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Editorial: STEM: innovation on teaching and learning

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Editorial on the Research Topic
STEM: innovation on teaching and learning

This Research Topic centers on Science, Technology, Engineering, and Mathematics (STEM) education, a model that inspires extensive studies on innovative teaching and learning approaches. Given STEM's alignment with the development of 21st century skills, there is a growing need for additional research to deepen our understanding and improve the application of this model, in formal, non-formal, and informal education.

To address these needs, this Research Topic assembles high-quality studies that focus on STEM education, encompassing both teacher training and students' engagement across educational stages. It aimed to include a broad spectrum of research areas that support effective STEM implementation in classrooms and provide valuable insights into STEM focused educational training experiences. The 10 articles cover a variety of approaches, both qualitative and quantitative, with different types of studies (empirical research, research-action, training, exploration), from five continents and 16 countries. They are organized in four areas, according to the subject or context.

Teacher concerns in STEM education

Evagorou explores how pre-service kindergarten teachers understand and implement STEM education, in a Science Methods Course for Kindergarten. Findings revealed that they were initially unfamiliar with STEM and highlights the need for teacher preparation programs on STEM knowledge and lesson implementation skills. Zhumabay et al. examine the impact of a STEM education course on teachers' self-efficacy and experiences. Data from mathematics master's candidates showed a significant increase in self-efficacy in teaching STEM, with positive feedback on course content, activities, and assignments. Their findings provide insights into designing effective STEM courses and offer practical implications for course development. Lai and Cheng advocate the introduction of engineering into primary science classroom, presenting an innovative pedagogy: the STEM × Play program. Authors study about students' perceptions and attitudes toward learning STEM and teachers' perception of teaching STEM. Results showed students developed skills essential for STEM jobs and its inclusion in the community of practice was important for improving teachers' STEM skills.

Integration of educational technology

Rodríguez investigates the effectiveness and challenges of creating Virtual Reality (VR) based teaching sequences using interactive tools such as Neotrie, with pre-service teachers. The study showed that the integration of VR environments provided teachers a great deal of freedom and flexibility to create VR scenes themselves. Nevrelova et al. analyze the impacts and benefits of Augmented Reality, specifically of Quiver application, as an educational tool in primary school. The conclusions emphasize that the use of this type of application promotes the development of digital literacy of the students, while promoting engagement, motivation and collaborative communication. Debrenti evaluates the effectiveness of game-based learning, comparing the impact of digital and non-digital games on student engagement and learning, in elementary school (9–11 years). The results showed that digital games often led to better student performance, especially in tasks that required logical thinking, while non-digital games offered valuable opportunities for hands-on learning and social interaction. Both modalities should be strategically integrated into math's teaching to address different learning needs and objectives.

Developments in higher education

Fehér et al. investigate the use of propositional logic among university students in different study programs. They found significant differences according to gender, age, type of secondary school leaving exam and parents' highest education level. Mathematics-informatics students achieved the best results, followed by engineering, economics, education, sciences, and humanities students. They also demonstrated that students performed differently in three selected areas of formal logic, with the lowest performance on statement negation tasks. Debrenti and Bordás focus on logical basic knowledge and operations in everyday life, mathematical, physical, chemical, and biological contexts, in a western region of Romania. Their main results showed that daily life problems were solved correctly by the highest percentage of students, followed by problems in biological, physical, and mathematical context. Students were least successful in logical problems related to chemistry. Thus, authors state that semantic content must be considered. Armenta and Dominguez analyze interdisciplinary experiences of twelve university students in a calculus course through three categories: (i) what students think about interdisciplinarity, (ii) how they act when being involved in integrations, and (iii) what external factors are involved in shaping their experience. This work contributes to the understanding of educational interdisciplinary practices in a student-centered perspective, providing empirical evidence of interdisciplinary engagement in a calculus course.

Assessment strategies

Hanauer et al. present a course-based research pedagogy enrolling students in authentic research to enhance learning and persistence in science. A model for assessing students was developed, focusing on four aims: (1) assessing laboratory work and scientific thinking, (2) evaluating mastery of concepts and skills, (3) appraising scientific communication, and (4) fostering metacognition. This model balances feedback and grading to support student engagement without undermining the goals of course-based research education.

The studies in this Research Topic emphasize the actual relevance of STEM Education, highlighting further innovative and interdisciplinary approaches to STEM. Furthermore, it addresses how STEM education relates to the development of 21st century skills, challenges and opportunities. To this end, it is mandatory to continue prioritizing teachers (initial and continuing) training, as well as using inclusive practices in STEM education.

By addressing diverse contexts and using multiple theoretical frameworks, these studies can provide a solid foundation for future research and practice in the STEM Education. We hope that these contributions encourage more innovation and collaboration for STEM Education, necessary to develop innovative solutions to complex and really problems and build a more sustainable and equitable future.

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Conflict of interest

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