EVALUATION OF THE IMPACT OF TRAINING IN PROGRAMMING WITH SCRATCHJR ON FUTURE PEDAGOGY PROFESSIONALS

P. Ibáñez-Cubillas[1], M. Santos Miranda Pinto[2], S. López Rodríguez[3]

[1]Universidad de Málaga (SPAIN)
[2]Universidade Aberta (PORTUGAL)
[3]Universidad de Granada (SPAIN)

Abstract

The objective of this study is to evaluate the impact of an online course on the ScratchJr programming language, which promotes the development of computational thinking and coding. This course is available for free in the @rcaComum community (hosted on the Moodle platform - https://comunidade.arcacomum.pt) and is based on a training proposal that has been financially supported by the Arcacomum Association in Portugal (https://www.arcacomum.pt), the Scratch Collaborative Education community of the MIT Media Lab, led by M. Resnick, and the DevTech Research Group at Boston College, led by Marina Bers, between 2022-2024. For this purpose, a formative evaluation of the online course for learning ScratchJr was carried out with Pedagogy students at the University of Malaga. Initially, a questionnaire on general knowledge about Programming Languages in Education was applied. Then, the students took the ScratchJr online course aimed at education professionals (in initial or continuous training) where learning is done autonomously for five days and with a total of ten hours. At the end, a final questionnaire was applied to compare changes in the level of knowledge of those students who completed the training. The findings of the initial questionnaire showed that the students had no knowledge of Programming Languages (77.1%), ScratchJr (79.2%) and Computational Thinking (87.5%). They were also unaware of other Programming Languages for children (95.8%) and did not know how to code with any Programming Language (97.9%). After the completion of the course and the evaluation of the final project, the students acquired basic knowledge and skills on Programming Languages, Computational Thinking and Coding, while learning to program with ScratchJr. In addition, the results of the final questionnaire revealed an impact of the training, since between 96.4% and 100% of the students valued the importance of including Computational Thinking and Programming with ScratchJr in the initial training of the pedagogue for their future professional practice in different areas of Pedagogy. Thus, it is concluded that the autonomous and self-manageable realization of the ScratchJr course has an important impact on the training of students, contributing to significant learning about Computational Thinking and Programming through ScratchJr. The ADDIE (Analysis, Design, Development, Implementation and Evaluation) Instructional Design model followed in the creation of this online course is also valued, since the evaluation phase is fundamental to determine its continuation and effective implementation.

Keywords: ScratchJr; Programming Languages; Online Training; Pedagogy; ADDIE model.

1 INTRODUCTION

ScratchJr is a visual programming platform designed for children from preschool and elementary school onwards. It is a good way to start learning to program, as it is easy to use and has a child-friendly interface [1]. By introducing learning programming from preschool age, we are allowing children new ways of getting to know themselves in relation to the spaces around them and to other children. It is a different way of looking at the world and allows them to develop skills that can be useful in their present and future lives. It helps children find a meaningful way to solve the problems they face in different games, challenges, and activities [2].

Learning to program with ScratchJr in preschool can be a way to take advantage of the technologies that most children have in family or educational contexts and give children the possibility to create their own stories and their own games. The recommended age for this application to learn to program is from 5 years old and this was one of the reasons for integrating it into our research. The application is free, works on a tablet and is supported by the website: http://www.scratchjr.org.

This application has been developed by Berns and Resnick who consider it a way to introduce a programming language that encourages creativity and expression, so that children from 5 years old can create their own interactive projects through block programming.

ScratchJr is a programming language based on Scratch [3] and drawn for the developmental and learning needs of children from preschool through second grade. The creation of ScratchJr refers to the relative lack of technologies for digital creation and programming in early childhood education. This tool provides children with the ability to create interactive and animated stories, as well as offering curriculum and online resources to support educators and teachers [4].

The ability to learn with ScratchJr allows children to develop skills such as problem solving, creativity, and critical thinking, while having fun creating interactive projects. ScratchJr can be an excellent tool for future pedagogical professionals, as it allows them to introduce programming and computational thinking concepts in their university training and then work on them with their future students from an early age, while fostering skills such as creativity, problem solving and teamwork. By specializing in programming with ScratchJr, future educational professionals will be armed with a useful skill that can help prepare children for the future in an increasingly digital world.

1.1 Online Course for Learning ScratchJr

Within the scope of the research project Kids Media Lab: Technologies and Learning Programming in Preschool Age, developed at the Institute of Education of the University of Minho from September 2015 to January 2019, we set out to study during the school year 2016/2017 and 2017/2018, how children learn to program in preschool using ScratchJr as the main tool for learning to program [5].

