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Teleological Structure of Scientific and Mathematical Education

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Abstract

One of the main educational objectives in the current Spanish curricula is to develop mathematical and scientific competences, understood as the set of skills and abilities needed to apply Mathematics and Science in situations where are required. This is therefore closely related, on one hand, to the functionality of the knowledge, in the sense of its usefulness in problem solving and in mathematical and science modeling problems. And, on the other hand, is related to the understanding of disciplinary knowledge, a cognitive phenomenon that enables and gives competence to the individual to elaborate contextualized and accurate answers. These answers involve the use of mathematical and scientific knowledge in some of the categories of their phenomenological and epistemological dimensions. For this reason, in this work we carry out a theoretical and reflexive analysis that tries to determine which aspects of the Mathematics and Science Education should be promoted in order to optimize the formative dimension of an individual in these disciplines. This dimension, frequently forgotten in learning and teaching processes, turns out to be, in conjunction with the functional and instrumental dimensions, necessary to acquire the appropriate knowledge in Mathematics and Science that will enable future citizens to permanently adapt to the environment and eventually transform it positively. The results of the analysis show the components of this dimension that should be prioritized in the Science and Mathematics Education: the intellectual autonomy, understood as the ability to think for ourselves and to put in use our abilities and skills to generate information to solve real life problems and to make the right decisions; the moral autonomy, defined as the capacity to face with real life problems with ethical implications; and the social autonomy, understood as the aptitude to make decisions using social abilities and skills. Lastly, this work provides some key aspects to develop these autonomies from the Science and Mathematics Education.

Keywords: *Science and Mathematics Education; autonomies; formative dimension; mathematical and scientific competences*

1. Introduction

Educative processes organised in non-university levels difficultly adapt to the needs and circumstances of a society and world in continuous change. Mathematics and Science teaching are permanently faced with the challenge of improving the methodology, the resources or the evaluation used or the motivation and attention among other factors. All of these are involved in the modelisation, the problem solving and the experimentation, which should be core points in the educative processes and means to guarantee the development of comprehension and key competences as the ultimate purpose of the educative process.

In these paradigms, educative processes are often based in teaching and learning units or proposals of curriculum development organised in textbooks, which have a predominant role in teaching planning ([1], [5], [6], [14]). Therefore, a question arises: How should Mathematics and Science be approached in classroom in order to obtain optimal results and to guarantee a proper formal education required in the 21st century?

In this sense, most studies on the analysis and assessment of teaching proposals have been focussed on isolated aspects or in aspects that don't question the quality or the didactical potentiality of those proposals (Ex. [1], [8], [9], [15]). These studies have paid little to none attention to analyse whether those proposals: 1) consider quality experiences and educative processes; 2) incorporate results from research in didactics; 3) fulfil the requirements and recommendations in official education laws; 4) ignore the recommendations and didactical proposals from relevant organisations and institutions in education. Due to all this, it is absolutely necessary a theoretical and reflexive analysis on the characteristics that are recommended for quality educative processes in official laws, scientific

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research and relevant institutions in order to safely address the necessary changes to improve educative processes in Mathematics and Science and their results.

2. Characteristics of quality educative processes in Mathematics and Science comprehension and competences.

One of the main objectives in the current curricular guidelines is the development of mathematical and science competences, understood as the set of skills needed to tackle situations that need mathematical, science and technological knowledge ([10], [|11], [12], [13]).

These competences are intimately related, firstly, with the functionality of the knowledge, in the sense of its usefulness in problem solving and modelisation situations (in both mathematics and science); and secondly, with the comprehension of the specific knowledge of these disciplines, understanding the comprehension as a cognitive phenomenon that enables and gives competence to the individual to elaborate contextualized and accurate answers. These answers involve the use of mathematical, scientific and technological knowledge in some of the categories of their phenomenological and epistemological dimensions ([2], [3], [4], [13]).

The development of both aspects, comprehension and competence, and consequently, the quality of the educative process in Mathematics and Science depend on school practices, assignments, methodology, etc., which refer to the design of teaching proposals, to the materialization into proactive lesson plans and their precision in curricular plans used in classrooms. We are referring to an educative process needed to ensure the transmission of mathematical and scientific culture, that tries to facilitate knowledge discovery and improve critical thinking, imagination and attitudes towards Mathematics and Sciences while reinforcing the usefulness of mathematical and scientific thinking among other factors. This educative process must devote more attention to meaningful knowledge, to the key competences and ultimately connections between knowledge and comprehension [16].

Therefore, considering these characteristics, the educative process in Mathematics and Science should consider the following areas:

- Education in disciplinary skills and competences and their relations to Mathematics and Science: developing specific mathematical and scientific skills and competences as well as interdisciplinary abilities in relation with Mathematics and Science (linguistic competence, digital competence, etc.)
- Education in key competences and their relations to Mathematics and Science: promoting the development of aspects such as critical spirit, self-knowledge, reflective capacities, analysis and synthesis abilities, learning to learn, metacognition, capacities to experiment, estimate and invent; the initiative and entrepreneurial spirit and risk evaluation.
- Emotional education and its relation to Mathematics and Science: involves stimulating aspects such as affectivity, attitudes towards Science and Mathematics (interest, curiosity), emotions, moods, motivation, self-confidence and reassurance, self-esteem or maintaining a positive attitude towards mistakes.
- Education in moral values and their relations to Mathematics and Science: includes the fostering of values such as respect; coexistence; civic and social values; conversation, debate and opinion; the understanding and communication; democratic principles; equality and equity; solidarity; cooperation and collaboration; empathy; conflict resolution or tolerance.

These last three areas are often forgotten in teaching and learning processes in Science and Mathematics, but emerge, in combination with the first one, essential so as to acquire proper knowledge in these areas that will enable future citizens to permanently adapt to the environment and eventually transform it positively. From Mathematics and Science education, this leads to the necessity to promote an individual's autonomy from three aspects: intellectual, moral and social. That is, considering authors such as López-Melero, Mancila & Sole [7], we believe that mathematical and scientific areas should boost: the capacity to think for oneself and generate information to solve real life problems (intellectual autonomy); the ability to make decisions when faced with real life problems with a social conscience (moral autonomy); and the capacity to make decisions applying social abilities and skills (social autonomy).

3. Conclusions

This paper shows the necessity to reflect on and propose the aspects that should be addressed from the mathematical and scientific education. On this matter, we propose a formation in two dimensions: one that enables the student to comprehend Mathematics and Science to adapt to the environment, organise and transform it, and that implies a deep knowledge of it. It is also required the development

of analytical abilities of reality, the production of models that allow to explore reality and its inner workings and act in consequence, with the objective of improving both individual and collective conditions. The other dimension translates into the capacity of the individuals to search and expand upon the information obtained from a situation, analyse every possibility and choose the best among them. Thus, the necessity of the promotion of a quality mathematical and scientific formation in which students acquire a fair share of intellectual, moral and social autonomy. This means changing the designs and lesson planning to adopt a mixed didactical approach, functional and instrumental, as the core of the formative activity. In this sense, we propose the use of proposals based on problems with a social and scientific approach, present in their daily lives and designed to foster cooperative work, the reasoning, the decision making and communication, among others.

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