CREATIVELAB_SCI&MATH: OPEN EDUCATIONAL RESOURCES IN TEACHER EDUCATION

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ABSTRACT

To face the important challenges of today's demanding and competitive digital society, multidisciplinary knowledge, new skills and competences are needed. These challenges necessarily imply the change of teaching practices and a strong commitment and support of teacher education throughout the innovation process. The CreativeLab_Sci&Math project was developed by teacher educators of the Department of Mathematic and Natural Sciences of the School of Education/Polytechnic Institute of Santarém and consists of involving future teachers in an innovative learning environment with a focus on integration of mathematics and science. In this project, inquiry and project-based learning interdisciplinary activities are carried out using digital technologies, which includes programming and robotics activities. The main goals of this project are to prepare teachers and future teachers to support innovation initiatives in schools, concerning mathematics and science. One way to achieve these goals involves producing Open Educational Resources and making them available on several online platforms, such as Casa das Ciências® and ERTE (Portuguese Ministry of Education). The produced resources have received national awards and resulted from the work developed by these educators in co-teaching, their participation in European projects and their experience in mobility programs.

RÉSUMÉ

CreativeLab_Sci&Math: Ressources Éducatives Libres dans la Formation des Enseignants

Pour faire face aux défis importants de la société numérique compétitive d´aujourd´hui, des savoirs multidisciplinaires, de nouvelles compétences sont nécessaires. Ces défis impliquent un changement de pratiques pédagogiques et un engagement fort et un support de la formation des enseignants par l´innovation. Le projet CreativeLab_Sci&Math a été développé par les professeurs du Département de Mathématiques et de Sciences Naturelles de l´ École d´Éducation/Institut Polytechnique de Santarém et consiste à engager les futurs enseignants dans des environnements d'apprentissage innovants avec le focus sur l´intégration des mathématiques et des sciences. Dans ce projet, les activités interdisciplinaires fondées sur l´approche par enquête et par projet sont réalisées à l´aide des technologies numériques, notamment des activités de programmation et de robotique. Les principaux objectifs de ce projet sont de préparer les enseignants et les futurs professeurs des écoles à soutenir les initiatives d'innovation dans les écoles, en mathématiques et en sciences. Pour atteindre ces objectifs, des ressources éducatives libres ont été produites et disponibilisées sur plusieurs plateformes en ligne, telles que Casa das Ciências® et ERTE (Ministère de l'Éducation portugais). Les ressources produites ont reçu des prix nationaux et résultent du travail de coenseignement, de la participation à des projets européens et de l´expérience vécue dans les programmes de mobilité.

Introduction

Even though integration of mathematics and science enhances students' understanding of both subjects, integrating mathematics and science in teacher education is a difficult task (Koirala & Bowman, 2003). In Portugal, the gap between an integrated teacher education in science and mathematics is even greater. The first stage of teacher education in Portugal, in kindergarten and primary school (grades 1-4 and 5-6), is the obtention of a degree named "Basic Education", with a curriculum of three years. Within that degree, and concerning scientific education, student teachers need to have a minimum of 30 ECTS in mathematics and in science, history and geography also a minimum of 30 ECTS. The second stage is the Masters degree where student teachers have a more profound contact with didactics and pedagogical practice. In both stages, the courses of mathematics and science are usually taught separately and do not have a formal connection. This was one of the reasons for the creation, in 2016, of the CreativeLab_Sci&Math project by teacher educators of the Department of Mathematic and Natural Sciences of School of Education /Polytechnic Institute of Santarém (SE/PISantarém) (Figure 1).

The aim of the CreativeLab_Sci&Math project is innovation in science and mathematics education. That innovation is expressed through carrying out STEM and other interdisciplinary activities, involving student teachers in innovative learning environments, and immersing them into integrated classes of mathematics and science where teacher educators of mathematics and sciences work collaboratively, so that they are able to promote these approaches in their practice.

In this environment, inquiry and project-based learning interdisciplinary activities are carried out using hands-on and minds-on activities. Digital technologies are present in many activities, for example, those that included programming and robotics. This global approach is in accordance with a recent law about the principles of conception, implementation and evaluation from primary to secondary school curriculum in Portugal, that promotes interdisciplinarity and collaborative work between teachers of different subjects (Decreto-Lei n.º55/2018).

One way to achieve these goals involves producing Open Educational Resources. The resources produced have received national awards and resulted from the work developed by these teachers in co-teaching, their participation in European projects and experience in mobility programs.

