STEM vs. STEAM: More Than Semantics? A Critical Examination of Inclusion of "A" in the STEM Education Acronym

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The debate surrounding the integration of Arts into STEM (mathematics, science, engineering, and technology) education acronym – transforming it into STEAM – is a persistent one within the educational community. Is this mere semantic maneuvering, or does the inclusion of Arts fundamentally alter the original approach to STEM education and outcomes of its students?

This theoretical paper delves into this question, carefully considering the arguments behind STEM vs. STEAM, primarily through a literature review. While the existing body of research directly addressing the core question of STEAM's impact remains limited (e.g., Hussain et al., 2019), we argue that a critical discussion within the MACAS community is crucial. This paper aims to stimulate further research into a nature of STEM and evaluate the potential benefits and challenges of Arts (or other disciplines') integration in STEM education.

To allow for deeper exploration of the attempts to change or extend the acronym, we focus on the Arts. After all, who could argue against enriching school curricula with more Arts education? The Arts are inherently positive, offering avenues for expression, relaxation, and personal fulfillment. Activities like singing, dancing, storytelling, and drawing are fundamental to human nature and often the first activities a child explores. Incorporating the Arts into STEM (creating STEAM) can make complex subjects more engaging and accessible, having an effect of taking a bitter pill covered in sweet chocolate.

The push towards STEAM primarily comes from educators, rather than STEM professionals or researchers. Common justifications include the belief that the 21st-century workforce demands creativity, which Arts education can foster; that integrating Arts can make rigorous STEM subjects more accessible and engaging, potentially broadening participation; and that Arts can infuse a vital humanistic element into what is perceived as a purely technical domain. Proponents also argue that the Arts are increasingly marginalized in curricula, creating a

detrimental disconnect between Arts and STEM fields (Belardo, 2015, p. 0), and that Arts can "re-invigorate the educational platform, providing not only an interesting approach, but also opportunities for self-expression and personal connections" (Land, 2013, p. 548).

However, the arguments against formally adding "A" to STEM are more fundamental, centering on the inherent nature of the disciplines themselves. A central counter-argument is that creativity, aesthetic considerations, and opportunities for personal fulfillment are already, or should be, integral components of STEM education and practice (Aguilera & Ortiz-Revilla, 2021; van Broekhoven et al. 2020). The essence of exploration and discovery, arguably the "bread and butter" of the STEM disciplines, is rooted in imagination and inventiveness.

While teaching STEM concepts through artistic mediums is logical and effective within arts-focused institutions – leveraging students' existing interests – the broader question arises: what does "STEM education" truly entail, and how feasible is its implementation in schools? Simply using examples from the Arts to illustrate STEM principles (e.g., applying dance to understand kinetics and forces, or analyzing geometry used in stage choreography) does not inherently justify expanding the STEM acronym. As Martinovic and Milner-Bolotin (2022) argue, the acronym itself is becoming overburdened, as seen in other proposals to replace letters with different meanings, such as instead of Engineering using Ethics or Environment, adding "A" that could stand for Arts or Architecture; or adding one more "M" to represent Medicine or Management. The core issue lies not in adding or replacing letters, but in better understanding the STEM acronym and the proposition to integrate its core disciplines within education.

This presentation will examine challenges in STEM education, specifically the nature of STEM knowledge and the potential of integrating Arts (epistemology, creativity, engagement). We will analyze mathematics and science curricula, highlighting how traditional STEM education can inadvertently prioritize logic and objectivity while neglecting emotional expression. The often-competitive environment may also hinder positive emotions toward learning and self-confidence. We propose that Social-Emotional Learning (SEL, Ontario Ministry of Education, 2020), is crucial for boosting student engagement and success in this demanding field. Drawing on motivation theories (Hattie et al., 2020), we will demonstrate how SEL cultivates self-efficacy, task relevance, goal setting, and resilience, ultimately leading to more engaging STEM learning experiences applicable across diverse subjects.

We conclude that while Arts integration can be beneficial, STEM inherently possesses creativity, aesthetics, and the potential for positive emotional responses, especially when empowered with SEL. Adding "A" to STEM to address these qualities may be redundant and misrepresent STEM's true nature.

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