As part of this research, we have developed a ScratchJr training plan for Preschool Educators and Primary School Teachers as lifelong learning, but which has also served to introduce it in teacher training in Education and Pedagogy courses. This training has allowed these professionals to acquire the necessary skills to work with children in their educational contexts.

This specific ScratchJr course for the training of future pedagogy professionals was developed at the University of Malaga (after its translation into Spanish) and through the training platform of the @rcaComum Community, of the Association of Education Professionals in Portugal (https://comunidade.arcacomum.pt/). The duration of the course was five days, with a total of ten hours and has been developed online in an autonomous and self-manageable format. The activities were scheduled and uploaded daily to the platform. The objectives of the training are:

- Know the ScratchJr application, relating it to the principles of programming and justifying its suitability for preschool and/or as an introduction to programming.
- To explore the ScratchJr application, recognizing its potential and limitations for curricular integration in preschool.
- Learn about ScratchJr activities integrated into the curriculum, through the examples found on the Official Website, ScratchJr Connect (https://scratchjrconnect.tufts.edu) and the resources provided.
- Register in the ScratchJr community (https://scratchjrconnect.tufts.edu);
- Describe the actions programmed in ScratchJr through the Algorithms activities.
- Develop Coding Cards activities in ScratchJr [6], as planned.
- Create and share a project in ScratchJr.

During the training, future pedagogical professionals had the opportunity to learn to work with ScratchJr in a methodology like the one they intend to work with children. The intention of this process is to get the adult (pedagogical professionals, educators, and teachers) to think and program as if they were a child.

2 METHODOLOGY

The ScratchJr course aims to provide or increase the level of knowledge about Computational Thinking and Programming through ScratchJr in Education professionals in initial or continuous training. The course was created with the Instructional Design ADDIE model (Analysis, Design, Development, Implementation and Evaluation), so this study focuses on the Evaluation phase, specifically on the formative evaluation, which allows determining if the objectives have been met and if it has had an impact on the participants. The evaluation phase is an essential component in the ADDIE model and an integral part of the course, as it is necessary to determine its continuation and effective implementation [7]. To this end, the evaluation process is carried out during the development of the course through the evaluative actions associated with each activity, as well as the correct delivery of the final project.

In this study, the sample consisted of 48 students in the third year of the Pedagogy Degree at the University of Malaga, who completed the initial questionnaire and underwent the training. The 81.3% (n=39) were women and 18.8% (n=9) men, with ages between 20 and 25 years. Of this population, 28 students delivered the final project with ScratchJr and completed the final questionnaire, requirements to consider the training completed and obtain the training certificate issued by the @rcaComum Association (https://www.arcacomum.pt). Of the 28 students, 78.57% (n=22) were women and 21.42% (n=6) men, aged between 20 and 24 years.

For data collection, two questionnaires created in Google Forms and integrated as a Moodle URL resource in the ScratchJr course structure were applied. Thus, before starting the training, the students (n=48) completed the initial questionnaire, composed of three sections; 1) Introduction to the questionnaire; 2) Demographic data (gender, age, university, and degree) and 3) Programming Languages in Education, composed of a total of seven questions; five dichotomous questions, one multiple choice question with the option to expand the information and one open question.

The students then completed the training over a period of five days (10h). Of the 48 students initially enrolled, 28 completed the training with the delivery of the final project with ScratchJr, so they had to complete the final questionnaire to obtain the certificate. This final questionnaire is composed of nine questions that allow determining: a) the acquisition of basic contents (programming language, computational thinking and programming); b) the impact of the training, assessing the importance of including computational thinking and programming with ScratchJr in their future professional practice and, c) the skills and knowledge acquired to integrate programming with ScratchJr in the different curricular areas of the educational level in which they are being trained. Thus, the final questionnaire included two open-ended questions, one dichotomous question (yes or no), one question with four answer options (yes, no, maybe, I don't know how to answer) and five questions with three answer options (yes, no, I don't know how to answer).

Data analysis was conducted with the interpretation of absolute frequencies and percentages for each of the closed-response items, and content analysis for the open-ended questions. Data processing and analysis was performed with Microsoft Excel.

3 RESULTS

The results obtained in the initial questionnaire show that a high percentage of the Pedagogy students did not know what a Programming Language is (77.1%, n=37), what ScratchJr is (79.2%, n=38) and what Computational Thinking is (87.5%, n=42). Similarly, they did not know other programming languages for children (95.8%, n=46) and did not know how to program with any programming language (97.9%, n=47).

