Science Technology Engineering & Mathematics (STEM): curricular entanglement and its raising challenges


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THE STEAM APPROACH

We will talk about the STEM educational *approach* by such a name as we lack a more precise one: this proposal was born in the USA and acquired different presentations according to the added discipline or the idea *sold* to the public.

STEM is characterised by promoting an *integrated curriculum* of different scientific disciplines - biology, physics and chemistry, and mathematics - and technical ones - IT, robotics and engineering. It aims at a limited or open dissolution of their boundaries to contribute to solving everyday problems. That is to say, to make them more attractive to the minds and actions of students -from initial levels to higher education- and thus, foster educational innovation and critical thinking.

At least five different presentations have been identified, each incorporating a new discipline or a particular focus: STEM has an *i* added for *imagination* and becomes iSTEM; in the case of STEAM , *art* is added; for ST®EAM robotics is included. The last acronym is the most difficult to decipher, as it changes the symbol - R enclosed in a circle - which stands for robotics and adds an (S) for sustainability. And so, the *supermarket trolley* called STEM is growing according to the disciplines and worldviews encountered along the way.

This educational proposal implies moving towards interdisciplinarity, multidisciplinarity, transdisciplinarity, or integration by breaking down the boundaries between the disciplines that comprise it. It is a situation in which teachers at different educational levels have not been trained for various reasons. Therefore, it constitutes an enormous challenge added to the ones imposed by implementing this educational approach in classroom practice. Moreover, this academic perspective is born of economic and political interests that try to maintain financial leadership and technological innovation through education.

CHANGING WHAT WE DO, A COMPLEX SITUATION TO RESOLVE

Nowadays, technological development, historical, social and cultural dynamics, as well as the production of knowledge itself, demand changes in educational systems. There is a need to move from the individual to the collective. Some have made curricular adaptations to respond to these needs. But still, some teaching traditions are firmly anchored in lecture and rote learning, in addition to inflexible teacher training and school management, which add complexity to their implementation. Changing the “how, what and what for we teach” requires dialogue and articulation between different educational actors, an issue that remains unresolved.

Aquesta proposta educativa implica transitar a alguna forma d’interdisciplinarietat, multidisciplinarietat, transdisciplinarietat o integració.

A curricular challenge is articulating, within each discipline, different concepts, strategies, and ways of learning, harmoniously and profoundly by grade and educational level.

As previously noted, this initiative to generate classroom dynamics that blend knowledge from different disciplines is not new. Attempts have been made to put this integration into action as many teaching professionals do in their work.

In the STEM approach, research results are contrasting. On the one hand, some positions show limitations in conceptualising STEM, implementing it in classrooms, and training teachers to balance the representation of the four disciplinary areas involved. Greater emphasis on science and less on mathematics, for example, has been documented. But, on the other hand, other reports have identified its relevance for building connections between concepts from different disciplines and contributing to solving complex problems.

These contrasting research results are perhaps a call to reflect on what is not working and to discuss and agree on new educational research agendas that respond to current needs, leading to a reconceptualization of STEM.

CHALLANGE FOR EDUCATIONAL RESEARCH

One issue pointed out in the specialised literature is the lack of empirical and sufficiently broad research on implementing this approach in its different interpretations – either interdisciplinary, transdisciplinary, multidisciplinary or integrated. Against this background, there is an opportunity for the community to research such interpretations, documenting experiences in classrooms and teacher training, with methodological rigour and in different educational realities. And to seek a characterisation, based on a theoretical conceptualisation, of proposals for curriculum design and development that integrate various domains of knowledge in a balanced way, accompanied by modifications to teacher training - initial, in-service and professional development-.

CHALLANGE FOR CURRICULUM DEVELOPMENT

A curricular challenge is articulating, within each discipline, different concepts, strategies, and ways of learning, harmoniously and profoundly by grade and educational level. With the STEM approach, the challenge is how to develop a conceptual understanding - basic knowledge - in each discipline; which areas are to be

integrated as interdisciplinary processes and how to develop supposedly generic skills such as critical thinking; but also how to articulate four disciplines, in which whatever is learned in each STEM area is distributed in a balanced way, without one of them being more visible than the others, reflecting multidisciplinarity or interdisciplinarity. That is, reflecting deep connections between disciplines when solving problems or developing projects.

CHALLANGE FOR TEACHER TRAINING

STEM involves the teacher, on the one hand, having general knowledge about each of these areas and, on the other hand, making connections between them. Therefore, it is crucial for teachers in initial or in-service training to experience individually and in groups how teaching content, skills, and ways of thinking from different disciplines interact, how they can support each other, and substantively complement each other.

What stimulating challenges we have to face.

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Recommended reading

Bogdan Toma, R. B., & García-Carmona, A. (2021). "De STEM nos gusta todo menos STEM": análisis crítico de una tendencia educativa de moda. *Enseñanza de las ciencias*, 39(1), 65-80. https://doi.org/10.5565/rev/ensciencias.3093

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