training during the spring semester of 2022, summative and formative assessments will take place to measure the effectiveness of the piloting.

The "Algorithmic Thinking Skills in Early Childhood" course, which is planned to be prepared within this project's scope, will be an innovation and provide support to other courses offered in the Early Childhood Education Department of all partner universities. This course will teach prospective teachers who graduate from this department to learn how to foster children's algorithmic thinking skills in various integrated areas. The curriculum will include modules, so the lecturers will be able to benefit from the module content during the courses. The curriculum will be published under the CC BY-SA license and be open access to all interested preschool teaching departments to use, share, copy, and redistribute the curriculum in any medium or format as well as to adapt, remix, transform, and build upon the curriculum for any purpose, even commercially, provided they mention the project, that is, give appropriate credit, provide a link to the license, and indicate if changes have been made. The prepared material can be used to remix, transform, or build upon the curriculum but under the same license as the original.

Learning motivation increases with play-based learning. The activities are interesting, keep the learner active, and enable them to learn through experience. Learning activities developed with this learning approach extend the learners' focus and facilitate continuous feedback, with errors corrected without delay. The effort to achieve the goals set through games also helps to repeat learning processes in a fun way and reinforce learning. Therefore, sample lesson activities that will be developed within the project scope will be handled according to the play-based learning approach to foster children's algorithmic thinking skills in this elective course.

Higher education lessons, whose content will be developed in the project for the students studying Early and Preschool Education, will be designed according to the flipped learning approach that enables the student's active participation in the lesson by using the information he/she has learned and acquired via e-learning.

B. Results and impact

The main results of the project practice will be the project's intellectual outputs: first, the higher education curriculum for the course "Algorithmic Thinking Skills in Early Childhood." The curriculum will be prepared based on the ECTS principles described in the Bologna process.

The second group of results is interactive animated presentations which include learning/teaching activities, ways of employing algorithmic thinking and giving the learners the opportunity to choose different options in decision stages. This will engage the learners with the content of the presentations, increase the motivation and focusing time. There will be opportunities like watching videos, listening to audio recordings, following the instructions, writing their answers for the next day's lessons, taking quizzes before the lessons, and creating other opportunities to discuss the learning/teaching activities for a longer period during the courses. Animated presentations will be uploaded to the project website and be open-access [9].

Other results are given as follows: undergraduates who participate in the piloting process will be asked to sign the signature lists – they will be certified in order to provide full attendance and will receive their ECTS credits; the project practice will strengthen the collaboration among European Universities and ICT sector representatives; all scientific documents produced during the project practice will be published on the project website and shared with the third parties; all documents will be open access according to the European Commission's requirements and project management activities will improve the project partners' existing knowledge and skills to coordinate a strategic partnership project requiring to monitor and manage several project steps synchronically.

The results will be disseminated through interactions in real and virtual platforms. The project practice will thereby reach at least 5 000 interested people using these dissemination channels.

The course content will be unique in terms of innovation, with a focus on integrating algorithmic thinking skills into all subject areas addressed in Early and Preschool education. Current preschool practices mainly focus on only coding lessons separately and teaching how to foster computation skills in these lessons. However, this project focuses on all developmental areas and how to integrate algorithmic thinking skills into their teaching processes.

The project practice will focus on these components while developing play-based learning/teaching activities. Three application stages will be dwelled on: first, the development of a children's skills to use linear algorithms while solving a problem; second, the application of various types of algorithms, and developing primary skills to create algorithms, and the third one is the reinforcement of algorithm skills and the transfer of learned algorithms to various subject areas and learning activities.

The planned implementation explained above is innovative in closing the gap in the teaching skills of preschool teaching undergraduates related to fostering preschool children's algorithmic thinking skills to become future code literates.

C. Other project activities

A series of activities will be implemented continuously throughout the project to disseminate and popularize the results in all partners' countries. Software developers and robotics education experts will take care of interactive animated presentations, including learning/teaching activities, ways of employing algorithmic thinking, and allowing the learners to choose different options in the decision stages. This will engage the learners with presentation content, increase their motivation, and focus.

At various events such as conferences, workshops, seminars on the use of ICT in education in partner countries and other European countries, experts participating in the project will present results to their colleagues – experts in this field, and, in particular, to interested practitioners for the dissemination in the field of ICT and Early and Preschool Education.

A final event, a multiplier event will be held in every partner country, presenting their own results of realization of learning, teaching and training activities, including benefits gained in the university elective course for experts and interested practitioners.

IV. EXPECTED PERFORMANCE OF THE PROJECT

The ALGO-LITTLE project is expected to impact the immediate participants and a larger and significantly wider group – the expert and the professional community – in creating a new enriched kindergarten culture, aware of the benefits of algorithmic thinking. The immediate participants will gain significant experience by participating in workshops and creating the development of learning material for university courses. By doing so, they will help European experts in the field of e-learning and programming, who will share their expertise, knowledge, and examples from practice with them. The project is also aimed at all other kindergarten teachers because the results of the project will be presented in all countries-partners and the developed learning materials with examples of good practices will be available to kindergarten teachers to improve their competencies, i.e., the acquisition of modern knowledge and skills geared towards innovative teaching in the field of ICT and coding. Ultimately, the project results will also serve formal education regarding the completion of syllabi at included universities and wider. Teaching through compulsory and/or elective courses within this new field and topics will also have an impact on students – future kindergarten teachers. The project results can be used immediately for informal learning in partner countries and beyond as they will be translated into English. The impact of the project on students will be directly reflected in kindergartens, which will implement new teaching strategies and activities. In doing so, students will cover play-based learning for algorithmic thinking and stimulate other interested parties, such as parents in kindergarten. Modern pedagogical approaches have had the opportunity to explore coding and developing algorithmic thinking since the earliest age. By expanding the impact of project results on larger groups of students and kindergarten teachers, there is also the expectation of improving attitudes towards algorithmic thinking and programming.

All partners have good networks, including various public bodies, universities, and NGOs, and they will disseminate the project results in their networks.

V. CONCLUSION

With fostering algorithmic thinking in preschool foundation, digital competencies are provided and supported. In this case, by acknowledging algorithmic thinking as a prerequisite for computational thinking, skills much needed for the future are strengthened, not just for the job market but for understanding more complex concepts that consist of making choices, doing things differently, and above all, achieving deeper understanding. With undergraduate students of Early and Preschool Education being taught how to integrate algorithmic thinking in everyday life in kindergarten practice, innovative methods and approaches are promoted for implementing algorithmic thinking in kindergartens, successful use of ICT in preschool education by giving examples of good practice. Additionally, there are activities for the dissemination and popularization of results. Students will promote the gained skills and competencies to children by applying algorithmic thinking in their own work and arrangements by developing their own digital competencies. Creativity, algorithmic thinking, and problem-solving will be fostered with play-based learning.

Currently, a joint knowledge paper is being developed with all partners included as well as workshops with experts and practitioners where they provide their outputs and suggestions on which the curriculum for the course will be developed. With this activity, the idea of algorithmic thinking is distributed, and the course is simultaneously constructed using the top-down (knowledge papers, course, teaching and learning materials) and bottom-up approach with practitioners' and experts' ideas from the everyday practice implemented into all prepared materials.

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