Development of Physics Competences in Primary Education through a STEAM Approach

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Abstract. There is nowadays extended consensus that it is crucial to foster scientific literacy and competence development since early age. Nevertheless, there are few studies available that investigate the notion of physics competence. In this study, we present a STEAM proposal constructed around the topic of electricity, and we show some results of a first implementation of such proposal with students in Primary Education. The high scores that we found in this preliminary intervention with respect to the science competence in physics point towards the pertinence of the STEAM approach for science education.

1 Introduction

In the last decades, many science educators state that a solid scientific literacy is essential to live in current society; there is also concern about the decrease in the numbers of young people who follow studies in science and technology. On the basis of this diagnosis, and under the consideration that traditional science teaching is reductionist in its treatment of separate disciplines [1], a new approach, known as STEM (Science, Technology, Engineering & Mathematics), advocates for the introduction of those disciplines, in an integrated modality, since early age [2].

On the other hand, the construct of 'scientific competence', which is at the core of the STEM approach, has been insufficiently investigated in primary education; particularly scarce are the investigations on physics competence [3].

In accordance with this, in this study we present the first results of implementation of a didactical proposal that uses the so-called STEAM (STEM + arts and design) approach. The proposal, constructed around the topic of electricity, is aimed at fostering the development of scientific competence in Primary Education.

2 Didactical proposal

The STEAM approach, which we adopt for our intervention, has been widely defended as a multi- and trans-disciplinary approach aiming at the solution of socially relevant problems through innovation and creativity [4]. In our design, we teach content from Science, Visual Arts and Mathematics in an integrated way.

The problem that we propose to students —"How can I design a prototype of the illumination system for my study room?"— deals with school content on electricity (Science), using information and communication technologies as well as technological ideas and practices linked to lighting (Technology), working on the design of a concrete prototype (Engineering), connecting with content on colour (Arts), and treating data through the use of variables, tables and graphs (Mathematics). This disciplinary integration aims at fostering the development of key competences.

3 Methodology

Our methodological design is inscribed within *design-based research* [5]. We assess, in successive iterations, the educational innovation that we propose through comparing students' learning results from each iteration.

3.1 Participants and instrument for data collection

Our STEAM proposal is being applied in the school year 2017-2018 with a sample composed of 122 students in the sixth year of Primary Education in a public school in Burgos, Spain. The instruments that we use to collect data are the teacher's class log and observation notes, and the students' productions and presentations. We evaluate students' competence level through a rubric containing 31 Evaluable Learning Standards (ELS) pertaining to the teaching contents. The vertical axis of the rubric contains those ELS, and the horizontal axis shows each one of the activities implemented in the proposal (17 activities and 3 globalised items). As some of the activities aid in the accomplishment of more than one standard, the maximum score of the rubric is 127.

4 Results

An overview of the results of the first implementation of our proposal with 20 students shows high levels of development of the scientific competence for the class group (M = 100.2 of 127). The ELS with the highest scores were: "The student conducts little experiments to study the attraction and repulsion of electric charges" (M = 9.3 of 10) and "The student identifies and interprets simple numerical data from everyday life" (M = 8.9 of 10). The ELS with the lowest scores were: "The student orally presents in clear and organised way content related to the area" (M = 5.5 of 10) and "The student uses ICTs in order to manage information" (M = 6.3 of 10). These two aspects are now being improved for the following iterations.

5 Conclusions

Aware of the lack of research around the construct of 'physics competences' in Primary Education, we had as a major aim in this study identifying students' level of competence *related to physics content*. Our preliminary results seem to provide arguments in favour of the use of a STEAM approach in the development of 'paradigmatic' competences in physics [6] for Primary Education.

References

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