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# Editorial: Rigorous and high-quality efficacy studies of educational technology interventions

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## Editorial on the Research Topic

Rigorous and high-quality efficacy studies of educational technology interventions

Information and Communications technology has been integrated into education for decades, offering accessible ways to reach resources and revolutionizing the teaching and learning paradigm (Teo, 2009; Wang et al., 2020; Huang et al., 2021). Educational technology (EdTech) provides opportunities to sustain teaching and learning, even in the emergency remote learning settings necessitated by the COVID-19 pandemic. However, the effectiveness of EdTech interventions may differ significantly because various interventions are developed based upon different theoretical frameworks, designed by different engineering teams, used for different purposes, and targeted at different student populations.

This Research Topic provides insights on whether cutting-edge educational technologies from around the world improve outcomes for different types of students in different contexts. It begins with four papers on rigorous efficacy studies of a personalized mobile-assisted system for English grammar learning (Wang et al.), mobile quiz apps with automated feedback (Rüth et al.), a game-based online social-emotional learning program (Li L. et al.), and a Science Notebook in a Universal Design for Learning Environment (Yu et al.). These papers also touch on facilitators and barriers to the implementation of these technologies in various education settings. The special issue continues with papers focused on teacher and student users' digital competencies, experiences with specific technologies, and other factors that influence technology uptake (Li W. et al.; Zhao and Zhao). It concludes with a systematic review of experimental and quasi-experimental studies of digital reading tools aiming to strengthen the design of future EdTech efficacy studies (Ostiz-Blanco et al.). Below we provide a synopsis of each manuscript, emphasizing the main contribution as viewed by the editors.

Wang et al. developed and tested a personalized mobile-assisted system with a self-regulated learning mechanism to facilitate English-as-a-foreign-language students' learning of grammar. Results showed that, for boys and girls alike, treatment students who had full access to the functions of the system obtained significantly higher scores on English grammar tests than the control group who only used the system to submit weekly assignments. Findings suggest the value of supplementary tools that incorporate supports for self-regulated learning, particularly in mobile learning contexts where students work independently from instructors.

Using an experimental design, R  th et al. examined the efficacy of two different types of automated feedback in mobile quiz apps—standard corrective feedback and feedback that incorporates additional information related to the correct response option—in laboratory and real-world settings. Irrespective of feedback type and setting, students' cognitive and metacognitive outcomes increased in the short and long term. Students found both versions of the quiz app interesting and enjoyable to use, indicating that quiz apps can be useful and effective tools to support factual knowledge acquisition and retention.

Li L. et al. examine students' social-emotional skill building during socially isolating and stressful COVID-19 school closures. They describe how a game-based online social-emotional learning program designed for in-person learning was adapted for successful implementation in distance learning settings based on the schools' infrastructure, preparations, and resource availability. Results also indicated that the program was significantly and positively associated with gains in students' social emotional skills.

Yu et al. examine the effect of the Science Notebook in a Universal Design for Learning Environment (SNUCLE) on elementary school students' science academic achievement and motivation outcomes using a cluster randomized controlled trial. Although overall results suggested that students who received the SNUCLE intervention performed similarly to the comparison group, students with disabilities who received SNUCLE had significantly higher motivation and achievement scores than students with disabilities in the comparison group. The SNUCLE intervention is an encouraging example of how EdTech designed with attention to accessibility and inclusion can support some of the most vulnerable student populations.

Li W. et al. investigated how Chinese teachers' digital competence affects online teaching behavior under the technological pedagogical content knowledge (TPACK) framework. Results indicated that the online teaching intentions of educators mediated the relationship between teachers' digital competence and online teaching behavior. Difficulties that students encountered moderated the relationship between teachers' digital competence and their online teaching intention. The authors also shared practical implications for improving

teachers' digital competence, cultivating their intention to use online teaching, and improving students' information literacy.

Zhao and Zhao studied the influence of Chinese faculty's digital nativity and computer self-efficacy on their intentions to use technology in the context of mandatory online learning during COVID-19. Extending the Technology Acceptance Model (TAM), results suggested that digital nativity was a key factor affecting faculty's online teaching and that computer self-efficacy significantly influenced their perceived ease of use. These findings have implications for teacher professional development to help instructors form more positive attitudes toward technology integration, which ultimately means they are more likely to engage in online learning.

Ostiz-Blanco et al. conducted a systematic review of experimental and quasi-experimental studies of digital tools used to improve first-language reading to shed light on features of the most reliable studies. Studies were diverse in sample size, length of intervention, and type of control group. Based on their findings, the authors provided guidance to strengthen future research through better-designed randomized controlled trials, with larger sample sizes, that can show whether the digital tool provides an improvement over the standard classroom education.

Collectively, these articles underscore that there is no one-size-fits-all approach to EdTech. Attending to context and population when designing and implementing EdTech in teaching and learning is critical. This special issue also emphasizes the importance of employing rigorous study designs to best isolate the impact of EdTech interventions on student outcomes. Quantitative impact studies are particularly valuable when coupled with qualitative measures of EdTech implementation, providing insights into what is working well and where there is room for improvement, as well as key leverage points that can support increased and more effective use. These findings on effective technologies and EdTech adoptions in planned remote learning offer useful direction for productive applications of EdTech in emergency remote learning contexts. Further studies in this emergent context are encouraged.

## Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

## 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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