STEM Educational and Didactic Reading Paths with Reasoned AI Integration

Marina B.A. Minoli

Royal Society of Biology, United Kingdom
Biologists Order Federation - STEM DidaInnovaBioLab, EU

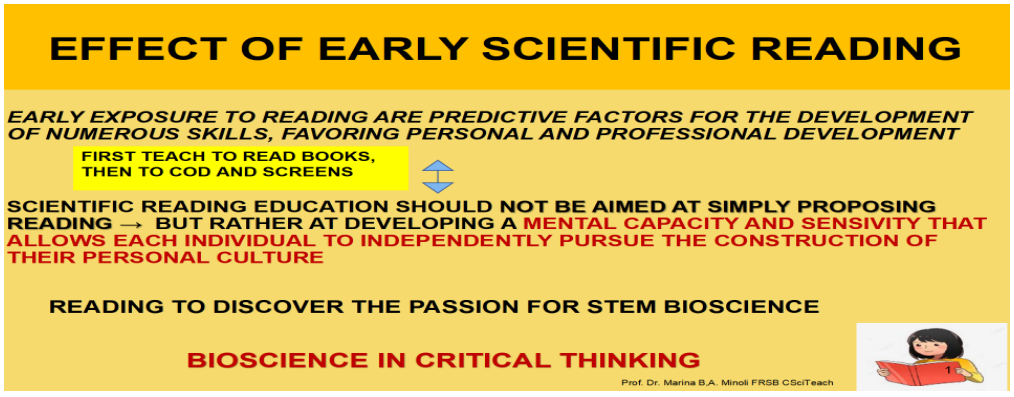
Abstract

The integration of artificial intelligence into STEM reading pathways represents a profound shift in how learners engage with scientific knowledge. Rather than replacing traditional reading practices, AI has the potential to expand and enrich them, transforming the act of reading into a more interactive, adaptive, and conceptually connected experience. Different STEM reading activities were realized at different education levels with the main objective to propose the passion of reading in critical thinking about some scientific discoveries. During the training sessions, detailed answers were provided to these questions: why to realize interdisciplinary book paths in the AI age, how to realize innovative STEM reading education at different levels; which interdisciplinary STEM reading activities with the protagonist reader at the center of the reading process. Some activities realized with the double role of “teacher-educator learning designer ” and of “reader-learning designer” were presented during the 2025 virtual SEB Outreach Event. It was useful for the integration of AI as a cognitive mediator, offering contextual explanations, generating analogies and visualizing complex ideas. AI systems have contributed tailor reading pathways also to individual learners by adjusting complexity, suggesting supplementary materials, and identifying misconceptions. Reading thus becomes a dynamic process that evolves with the learner's needs and pace. At the same time, it is useful to strengthen interdisciplinary thinking, a core dimension of the STEM education. Reading paths with elements of AI, in our context of research and teaching, will be realized to promote future activities not just as technological aid, but as a catalyst for deeper engagement, intellectual autonomy, and innovative learning practices.