Of the programming languages proposed in item 4, Tynker, KODU, and Code Monkey were unknown to the students, while 18.8% knew Scratch (n=9), 2.1% knew Python (n=1) and 4.2% (n=2) knew another programming language, Java, a response that coincides with the two students who responded affirmatively about the knowledge of other programming languages for children in item 3.

Item 6 asks about the concepts that students expect to learn through a programming language such as ScratchJr. In this case, only 14.58% (n=7) answered correctly "I don't know" because they had no knowledge of programming languages. The remaining 85.42% (n=41) answered based on the expectations projected in the ScratchJr course, obtaining answer under the following categories: Learning to program (n=7), programming simple and interactive games (n=4), using ScratchJr (n=2), designing didactic activities/resources (n=5), designing technological didactic resources (n=1), learning to teach with an active methodology based on ICT (n=7), programming language with ScratchJr (n=6), concepts related to Programming Language (n=8), concepts that help to work with the student body (n=1).

The final questionnaire was completed by 58.33% (n=28) of the students initially enrolled in the course, whose results show that, after the completion of the course, 89.3% of the students consider that Programming Languages allow the development of Computational Thinking in children, compared to 3.6% (n=1) that say no and 7.1% (n=2) that do not know how to answer. Therefore, the acquisition of basic contents on Programming Languages, Computational Thinking and Programming have increased after the completion of the ScratchJr course.

On the other hand, an impact of the training is evidenced when valuing the importance of including Computational Thinking and Programming with ScratchJr in their future professional practice. In fact, 100% of the students would include programming through ScratchJr in their professional practice (item

2), and 67.9% (n=19) think that as a future pedagogue they can apply or integrate Computational Thinking activities with children, although 32.1% (n=9) indicate that "maybe" (item 7).

Item 4 compiles the benefits perceived by the students after completing the ScratchJr course as future pedagogues. The answers provided fall into the following categories: Using ScrtachJr (f=12); Learning tool (f=11), referring to the use of the ScratchJr application as a tool or resource to promote learning; Teaching strategy (f=8), referring to the use of the ScratchJr application as a teaching strategy or methodology; Learning to program (f=7); Innovative tool (f=5), allude to the application of ScratchJr as an innovative tool; Theoretical knowledge (f=5), specific to the training (programming language, computational thinking, coding...; and Create technological teaching resources (f=1). Some of the answers provided about the benefits perceived as future pedagogues are: "I have learned about a new and innovative tool to use to enhance student learning"; "...I will be able to use ScratchJr in the classroom to learn in a more dynamic way"; "Create methods and resources to solve student problems"; "Ways of learning adapted to early childhood care students"; "Thanks to the ScratchJr course I have been able to learn the concept of programming language, as well as the use of its application".

In item 5, students indicate how they would apply ScratchJr in their professional practices as pedagogues and how they would relate it to the curricular areas. Therefore, the students contextualize the application of ScratchJr in the field of educational guidance by proposing the use of ScratchJr as a teaching strategy (f=20), as a learning tool (f=10) and as a tool for inclusion (f=4). They include different nuances to this, for example: using the stories to work on transversal themes, transmit values or address curricular content. They also allude to the use of ScratchJr as a tool to gamify the classroom or to learn in a playful way, to integrate digital technologies in the classroom or to develop creativity, but the proposals for use to promote the learning of students with specific educational support needs, for attention to diversity and for early intervention processes are especially noteworthy. Some of the answers provided are: "I could apply ScrachtJr through didactic learning units and/or for projects involving knowledge of content creation"; "Using gamification with curricular content..."; "To use innovative methodologies"; "... helping students with visual or spatial problems. I would relate it to games and playful dynamics"; "making stories that inculcate certain values and have messages of inclusion, diversity, etc."; "The benefit is limitless, since it can be used for many, many areas...".

Finally, the completion of the ScratchJr course has promoted the acquisition of knowledge and skills to integrate programming with ScratchJr in the different areas of Pedagogy. In fact, 100% of the students consider that programming languages can be related to pedagogy in different areas (item 1). Moreover, as future pedagogues, 100% of the students believe that training in Computational Thinking is necessary (item 8), in fact, 96.4% (n=28) would include the areas of Computational Thinking and Programming in the university training in the course of Pedagogy and/or Education versus 3.6% (n=1) who respond negatively (item 9). 96.4% (n=27) of the students believe that it is necessary for pedagogues to have training in ScratchJr to incorporate it in classes or intervention practices with children. Only 1 of the students (3.6%) does not "know how to answer" (item 3).

