Enhancing STEM Skills Through the Art

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Abstract

Nowadays, ensuring the learning of STEM (Science, Technology, Engineering, Mathematics) skills allows young people to participate fully in the social life in terms of employability, productivity and social cohesion. However, on the basis of the international surveys, such as PISA and TIMSS, maths and science mean scores obtained by an essential part of European students, are below the OECD average.

Although the national educational systems try to promote the interactive teaching of sciences belonging to the STEM field, they fail when compared to the American, because the scientific subjects presented seem to be opposed to the humanities ones. The risk to consider here is that such an approach favors the lost of a great part of an analytical and critical ways of thinking inherent to humanities.

In this context, a new educational method, based on a proper balance between humanities and scientific disciplines would allow a more effective development of the logical and critical skills and tools by improving study performance and increasing the mind potential in young people. This point is of absolute importance especially for the children of 5 years old when the natural continuous interactions between the two brain hemispheres determines the predominance of one over the other, i.e. the functional asymmetry which causes a brain to work as a pair of opposites.

In the work a new pedagogical approach to the STEM education is presented. As the unifying element, that may assist the harmonious development of both hemispheres, the Art is considered. Authors show, how being a purely intuitive and stimulating the creativity from one side, together with an enormous informational capacity that may encode the vast variety of scientific concepts from the other, Art may be used as an effective educational mean, that aids the development of young student abilities thanks to the simultaneous stimulation of both brain hemispheres with suitable exercises designed.

Keywords: STEM education, teaching, new learning approach

1. Introduction

According to the European Communication EUROPA 2020 – A strategy for smart, sustainable and inclusive growth of 2010, a stronger strategy have to guarantee the transformation of the European Union into smart, sustainable and inclusive towards a high level of employment, productivity and social cohesion [8]. This plan can be favored by a new approach, so called STEM Education, to the scientific subjects supporting young students as potential future scientists. STEM stands for a curriculum based on the idea that students should be educated in four main specific disciplines, Science, Technology, Engineering, Mathematics in interdisciplinary way. This would allow them a more cohesive learning approach based on real-world.

However, the results of international surveys, such as PISA (Program for International Student Assessment) [14] and TIMSS (Trends in International Mathematics and Science Study) [13], show a critical picture where the math and science main scores obtained by an essential part of European students are below the OECD average.

In this context, a different and interdisciplinary approach is required to develop and promote STEM skills in students through the use of innovative tools and methodologies that can guarantee an active involvement and a creative inclusion of learners in order to let them test the interconnection of different languages, such as visual, sensory, verbal and non-verbal [1]. An element that can be used as interconnector is the “Art” which supports a problem-oriented creativity development, especially, in young people.

In fact, imagination and creativity have always been at the cornerstone and joining factor between mathematics and art. These faculties have guided and sustained the science branches during the long millennial development, in which the assimilation from the students' side has always resulted in a

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certain degree of separation and difficulties. In view of the above, authors claim, that imagination and creativity are potentially capable to recreate the harmony of the integral (holistic) vision.
Using this idea as the way to combine math education with artistic vision, the purpose of this article is to present the first steps of the research on a new method and its potentialities for the STEM education.

2. Art as learning facilitator in STEM subjects

Since the art is a unifying element among different languages, it encourages the development of both cognitive and emotional dimensions and becomes an important element for the harmonious development and growing up of human being [6] [12].
The current separation between science and humanities in school education has deep roots and stems from ancient concepts that led to the birth of the school system [2]. Every matter has been considered as the closed box composed of the series of concepts non-interfacing with other disciplines. There were only two means that could open these boxes, and create a certain interchangeability, namely the logic and criticism. Logic, born from philosophy and subsequently became the basis of science, has enabled the building of bridges between science subjects so that the concepts were logically linked to each other through rational patterns and then translated into physical laws. Critical thinking, in its turn, allowed to evaluate and interpret through the creation of these abstract schemes.
The school system thus created had led the students to specialize or at least to prefer one of the two systems [3]. The results of this training is reflected in the overcrowding of the humanities departments in university and lack of professionals in science subjects [13] [14]. These data, showing lack scientific basic competences, are confirmed by the results achieved in mathematics and science subjects emerged by international and national surveys, such as PISA, TIMSS and INVALSI in Italy. The common aim of each European Ministry of education is to share and agree the educational objectives and results that are the base of these surveys in order to find a strategy to reduce the average of students with difficulty in scientific topics, such as mathematics and science.
Thus, the problem needs to be tackled in the adolescent pre-university education through the introduction of innovative and more attractive learning approaches focused on the interdisciplinarity of science, technology, engineering, art and mathematics.