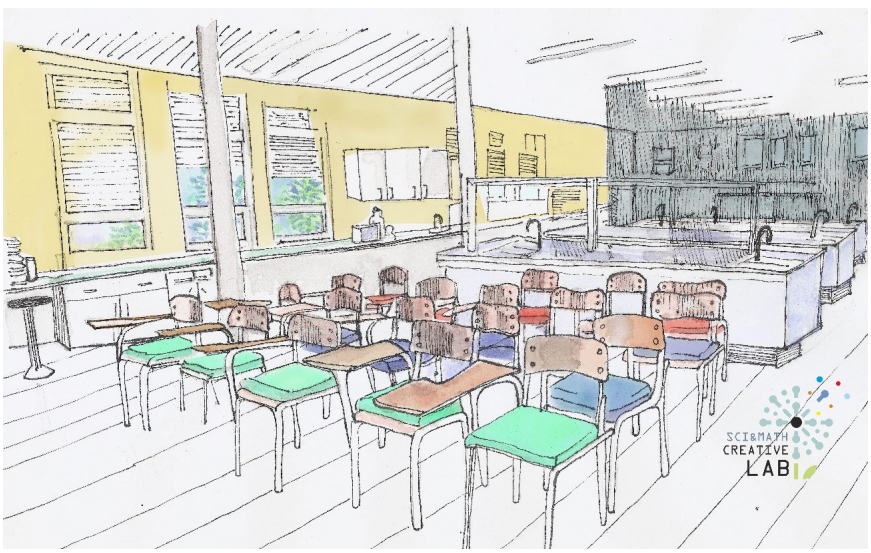

Figure 1. Organization of CreativeLab_Sci&Math environment (Art by Clara Brito).

Open Educational Resources

The CreativeLab_Sci&Math teacher educators collaborate to create digital educational resources for teacher education with a strong focus on interdisciplinary activities. They are available on several online platforms, such as Casa das Ciências® and ERTE (Portuguese Ministry of Education), so that other teachers can use them. Two of those resources are presented below.

CreativeLab_Sci&Math | Bad Plastics (Linhares & Cavadas, 2018): This activity aims to raise students' awareness about the problematic of ocean plastic and empower them to contribute to the solution of that ecological problem. In an outdoor activity, students have to collect different sizes of plastic in a beach area with 10m x 10m, register their quantity and identify the original materials. Afterwards, in lab environment, they weigh the plastics and identify microplastics in a sample of the sand collected in the beach, trough microscope observation. To empower students and the community, they also produce a digital resource to alert about the ocean plastic.

CreativeLab_Sci&Math | Research animals' footprints (Cavadas, Branco, Linhares, Durão, André & Duarte, 2019): The study of trackways enables the identification of the animal type that produced them and the characteristics of their behaviour. Each footprint and trackway have distinctive features concerning shape and size. This activity involves different tasks of sciences and mathematics. One of the main goals is the identification of animal footprints in nature using an app. The app *Research animals' footprints* (Cavadas, Linhares, Cavalheiro & Pacheco, 2018) was done collaboratively by science education teachers and the Center for Competencies in Digital Technologies of (SE/PISantarém). In mathematics the data collected in the field about the number of different animal footprints in different areas are organized and analysed to determinate the area with more

biodiversity. Another math task involves the measurement of the area of footprints using the registers collected in the field.

Programming and Robotics

Besides privileging project-based learning approaches to develop preservice teachers' content and pedagogical knowledge concerning STEM activities, CreativeLab_ Sci&Math also involves computational thinking, programming and robotics. According to Nouri, Zhang, Mannila and Norén (2019), programming is essential to the digital world and develop skills such as creating solutions, solving problems and implementing ideas. Although teachers identified the development of computational thinking skills and general skills related to digital competence/literacy and 21st century skills when learning programming (Nouri et al, 2019), they face some struggles to develop and implement this type of activities. To overcome those difficulties, it is crucial to enhance teachers' knowledge of programming and the didactics of programming (Nouri et al, 2019). Several studies (e.g. Kim & Lee, 2016) have demonstrated that engaging preservice teachers in programming and robot programming have positive effects on their perceptions and attitudes towards computer programming and robots, which may lead them to be more predisposed to develop these activities in their future professional practice. For that reason, in CreativeLab_ Sci&Math we engage student teachers in programming and robotics activities, for example, about simulated missions related with the explore of Mars' surface.

Conclusion

Preparing preservice teachers to embrace the challenges of subject integration in innovative learning environments, full of digital technologies, is a huge task. Like Koirala & Bowman (2003), we strongly believe that "if we want the integration of subject areas in middle schools to be successful, it is important that preservice teachers experience integrated methods courses" (p. 145). In the CreativeLab_ Sci&Math project we embrace both challenges through collaboration between science and mathematics education teachers with the aim of creating an innovative learning environment to prepare preservice teachers for the integration of mathematics and science.

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