4 CONCLUSIONS

The application of the ADDIE model in the creation of the ScratchJr online course served as a guide to carry out the processes in a systematic and exhaustive way, allowing the creation of a virtual environment oriented to the achievement of the learning objectives. Therefore, the results obtained in the evaluation phase show the effectiveness of the ADDIE model in the learning process. It also highlights the effectiveness of the online course with respect to the acquisition of content and skills on the ScratchJr programming language, as well as the impact produced in the training of students and in their future professional practice.

Before starting the course, students in the third year of Pedagogy had no knowledge of programming languages, computational thinking, programming tools for children (including ScratchJr) and did not know how to program in education with any programming language. In fact, when asked about the concepts they expected to learn through a programming language such as ScratchJr, the students indicated that they could not answer because they lacked the knowledge and, failing that, they responded with the expectations projected in the training. Therefore, future teachers are not being trained in computational thinking in a transversal way to integrate it in the areas of professional performance, even though computational thinking is a key competence in the 21st century.

In order to consider the data obtained in the final questionnaire as valid, the students had to complete and submit the activities and the final project with ScracthJr, since it allowed us to verify that the learning objectives had been achieved. In this sense, the results of the final questionnaire highlight the acquisition

of basic knowledge on Programming Languages, Computational Thinking and Programming with respect to the beginning of the course.

On the other hand, it is evident that there is an impact on the students' training, which may possibly have repercussions in their future professional practice. After completing the course, all the students expressed interest in including programming with ScratchJr in their professional practice and more than half of them considered that they would apply or integrate Computational Thinking activities. In fact, they propose a variety of applications with ScratchJr from the discipline of educational guidance, specifically in the areas of support for teaching and learning processes, tutorial action and attention to diversity. And from the children's field, reference is made to Early Childhood Care. In addition, after this learning experience with ScratchJr, the students express the need to incorporate the areas of Computational Thinking and Programming in the university training of the Pedagogy Degree, as they consider it necessary for the professionalization of the pedagogue in the various areas of action. In fact, the interest and concern for a quality professional performance is manifested in different moments or spaces:

1 The expectations expressed before starting the training refer to the knowledge of contents and tools, as well as the development of skills to guide teaching practice (as one of the functions of guidance);

2 The benefits obtained after completing the course refer to the mastery of ScratchJr for the creation of technological didactic resources and as a tool or resource to promote learning or improve teaching.

3 The possible applications of ScratchJr in the professional practice of the pedagogue reflect the students' concern for dynamic, playful, innovative teaching-learning processes that meet the needs of students from the point of view of attention to diversity and early attention, together with the acquisition of theoretical-practical knowledge that will allow them to apply it in their professional practice.

Thus, the feedback from students in the evaluation phase suggests that the online introductory ScratchJr training is valid and effective, which leads to maintain its continuity and availability for education professionals.

ACKNOWLEDGEMENTS

LE@D, Universidade Aberta - Financed national funds through FCT – Fundação para a Ciência e a Tecnologia, I.P., under the projects UIDB/04372/2020

Scratch Education Collaborative (SEC): 2022-2024 Cohort.

REFERENCES

[1] M. U. Bers, & M. Resnick, *ScratchJr* (I. No Starch Press (ed.)). San Francisco, CA: William Polloch. William Polloch. 2016.

[2] M. Miranda-Pinto, & A. J. Osório, “Scratchjr App in Portuguese Schools: Kids Media Lab Project”. ICERI2020 Proceedings, 1(November), 5709–5718. 2020. https://doi.org/10.21125/iceri.2020.1227

[3] Lifelong Kindergarten Group at the MIT Media Company. Scratch. MIT Media Lab. 2014. https://www.scratchfoundation.org

[4] L. P. Flannery, E. R. Kazakoff, P. Bontá, B. Silverman, M. U. Bers, & M. Resnick, “Designing ScratchJr: Support for Early Childhood Learning Through Computer Programming”. In *IDC (Ed.), 12th International Conference on Interaction Design and Children*. ACM New York, NY, USA. 2013. https://ase.tufts.edu/DevTech/publications/scratchjr_idc_2013.pdf

[5] M. S. Miranda-Pinto, & A. J. Osório, “Kids Media Lab: Tecnologias e a Aprendizagem da Programação em Idade Pré-escolar”. In M. do R. Rodrigues, M. L. Nistal, & M. Figueiredo (Eds.), XVII Simpósio Internacional de Informática Educativa (pp. 432–435). Escola Superior de Educação do Instituto Politécnico de Setúbal. 2015.

[6] M. U. Bers, & A. Sullivan, *ScratchJr Coding Cards*. No Starch Press. 2018.

[7] Maribe, R. *Instructional Design: The ADDIE Approach*. Springer. 2009. https://doi.org/10.1007/978-0-387-09506-6