STEM education and critical thinking training

Science teaching, in its different approaches, must be based on the socio-scientific context and the interests of the students.

by Óscar Eugenio Tamayo

The qualities that determine good teaching and learning processes are many, very diverse and of different nature. Of them all, we are now interested in referring to those directly linked to the relationship between education and context. *Good teaching* is characterised, among other factors, by being contextualised and responding to the students' interests, aspects that must be taken into account by teachers. To understand these multiple interactions, three approaches or movements in science education have gained interest in the last three decades: Science, Technology, Society and Environment (CTSA); Science, Technology, Engineering and Mathematics (STEM), and the latter plus the inclusion of the arts (A) and design as a complementary field to the above (STEAM). (Dori et al., 2018; Tamayo, 2021).

Without going into fine distinctions between these three perspectives, we can point out that they promote, among other things, the incorporation of scientific, social, human, economic, political, ethical and artistic aspects in teaching processes. Furthermore, these perspectives emerge as a rejection of the exclusively centred teaching on the scientific rationality of the different disciplinary fields. In this sense, the teaching processes that are gaining interest are those based on recognising students' interests and the socio-scientific problems inherent to the educational contexts in which the school's training activities are carried out.

THE IMPORTANCE OF CONTEXTS IN EDUCATION

Teaching science from these perspectives requires teachers to transpose or adapt these socio-scientific issues to the classroom. This process requires, in the first instance, a precise knowledge of teaching and learning contexts, as well as of the students' interests and, secondly, an adequate plan of teaching actions based on the recognition of these issues in terms of achieving both specific scientific competencies and others related to the social, human, personal and interpersonal dimensions, among others.

Teaching science from CTSA, STEM and STEAM angles strengthens the links between school science activity and the contexts in which children and young people are educated. These are perspectives that, based on contextualised teaching, contribute to a comprehensive understanding of the socio-educational contexts as well as to the scientific and technological foundations required. To this end, they guide actions in terms of scientific and technical literacy, the formation of scientific, critical and creative thinking and its integration with technology, development of communication skills related to scientific knowledge, improvement of an attitude towards science,

technology and scientific work, in the understanding of the multiple relationships between science, technology, economics, politics and the arts.

STE(A)M PERSPECTIVES AND CRITICAL THINKING

This education focused on recognising socio-scientific problems is teaching-oriented towards the achievement of critical, creative and transformative thinking, which is the school's crucial purpose. Some means to achieve this thinking in teaching are problem-solving and decision-making activities, the use of languages and argumentation, emotions-motivations and metacognition. The integration of these four dimensions acquires the conceptual and methodological particularities of different fields of knowledge: social, human science and natural sciences, arts, mathematics and technology.

Concerning the relationship between STEM-STEAM perspectives and the formation of critical thinking, we would highlight: firstly, the necessary interaction between individual and social processes, both for learning theories and concepts and the development of other dimensions of human and social development; and secondly, the recognition of the context as a starting point for warm teaching processes, in which the design of classroom interventions is based on the recognition of socio-scientific problems and considers, in turn, the transfer of learning achieved in the classroom.
Teaching in a STEM-STEAM perspective is a contextualised teaching that fosters critical and creative thinkers at its end. It requires orienting actions intellectual independence and qualification in decision-making related to the socio-scientific problems transposed for study in the classroom. It requires teachers with the knowledge and metacognitive awareness of their teaching processes. It also demands teaching action planning that articulate context and school in terms of the development of argumentative competencies and the use of technical languages in the studied disciplinary fields; in problem-solving and appropriate and pertinent decision-making; in cognitive and emotional self-regulation at the service of the students' learning processes and their performance as citizens.

Teaching science from CTSA, STEM and STEAM angles strengthens the links between school science activity and the contexts in which children and young people are educated.

Óscar E. Tamayo Alzate. Profesor Universidad de Caldas-Universidad Autónoma de Manizales. Colombia. Leader of the *Cognition and Education* group at the Universidad Autónoma de Manizales. Models and modelling, teaching and learning of science; formation and evolution of scientific concepts; language, argumentation, metacognition in the science classroom; science didactics and formation of critical thinking.

References

Dori, Y. J., Mevarech, Z. Y and Baker, D. R. (Eds). (2018). *Cognition, metacognition, and culture in STEM Education*. Springer.

Tamayo, A. O. E. (2021). Pensamiento crítico en la didáctica de las ciencias. Un modelo para su estudio. En: Alonso, A. y Campirán, A. (2021). *Pensamiento crítico en Iberoamérica: Teoría e intervención transdisciplinar*. México: Editorial Torres Asociados. p 497-512.