Transforming STEM Learning: Online Biology Education for Community College and P-TECH Pathways

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Abstract

Online teaching has become increasingly widespread across all levels of education—including K–12, higher education, and professional development—especially in the wake of the COVID-19 pandemic. This rapid expansion has redefined how instruction, collaboration, and assessment occur in digital environments. Community colleges, in particular, play a foundational role in this transformation, serving diverse populations that include traditional college students, adult learners, and high school students participating in Pathways in Technology Early College High School (P-TECH) programs. These P-TECH initiatives create unique opportunities for students to earn college credit and gain exposure to STEM disciplines early in their academic journeys, but they also present challenges in aligning secondary and postsecondary curricula, balancing course rigor with accessibility, and maintaining student motivation and persistence in online learning environments.

STEM disciplines—especially the biological sciences—face additional hurdles when transitioning to virtual instruction. Laboratory-based learning, hands-on experimentation, and real-time peer collaboration are central to developing critical thinking and scientific reasoning skills. Ensuring these experiences remain authentic and engaging in an online setting requires innovative pedagogical design and the integration of interactive technologies.

In this poster, we present a comprehensive set of strategies and best practices for teaching Biology online within a two-year community college framework, with particular attention to courses that also serve P-TECH students. These practices include intentional curriculum alignment between high school and college outcomes, the use of simulation-based and virtual laboratory tools, and the adoption of active-learning methodologies that encourage inquiry and collaboration. Furthermore, we explore how artificial intelligence (AI) tools can be leveraged to personalize learning, automate feedback, and provide adaptive assessments that support diverse learners. Our approach emphasizes inclusivity, accessibility, and academic integrity, fostering an engaging and equitable online learning environment. Through these efforts, we address both the pedagogical and logistical challenges of delivering high-quality STEM education that meets the evolving needs of students in community colleges and P-TECH programs alike.