Toward a STEAM professional development program to exploit school mathematics

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Introduction

Following European Union recommendations, many countries have incorporated the competence-based learning approach in their curriculum. This approach aims to prepare citizens for current and future challenges in Science, Technology, Engineering, and Mathematics (STEM, Diego-Mantecón et al., 2021a). To provide citizens with the necessary competences, there exists an increasing interest to integrate Arts into STEM, in the so-called STEAM Education.

STEAM education entails teachers crossing boundary disciplines to adequately integrate content. In countries like Spain and Greece, secondary education teachers are usually qualified to teach a single discipline. In an integrated context, it means that teachers must design and implement activities involving content from disciplines in which they did not receive specific training. In STEAM activities science and engineering disciplines often take a dominant role (Martín-Páez et al., 2019), whereas mathematics appears in a basic and utilitarian manner (Lasa et al., 2020). Recently, Diego-Mantecón et al. (2021b) found disparities in the characteristics of the STEAM activities implemented by in-field and out-of-field mathematics teachers as well as in the manner they exploit mathematics. In-field mathematics teachers, unlike the out-of-field ones, seem to avoid transdisciplinary projects (based on real experiences) because of the difficulty in addressing school mathematics. Even when implementing interdisciplinary projects (contextualized based experiences), mathematics teachers encounter problems to meaningfully exploit mathematics and promote high cognitive demands. As consequence, Diego-Mantecón et al. (2021b) suggest developing training programs focused on reproducing experiences in collaborative environments, where both in-field and out-of-field mathematics teachers cooperate to construct and deliver knowledge.

The study

Following Diego-Mantecón et al.'s (2021b) suggestion, we attempt the so-called STEAMTeach project (https://www.steamteach.unican.es/), which is a Teaching Professionalism European-funded initiative based on the Erasmus+ Programme. The objective is to design a cross-cultural STEAM professional development (PD) program for training in-service teachers to exploit mathematics within a STEAM context at middle and high schools. To design this PD program, we firstly interviewed 25

STEAM trainers in five countries: Spain, Austria, Finland, Greece, and Hungary. The interviews helped to identify issues obstructing the implementation of STEAM activities in school classrooms. In the next, we report a preliminary framework emerging from the Greek and Spanish data.

Results

The analysis revealed that trainers agreed on the importance of introducing teachers to theoretical aspects of the integrated STEAM education approach and to the following four active methodologies: (1) collaborative learning, (2) design-, (3) inquiry- and (4) problem-based learning. Based on these outcomes, we devised a preliminary PD framework comprising three blocks: a theoretical block in which, through different sessions, teachers are introduced to STEAM education and the methodologies listed above; an experimental block where teachers, grouped in teams, have to attack a series of STEAM activities in the same way that their students would do it; and an implementation block where teachers are requested to design and implement activities in their classroom with the trainers' support. After executing the first round of training courses, we observed that this preliminary PD framework allows teachers to gain insights into the meaning of STEAM education and its application in the classroom, as they were forced to experience the difficulties that arise in different STEAM contexts. This in turn increases teachers' confidence to implement their STEAM activities and exploit school mathematics. Importantly, this preliminary PD framework is under an iterative process of implementation and evaluation, and hopefully subsequent training courses will provide us with extra data to refine the initial framework into a more consistent and reliable instrument.

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