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RECEIVED 18 February 2024  
ACCEPTED 04 March 2024  
PUBLISHED 21 March 2024

CITATION  
Chiu W-K, Lam H-M and Jong MS-Y (2024)  
Editorial: Innovations and technologies in  
science/STEM education: opportunities,  
challenges and sustainable practices.  
*Front. Educ.* 9:1387540.  
doi: 10.3389/educ.2024.1387540

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# Editorial: Innovations and technologies in science/STEM education: opportunities, challenges and sustainable practices

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## KEYWORDS

science education, STEM education, education for sustainable development, teacher competency, laboratory learning, pedagogy, innovation, technology

## Editorial on the Research Topic

[Innovations and technologies in science/STEM education: opportunities, challenges and sustainable practices](#)

## 1 Introduction

We are witnessing an unprecedented paradigm shift in the contemporary education system entering a new era of digitalization and artificial intelligence (Dai et al., 2023; Jong, 2023). Recently, the COVID-19 pandemic has further institutionalized the applications of emerging technologies and heightened their roles, accenting the new normal of embracing innovations and harnessing technologies in education (Huang et al., 2022a). The overall picture has revealed novel opportunities for teaching and learning which were not previously evident. This is particularly true in the contexts of science/STEM education where laboratory activities, as well as graphical representations and visualizations of scientific theories, are fundamental and detrimental to the facilitation of teaching and learning (Chiu, 2021; Thees et al., 2021; Wong et al., 2021).

Despite the remarkable advancement of technologies and their emerging applications in teaching and learning, the accelerating tendency of technologization has presented challenges in education (Zhai et al., 2021; Lau and Jong, 2023). For example, effective use of innovative tools and technologies would require educators to genuinely understand the significance of human connection and interaction in classroom teaching. Pedagogic design also demands teachers' professional development of competency and capability to integrate knowledge of different STEM disciplines (Jong et al., 2021; Huang et al., 2022b). Meanwhile, further work is also needed to address various issues, such as promotion of inclusion and equity, development of teaching resources for sustainability, and redefining the roles of teachers and students in science/STEM education supported by emerging technologies. All these opportunities and challenges prompt us to initiate the present collection of Research Topic.

## 2 Emerging themes of the Research Topic collection

This Research Topic was established to collect quality studies related to applications of emerging technologies in science/STEM education, as well as innovations in the teaching and learning of various STEM subjects. Overall, 12 articles contributed by scholars across various countries have been published; the studies involve research review, empirical research, as well as curricular, instructional and/or pedagogical design and implementation. Two prominent themes permeating the included articles are identified: (1) impact of innovations and technologies on students' learning; and (2) teacher competencies and student skills for sustainable development. The sub-sections below present an overview of the included articles.

### 2.1 Impact of innovations and technologies on students' learning

Wick et al. present the use of a binary classification model as a strategy to identify and help under-prepared engineering students in early foundation STEM courses. Student performance data were used to design the model and the interventions were found to achieve an overall improvement for the high-risk engineering students in terms of success and retention rates. Firetto et al. provide another example of innovations and explore the implementation of an online module regarding effective study strategies and its association with better exam performance in an introductory anatomy and physiology subject class. Besides student success, the impact of technologies on students' interest and learning experience in science/STEM education is another high-priority topic in the research agenda in the field. Tablatin et al. investigate the use of Minecraft to cultivate Filipino students' STEM interest and the effects of deploying game-based activities on students' learning experience. Gopabala Krishnan et al. highlight the potential of a graphical user interface tool in simplifying the learning process for students in STEM disciplines. Oss Boll et al. report on the design and development of synthetic biological circuits by 3D printing. The novel STEM educational resources demonstrate its usefulness as a teaching tool to facilitate students' learning and understanding of synthetic biology, a relatively new discipline in science. The work of Doore et al. provides another example of harnessing emerging technologies for graphical representations in STEM education. They report on the design and evaluation of a universally accessible multimodal system for both students with and without visual impairment, in the communication and interpretation of graphical representations.

### 2.2 Teacher competencies and student skills for sustainable development

Teachers' professional development and competencies, as well as students' essential skills such as digital literacy and self-organization of knowledge, have influential contributions to

the sustainable development of education in this digital and intelligence era. Thyssen and Meier report on a comprehensive analysis of teachers' perceptions toward the use of 3D printing technology in classroom teaching in Germany, with regards to skill development and didactic integration of the technology in subject lessons. Li presents the pedagogical frameworks, development and implementation of open education resources to address the issues of inadequate sense of STEM identity among students when teaching foundation computational social science incorporated with data science methodologies and social science theories. Halonen et al. describe the use of AI-directed speech recognition technology in a science education context and analyze its role in the co-construction process in terms of self-organization of knowledge. The work of Liu et al. underscores the need for cross-cultural collaboration and the prominence of innovation mindset for students to address global issues in the future. Their study examines maker education through thematic analysis and identifies key educational themes such as transdisciplinary creativity and skills in relation to sustainability.

In view of the evolving landscape of education with the emergence of new technologies and innovations, periodic review and analysis are necessary and serve as important resources to identify emerging trends and research directions. Muilwijk and Lazonder report on the systematic review of studies comparing virtual and physical investigations, and the relevant findings from the meta-analysis regarding the implications on STEM teachers in the option for virtual or physical investigations. Chakraborty et al. present a bibliometric analysis of prior research attempts in the contexts of key components such as learning methodologies and competencies for the mapping between Industry 4.0 and Education 4.0.

## 3 Conclusion

This Research Topic collection underscores the roles of technologies and innovations in shaping the future of science/STEM education. The diversified perspectives presented in the included studies highlight the importance of continuous efforts and more research investigations to harness innovations and emerging technologies within the contexts of science/STEM education. We hope this Research Topic collection will provide a pathway for ongoing dialogue and further insights regarding the opportunities and challenges of sustainable development in education in this new era, and provoke thoughts leading to future studies of education supported by the emerging technologies and innovations for our next generations to address the global challenges.

## Author contributions

W-KC: Writing – review & editing, Writing – original draft. H-ML: Writing – review & editing, Writing – original draft. MJ: Writing – review & editing, Writing – original draft.

## Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

## Acknowledgments

We thank all the scholars who have contributed to the review process and given valuable comments to the authors.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

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