AI IN STEM EDUCATION: WHEN IT WORKS, WHEN IT DOESN'T, AND WHY THE DIFFERENCE ALMOST ALWAYS COMES DOWN TO INSTRUCTIONAL DESIGN

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Technologies such as AI typically enter education systems on two grounds: schools are expected to prepare young people for lives and work shaped by these tools, and new technologies are repeatedly introduced with the promise of improving or optimising teaching and learning. Yet every technology that enables cognitive offloading reopens a fundamental educational question: what should count as knowledge and understanding, what may be delegated to tools, and what must remain part of human learning. Cognitive offloading - the reduction of mental effort through reliance on external supports - is not a new phenomenon; writing, maps, and clocks are among its oldest examples. The question, then, is not only what such tools make easier, but also what may be lost when cognitive work is systematically delegated to them.

Alongside these broader concerns, educators and policymakers face a more practical set of questions: how should such tools be introduced, under what conditions, and with what safeguards? To address these issues, I revisit historical cases of educational technology adoption, drawing on the structural pattern identified by Larry Cuban [1, 2]: initial promise and high expectations, followed by investment and equipment purchases, classroom adaptation or quiet resistance, and ultimately, disappointment or calls for a reset.

In the final section, I present a model for designing and implementing educational innovation grounded in ten years of experience at the Copernicus Science Centre. The model is structured as an iterative process that integrates research, design, and classroom practice: teachers are positioned as co-researchers, students engaged as active participants in testing and refinement, and institutional constraints treated not as barriers but as core design conditions.

[1] L. Cuban (1986). Teachers and Machines: The Classroom Use of Technology Since 1920. Teachers College Press.
[2] L. Cuban (2001). Oversold and underused: computers in the classroom. Cambridge: Harvard University Press. https://doi.org/10.4159/9780674030107