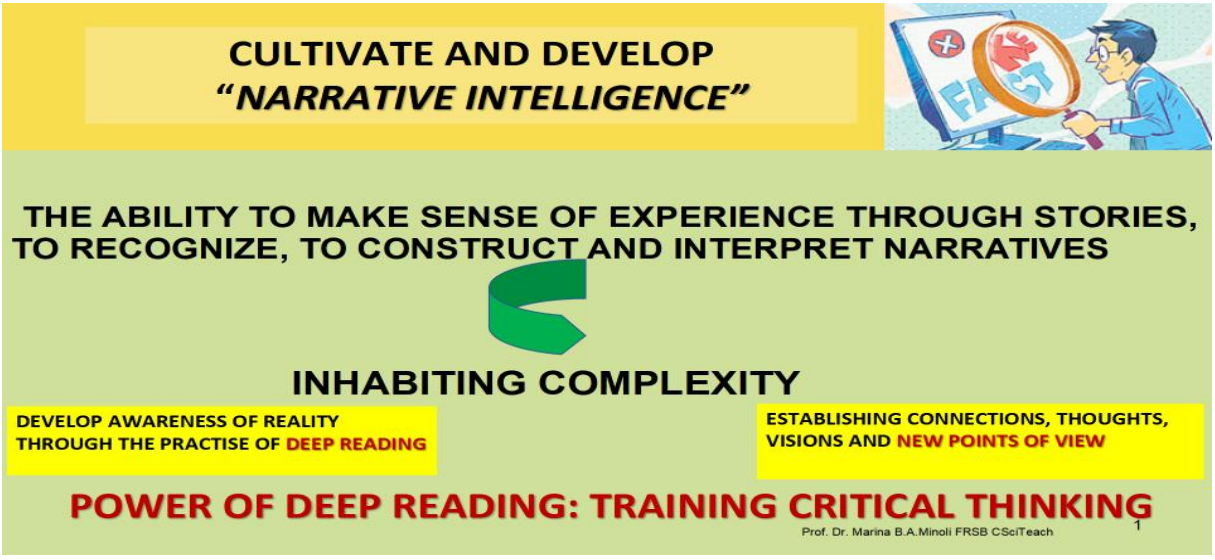
Keywords*: STEM Education; Teacher-learning designer; Student-Learning designer; STEM Books reading paths; AI in Critical thinking*

1. Introduction

The objective of all realized reading activities was to promote interest and passion for the STEM books and critical thinking skills, analyzing in particular the formative effects of an early habit of scientific reading as predictive factors of the development of numerous skills, favoring personal and professional development.
All didactic itineraries organized with high schools teachers and students were presented in two engaging virtual webinars, event disclosed on STEM Learning Centre, YORK; Royal Society of Biology, London; attracting a lot of interest with participants of different countries in the world. Event approved by Royal Society of Biology for 9 CPD points for continuing professional development .
The reading activities implemented across different contexts aimed to foster interest in STEM books and to develop critical thinking skills. Particular attention was given to the formative effects of early scientific reading as a predictor of multiple competencies relevant to personal and professional development.

