# Chapter 5
# Bridging the Gap: Integrating GenAI Into Secondary Science Curricula

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## ABSTRACT

*The transformation of science curricula in the digital age requires the integration of advanced technologies such as Generative Artificial Intelligence (GenAI). This chapter discusses the urgency of using GenAI in science education at the secondary level to enhance personalization, scientific simulation, and interdisciplinary collaboration. Despite its significant potential, the implementation of GenAI is still hindered by teachers' digital literacy, infrastructure, and ethical considerations. Global studies highlight best practices that can be adapted through teacher training, smart curriculum design, and the development of AI literacy laboratories as critical and ethical learning spaces.*

The transformation of education in the 21st century requires more than the simple digitisation of learning. While the internet, computers, and multimedia technologies have become widely available, their implementation in classrooms often remains unresponsive to the personalised and contextual needs of learners. The emergence of Generative Artificial Intelligence (GenAI) marks a new phase in the advancement of digital education. GenAI enables multimodal, adaptive, contextual, and interactive

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learning that aligns with the needs of students who live in dynamic digital ecosystems (Luckin et al., 2022; Holmes et al., 2022).

The urgency of this transformation is heightened by global challenges such as climate change, energy crises, and pandemics that have disrupted education worldwide. In this context, the science curriculum must evolve to equip students with the competencies of critical thinking, data-informed decision-making, and innovation in developing science and technology-based solutions (Jayachandran et al., 2024; Musaev et al., 2025).

Integrating GenAI into the science curriculum provides multiple opportunities. Technologies like ChatGPT, DALL·E, and AI-driven simulators can translate abstract scientific concepts into accessible forms of learning. For instance, photosynthesis can be dynamically narrated and visualised at different levels of comprehension, while Newton's laws can be simulated interactively to illustrate force and motion across varied environments (dos Anjos et al., 2024; Moura et al., 2025). Such multimodal approaches have been shown to improve engagement and strengthen long-term retention of scientific concepts. Beyond instructional support, GenAI can serve as a learning partner that provides instantaneous feedback, adjusts the level of difficulty to students' capabilities, and stimulates higher-order thinking through open-ended discussions (Zawacki-Richter et al., 2023).

However, these opportunities cannot be realised without a supportive educational ecosystem. Current barriers include the absence of national policies promoting AI integration, the lack of professional training for teachers, and persistent digital divides, especially in disadvantaged and remote areas (Chen et al., 2023; UNESCO, 2022). Additionally, few pedagogical models have systematically embedded GenAI into instructional design, resulting in what can be described as a "pedagogical gap" between the potential of technology and its effective use in science education.

## CHAPTER ROADMAP

This chapter explores how GenAI can contribute to the transformation of science curricula at the secondary level. It is organised into six main sections:

1. Potentials of GenAI in Science Learning – exploring simulations, personalised learning, and project-based approaches.
2. Curriculum and Assessment Implementation – presenting models for hybrid teaching, authentic assessment, and evidence-based evaluation.
3. Teacher Readiness and Infrastructure – examining literacy gaps, professional training needs, and digital divide challenges.

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