3. Towards a STEAM education

The arts, music, painting, dance, theatre, etc., help students connect better scientific subjects and reality by rediscovering their usefulness and their application in everyday life.
Consequently, an innovative learning approach based on this new combination between logic and creativity is necessary, by giving up the past logic and critical distinction. Logic and creativity become essential elements in the learning path in both formal and informal education [9].
In particular, on the base of the theory of the Didactics Hexagon proposed by Guy Brousseau constituted of four elements (knowledge, learner/student, teacher and milieu), the art can be considered as the “context” or, referring the Author schema, the “milieu” to be used to reach knowledge [4].
This allows students to reinforce their STEM knowledge through the arts to develop systems thinking based on applicable knowledge, imagination, creativity and problem solving skills. In this framework, the STEM education is reinforced and supported by the introduction of the use of the arts, leaving the place to the development of what is called "STEAM" (science, technology, engineering, art, mathematics) education [5].
The artistic activity becomes a sort of prosthesis of the mind, a form of reasoning by which to promote interaction with the external world [15] which, as the mathematician J.D. Barrow claims, is well represented by the mathematical language that explains its nature and operation.
Certain structures and certain real-world objects can be represented by a mathematical abstraction, and conversely, the mathematical world contains abstract notions that may be reflected as "examples" in the real world.
Thus, the human accomplishments reflected in the art become attempts to break free from a binding concreteness. The art itself heads for the opportunity to represent dreams, ideas, fantasies as well, just as it the math does [7].
The artists of all ages have tried to create their works that represented "human beings" and their dimensions using mathematics concepts such as perspective and proportion. It is enough to think of the concept of “beauty” in human beings and the “golden ratio” that is a geometrical proportion, a reference standard for the artists, used, especially, in figurative arts in order to create harmony,

perfection, meant as “beauty”. Another example is in the representation of Vitruvian man realized by Leonardo Da Vinci, the human figure follows very precise symmetrical relationships: the man’s height is equal to the distance between the ends of the hands with arms extended by determining the possibility to inscribe the whole figure in a square.

Comparing the creative art processes with those that normally make up the procedures for the resolution of problems in science one can identify an equal methodology. J. Gary Knowles and Andra Cole [10] claim that: "[a]rts-based research can be defined as the systematic use of the artistic process, the actual making of artistic expressions in all of the different forms of the arts, as a primary way of understanding and examining experience by both researchers and the people that they involve in their studies".

This approach becomes an emerging set of methods that are extremely diverse, but joined by their ambitions to delete any distinct division between “science” and “art.”

These methods use the artistic process as the main mode of inquiry, creating various forms of art as a way to collect data, conduct analysis, and/or represent social science research [11]. In the past, already, the UNESCO in Road Map for Arts Education [16] agrees that the arts give a useful means of investigation and knowing for everyone.

The common elements between how to work with the arts and how to do research are as follows: a) problem finding, b) definition of a problem through intuition; b) problem shaping, using critical thinking to outline and define it; c) problem solving through a creative solution. The result of this process is that the problem solving is how to create a work of art and vice versa by allowing researchers and/or participants to explore questions and express understandings not necessarily accessible or re-presentable through other means. Therefore, applying this new approach to the student learning process is equivalent to realization of a didactic approach devoted to the development of a new concept of artist-researcher. The last is a purely interdisciplinary figure, who acts on the base of the direct observations of reality. From one side this new role runs away from following just a binary distinction between logic and intuition thinking, and from the other it reinforces itself through a harmonization of functional aspects belonging to both cerebral hemispheres.

3. Conclusions

The STEAM method is the core of the harmonization between logic and intuitive thinking. By promoting the interrelation of math with art and artistic creativity, the learning/teaching process may potentially become more attractive and stimulating. Authors hope, that such feedbacks, that stimulate logic/rational thinking through art from one side, and the artistic creativity, based on a solid mathematical rationing from the other, may essentially favour the inquiry-based learning through the emotional aspect triggering and, thus, contribute to a balanced cerebral development.

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