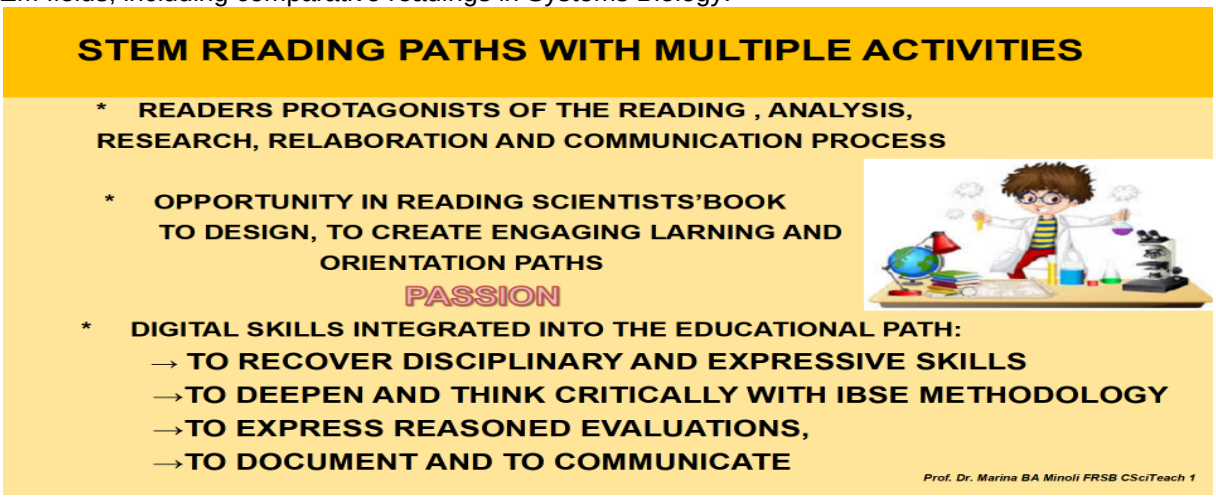


Beginning with an analysis of global reading trends—which reveal significant disparities in the percentage of active readers—the first BioTalk presented the results of activities conducted with high school students motivated to read science books in the era of artificial intelligence. The central question guiding the discussion was: *"What if AI reads and interprets bioscience texts for us?".* The BioTalk introduced the dual role of teachers and students as *learning designers*, presenting reading pathways based on bioscience books such as *The Double Helix* and *The Secret of Life* by James Watson, *King Solomon's Ring* by Konrad Lorenz, *An Immense World* by Ed Yong, and other texts used in different reading projects. A comparative analysis was then proposed to examine reading pathways designed before and after the emergence of generative AI, focusing on methodological and organizational differences in activities involving students, teachers and citizens interested in science. The discussion emphasized that scientific reading should not be offered to young people as a simple, isolated activity. Instead, it should be embedded within structured educational pathways that develop mental capacities, cultural sensitivity and the "narrative intelligence" needed to build personal scientific culture and cultivate a passion for STEM integrated with critical thinking.



2. Methods

The second BioTalk presented a set of reading activities designed to make students *protagonist readers*, improving text comprehension, knowledge retention and operational reasoning skills. Teachers and students explored two key questions through educational pathways based on books written by scientists in biology and STEM fields, including comparative readings in Systems Biology.

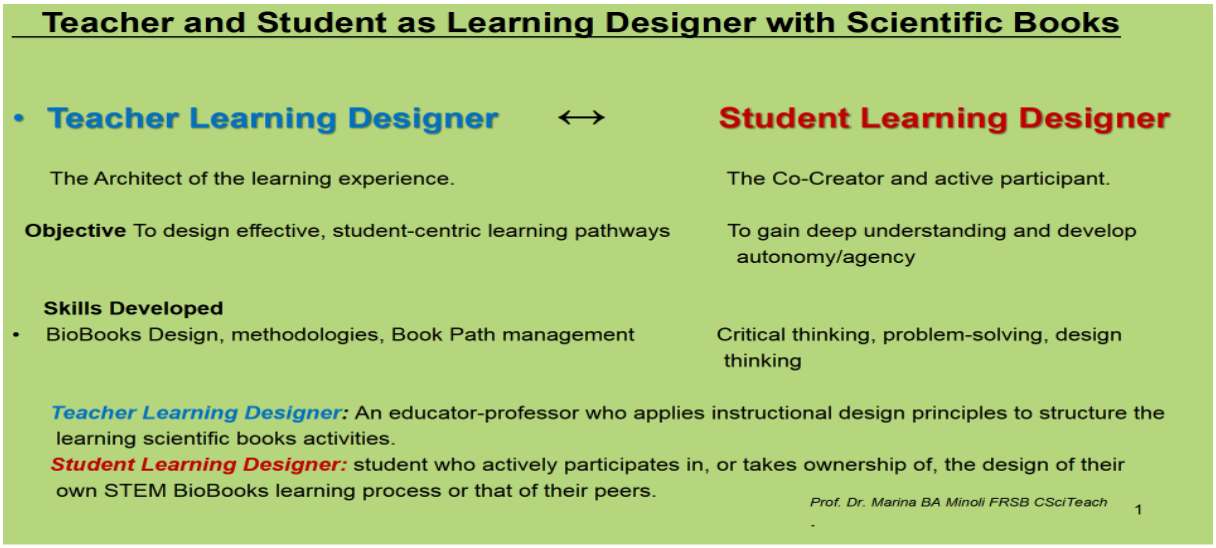


The guiding questions were:

