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Letter to the editor

Trends and impact of educational technology in medical education post-COVID-19 in Indonesia

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To the Editor,

The rapid advancement of educational technology (EdTech) has significantly transformed medical education, impacting both undergraduate and graduate levels (1). Integrating digital learning tools, simulation-based training, and artificial intelligence-driven platforms has enhanced the teaching and learning experience, fostering deeper engagement and improved knowledge retention among medical students. Moreover, the post-pandemic era has solidified the role of these innovations, as institutions increasingly embrace hybrid learning models to balance technological advancements with essential clinical training. Medical education has traditionally relied on didactic lectures, textbooks, and hands-on clinical training (2). However, recent trends indicate a shift towards blended learning, where technology complements traditional methods (3). The COVID-19 pandemic further accelerated the adoption of online platforms, compelling institutions to rethink their pedagogical approaches. Virtual reality (VR) and augmented reality (AR) have provided immersive learning experiences, allowing students to practice clinical skills in a controlled environment. Similarly, artificial intelligence (AI) in medical education has shown promise in personalized learning by tailoring content based on students' progress and performance. One of the most significant benefits of EdTech in medical education is the increased accessibility of resources (4). Online platforms and mobile applications have enabled students to access high-quality medical content at any time, reducing geographical and financial barriers to education. Additionally, simulation-based training has proven effective in improving procedural competency and decision-making skills before students interact with real patients, thereby enhancing patient safety. Despite these advantages, challenges remain in the implementation of EdTech in medical education. The digital divide continues to be a concern, with disparities in access to reliable internet and technological devices among students in different regions. Furthermore, excessive reliance on technology may reduce the development of essential hands-on skills and interpersonal communication necessary for patient care. Faculty training is also crucial to ensure that educators can effectively utilize these technologies and integrate them into the curriculum. We reviewed the literature to assess the trends in educational technology adoption in medical undergraduate and graduate education following the COVID-19 pandemic. We analyzed the changes in digital learning strategies, the integration of simulation-based education, and the impact of AI-driven tools across various medical institutions in Indonesia. Reports indicate that online learning platforms were supplementary to conventional medical education. However, during the pandemic (2020-2021), there was a dramatic shift, with over 80% of medical institutions implementing fully online curricula globally. A study from 2021 showed that 75% of medical students reported improved flexibility and access to educational resources, although 40% expressed concerns about reduced hands-on clinical

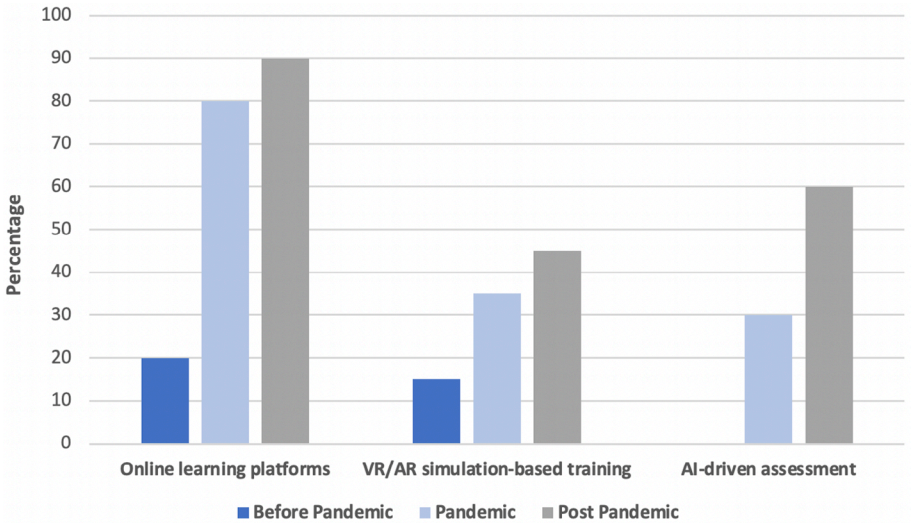

Figure 1. The trends in educational technology adoption in medical education before and after COVID-19 pandemic.

exposure. Post-pandemic data from 2022-2023 suggest that a hybrid learning model, combining virtual learning with in-person training, has become the preferred approach, with 90% of surveyed institutions adopting blended learning strategies. Figure 1 visualizes the trends in educational technology adoption in medical education before and after the COVID-19 pandemic. Simulation-based learning showed a significant increase, with the use of VR and AR tools rising from 15% pre-pandemic to 45% in 2022. Notably, AI-driven adaptive learning platforms gained traction, with 60% of medical schools implementing AI-based assessments and feedback mechanisms. These advancements have contributed to improved engagement and performance in theoretical and procedural skills training.

The shift towards online and hybrid learning models reflects a fundamental transformation in medical education, influenced by necessity during the pandemic and sustained by emerging pedagogical advantages (5). The increased flexibility of digital learning platforms has allowed students to access a wealth of resources at their own pace, contributing to more personalised and adaptive learning experiences. Most of medical students appreciated the flexibility of online learning, while 60% reported concerns about the lack of practical clinical exposure. This highlights the ongoing challenge of balancing technology-driven education with hands-on clinical training. The significant rise in simulation-based learning, mainly through VR and AR technologies, has partially solved these challenges by allowing students to develop practical skills in a controlled environment (6). Studies have shown that VR-based medical training improves procedural accuracy by 29% and enhances decision-making skills compared to traditional methods. The effectiveness of these tools in enhancing procedural competence underscores their growing importance in medical training. However, the cost and accessibility of these technologies may contribute to disparities among institutions, particularly in low-resource settings. The post-pandemic landscape of medical education underscores the necessity for a balanced approach that leverages technological advancements while preserving essential clinical training components. Future studies should focus on long-term educational outcomes and the sustainability of these innovations in diverse learning environments.

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