- How to learn science through STEM books

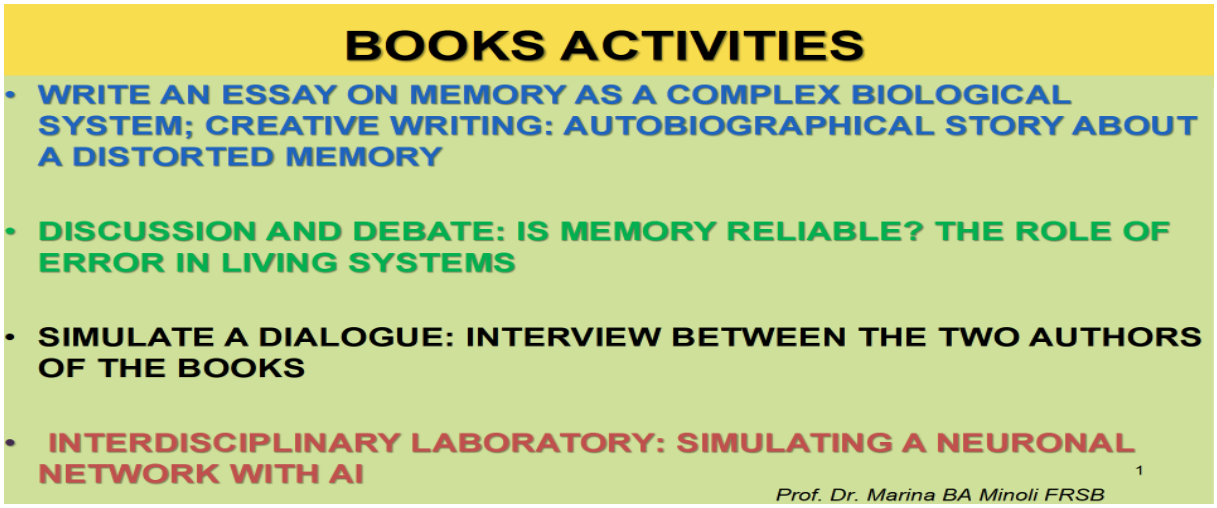
- Why a systemic culture of reading is essential
- Which Systems Biology perspectives support open science
- When to promote curiosity and passion for STEM reading
- Which books foster interdisciplinary STEM contaminations

In all activities, participants assumed the roles of student-designers and teacher-designers. Analysis, comparison, re-elaboration and communication were carried out in an integrated manner with generative AI, while maintaining human guidance at all levels. STEM books were used for individual and group work within a reasoned and interdisciplinary approach, identifying AI as an enhancer—never a substitute—for the work carried out. The selected books addressed themes such as biological memory, information technology, the discovery of DNA, the evolution of molecular biology, botany and astrobiology. For each text, a structured pathway was designed using diverse teaching strategies, including digitalization of final outputs and AI-supported comparison and enhancement. Teachers summarized the educational value of these reading activities for their students.



In reading pathways dedicated to DNA, molecular biology, botany and neuroscience—with particular attention to memory processes—the introduction of generative AI has transformed teaching design into a cooperative, active and critical learning experience that moves beyond traditional disciplinary boundaries. At the level of cooperative working, the reading of scientific popularization texts is supported by digital tools that generate preliminary concept maps on topics such as DNA replication, plant communication or synaptic plasticity. Students compare these maps with their own and collaboratively build a shared representation that integrates scientific knowledge with language, metaphors and cultural references, naturally opening connections with philosophy, the history of ideas and scientific literature. Active and reasoned reading is enriched through contextual digital reformulation offered by AI: complex concepts—such as Epigenetics, long-term memory or adaptive strategies in plants—are rewritten in different registers and linked to real-world issues or humanistic narratives. Molecular biology intersects with ethics (genetic editing), botany with aesthetics (the perception of landscape), and neuroscience with philosophy of mind (identity, memory, consciousness). Students produce critical notes that relate the scientific text to broader cultural perspectives.

Finally, AI becomes a laboratory for argumentative writing and critical thinking, where students design prompts that require the system to take a position on questions that cross science and the humanities: the relationship between nature and culture in memory, the narrative dimension of DNA as an “archive”, plant intelligence as a challenge to anthropocentric models, or the ethical implications of biotechnologies.



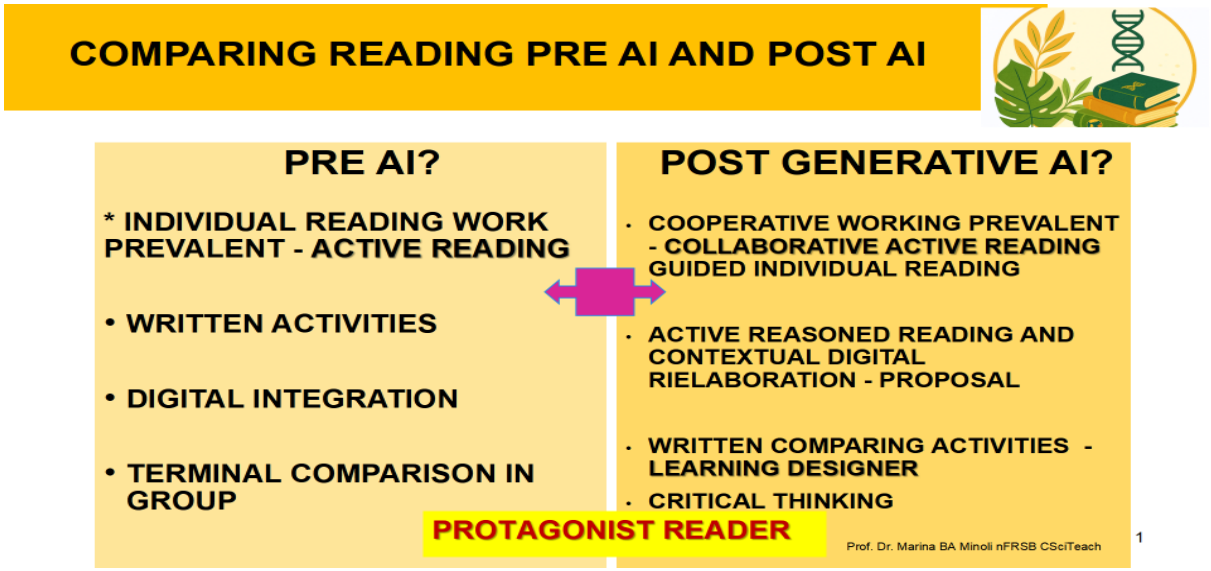
The responses are evaluated according to criteria of scientific accuracy, logical coherence and awareness of cultural bias. In this way, generative AI not only amplifies the understanding of scientific content but also fosters authentic interdisciplinary learning, where biology, botany and neuroscience interact with philosophy, literature, the history of science and ethics, transforming reading into a complex, cooperative and deeply cultural cognitive experience.

3. Results

Teachers were asked to identify differences in their work before and after the integration of generative AI, starting from the difficulties that often discourage young readers from engaging with STEM texts.
Three main differences emerged:

1. Cooperative working – collaborative and guided reading, with increased student participation.
2. Active, reasoned reading – contextual digital reformulations that support comprehension and comparison.
3. Written activities for critical thinking – production of reflective and argumentative texts as learning designers.

Across all classes, teachers observed strong student engagement: independent reading, group work, analysis, evaluation, comparison and communication of results. Students appreciated the integration of AI as a tool for comparing ideas, strengthening intuitions and expanding evaluative thinking beyond superficial approaches.
Notably, students who were initially less interested in reading STEM texts became highly engaged in cooperative reading and AI-supported comparative work. In the final survey, 80% of students expressed very positive opinions, stating that they had the opportunity to read “in a different way,” as active protagonists, encouraged to propose ideas and compare them without fear of evaluation.



4. Discussion

The integration of generative AI into reading pathways dedicated to DNA, molecular biology, botany and the neuroscience of memory has shown—as verified in several reading experiences and classroom implementations—that technology can expand didactic possibilities without ever replacing what remains the true core of the educational process: the teacher's mind, vision and professional judgment. Across multiple reading pathways, it became clear that AI can generate maps, summaries, reformulations and interdisciplinary connections, but it is always the teacher who decides how, when and why these materials become meaningful learning tools. Final evaluations confirmed that students achieve deep understanding only when the teacher guides the process, selects stimuli, frames questions and constructs the interpretive context. AI provides possibilities, but the teacher provides direction, coherence and meaning. Similarly, the cooperative dimension observed in several classes does not arise spontaneously from AI use. It emerges because the teacher intentionally designs situations in which technology becomes a point of comparison, not a source of ready-made answers. Concept maps generated by AI, for example, proved useful only when teachers asked students to correct, discuss and integrate them, transforming them into opportunities for negotiating meaning. Evaluations also showed that active and reasoned reading strengthens when the teacher guides students in critically assessing AI reformulations: distinguishing between accurate explanation and oversimplification, recognizing bias, identifying omissions. AI can propose variants, but only the teacher can help students understand why one version is more rigorous, more coherent or more faithful to the scientific text. Finally, the emergence of authentic interdisciplinary learning, observed in several reading pathways, does not stem automatically from AI. It depends on the teacher's cultural vision, which connects biology to ethics, botany to aesthetics, neuroscience to philosophy of mind and to the literature of memory. AI may suggest connections, but it is the teacher who makes them relevant, profound and educational. The evidence gathered across these reading pathways confirms a crucial point: generative AI can be a powerful amplifier, but never a substitute. The priority remains unchanged: the teacher's ideas, intellectual freedom, critical capacity and creative leadership. Technology can accelerate processes, offer alternatives and generate materials, but it cannot determine what is pedagogically relevant, culturally meaningful or ethically responsible. These decisions belong to the teacher.

Ultimately, generative AI does not diminish the teacher's role; it makes it even more central. In an environment saturated with information, what matters is not producing more content, but shaping thought. And this remains, now more than ever, a human, professional and intellectual act that no technology can replace.

5. **Conclusion**

The experiences carried out in reading pathways dedicated to DNA, molecular biology, botany and the neuroscience of memory clearly show that generative AI represents a major opportunity to rekindle students' passion for formative reading. AI can open spaces of curiosity, make complex concepts more accessible, and create interdisciplinary connections that speak to different cognitive styles. Yet this opportunity becomes real only when AI is embedded within a solid pedagogical framework, guided by what remains the true engine of

learning: the teacher's mind, vision and professional judgment. The teacher is the architect of the pathway, the learning designer who intentionally shapes the learning environment and who—precisely through the conscious use of AI—can transform students into designers of their own thinking, capable of questioning texts, generating ideas, and evaluating responses critically. AI does not replace reading; it revitalizes it. It does not replace the teacher; it amplifies the teacher's impact. It does not replace thinking; it stimulates it, provoking reflection and intellectual movement. The future of education points in this direction: a school where students and teachers remain thinking minds, able to use AI as a tool for exploration, comparison and re-elaboration, without ever delegating to technology the responsibility for judgment, interpretation or deep understanding. Generative AI can become a valuable ally for building richer, more inclusive and more motivating reading pathways. But the heart of the educational process remains human: the teacher's guidance, relational presence and cultural vision. It is this intellectual leadership that allows AI to be what it should be: a didactic and formative support, never a substitute, serving a school that continues to form individuals capable of thinking, interpreting and imagining the world.

REFERENCES

[1]El Fathi, T., et al. (2025). *Integrating generative AI into STEM education: enhancing conceptual understanding, addressing misconceptions, and assessing student acceptance*. Disciplinary and Interdisciplinary Science Education Research.
[2]Otto, S., Lavi, R., et al. (2025). *Human-GenAI interaction for active learning in STEM education: State-of-the-art and future directions*. Computers & Education.
[3] Leon, C., Lipuma, J., Oviedo-Torres, X. (2025). *Artificial intelligence in STEM education: a transdisciplinary framework for engagement and innovation*. Frontiers in Education.
[4]Ajayi, A. (2024). *AI Integration in STEM Curriculum: A Conceptual Model for Deepening Student Engagement and Learning*. International Journal of Advanced Multidisciplinary Research Studies.