Empowering teachers to bring AI into STEM Education

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Abstract

The integration of Artificial Intelligence (AI) in secondary STEM education remains fragmented and limited, largely due to educators' lack of both conceptual AI understanding and relevant pedagogical tools. The European Erasmus+ project AI2Schools aims to address this gap by proposing a structured, transnational strategy for teachers' professional development focused on embedding critical AI literacy across STEM curricula. The training adopts a blended, design-based approach, enhancing conceptual understanding of core AI mechanisms alongside ethical and pedagogical reflection. AI2Schools offers a scalable and pedagogically grounded model for fostering sustained, inclusive innovation in STEM teaching and learning. This paper outlines the structure of the project and illustrates how its vision is implemented in the classroom through a learning scenario. In the presented scenario, teachers guide the students to use AI tools to co-create a podcast that explains scientist's life, discoveries, and impact, while critically reflecting on the accuracy, bias, and ethical implications of AI-generated narratives.

Keywords

AI Literacy, STEM Education, Teacher Professional Development, Generative AI Tools

1. Introduction

The integration of Artificial Intelligence (AI) in secondary schools remains detached from curricular goals and limited to the episodic will and skills of some teachers. As AI evolves from a technological frontier to an everyday tool which plays a key role in culture and scientific advancements, there is a growing need to support educators in becoming agents of this transformation. Different studies highlight that AI education is still at the beginning and the need to develop teachers' competencies: UNESCO discusses both opportunities and barriers to AI adoption in schools [1]; Mikeladze et al. [2] and Tondeur et al. [3] converge on the importance of strengthening teachers' technological skills through clear, research-based frameworks, from general digital skills to those related to AI; Long and Magerko [6] and Touretzky et al. [7] emphasize the absence of coherent AI literacy frameworks and curricular integration, especially in K-12 STEM contexts.

The European Erasmus+ project AI2Schools (KA220-SCH[20] - Cooperation Partnerships in School Education) responds to this challenge by proposing a structured and transnational strategy for teacher training on AI literacy within STEM education. One key aspect of the project is that it brings together universities, schools, and educational professionals . In particular, universities contribute advanced knowledge about AI foundations and tools; schools provide pedagogical expertise and direct classroom contexts. This multi-level collaboration fosters reciprocal learning between teachers and researchers, and supports the design of adaptable and sustainable educational solutions.

The consortium includes the Warsaw University of Technology (Poland), the Pädagogische Hochschule Weingarten (Germany), the University of Padua (Italy) and Edumotiva (Greece) with four partner schools, one in each country, respectively Zespół Szkół nr 2 im. Eugeniusza

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Partners collaborate to design interdisciplinary, project-based programs grounded in the STEM approach, enabling teachers to integrate and apply AI concepts and tools across diverse educational contexts. In doing so, they must identify both the challenges and the potentials associated with the implementation of AI in schools [4]. This vision is supported by recent documents and frameworks such as the EU DigComp 2.2 [9], the UNESCO's guidance for policymakers [10], and the AI Competency Frameworks for Teachers and Students [11,12]. AI serves not only as a medium for enhancing teaching and learning but also as a technology that demands ethical awareness and responsible use, reshaping what students need to learn and how they learn [13].

The AI2Schools initiative is based on four key objectives:

1. To help both educators and learners understand the core mechanisms of AI, such as data, algorithms, and machine learning, and improve their digital competences.
2. To enable teachers to implement an AI Curriculum in their schools, designed specifically for secondary education.
3. To develop students' critical thinking and ethical reflection on AI's role and impact in society.
4. To foster the continuous professional development of teachers and enhance the international dimension of the teaching profession.

Ai2Schools presents AI as both a subject and a methodology: a field of knowledge, a cross-cutting skill, and a mean for critical reflection.

Furthermore, the project specifically aims to promote gender equity in AI and STEM education, in line with UNESCO's recommendations [5]. Learning scenarios and teacher training incorporate strategies designed to challenge stereotypes and encourage inclusive participation, particularly among girls.

2. Teacher training design: from awareness to implementation

AI2Schools has developed a training strategy to support secondary school teachers in becoming confident and critically engaged facilitators of AI education within STEM subjects. The program enhances teachers' roles as curriculum designers, inclusive educators and reflective practitioners who can meaningfully embed AI into their teaching practice.

The program does not focus merely on technical proficiency; rather, it supports teachers in developing a conceptual understanding of AI, such as how machine learning works and how data influences algorithmic output, while also addressing the pedagogical, social, ethical implications of AI use in schools. This approach is supported by a recent systematic review by Casal-Otero et al. [14], which highlights the importance of combining conceptual understanding with reflective and design-based strategies for AI literacy in K-12 education.

To this end, teachers engage in a blended training pathway that combines a self-paced online course with face-to-face workshops in Italy and Poland, and a summer school in Greece. These formats allow teachers to engage both individually and collaboratively with AI concepts, explore educational tools such as natural language processing systems and generative AI, and reflect on their relevance to STEM curricula. Particular attention is given to the risks of bias, issues of source reliability, and the role of AI in knowledge construction and communication. AI2Schools training model integrates classroom experimentation as a core element of the process. Teachers are invited to implement and adapt projects and learning scenarios, developed by Universities and educational organizations, with their students aged 13-17. This design-based and iterative approach [16] allows teachers to tailor activities to their specific subjects and learner groups, aligning it with specific subject goals and student needs. In this way, teachers are not passive recipients of predefined content, but active implementers and contributors. The training promotes active experimentation,

pedagogical reflection and ownership of AI education practices, supporting teachers agency and creating the conditions for meaningful and sustainable innovation in STEM education.

3. From frameworks to practice: designing AI learning scenarios

Integrating AI into school education requires teachers to develop new professional knowledge and adopt appropriate methodologies for teaching STEM subjects. The AI2Schools project supports this shift by using a combination of conceptual and methodological frameworks to inform the design of its training activities and teaching resources. Most existing training programmes for teachers are either tool-oriented (e.g. using ChatGPT in class) or overly technical. What is needed are accessible, pedagogically sound frameworks that explain the core mechanisms of AI (e.g. algorithms, data, models and learning processes), encourage critical and ethical reflection, and align with school subjects and real-world issues.

The first outcome of the project is the learning scenario ***STEM Voices***, developed by the authors as a prototype of classroom practice aligned with this vision. Implemented as part of the teacher training programme, this learning activity allows educators to experience and reflect on AI-enhanced pedagogical approaches before applying them in their classrooms. In *STEM Voices* students interact with an AI tool, providing materials, interacting, and instructing it to create a podcast in which a historical STEM figure, such as Ada Lovelace, Alan Turing or Marie Curie, recounts their life and scientific contributions, explaining the theories and discoveries that underlie the subject matter being studied.

Avatars have long been used in education, evolving from the use of simple lifelike characters that significantly boost student engagement and perception [19], to recent studies that have started to investigate the integration of generative artificial intelligence into virtual characters. For example, research includes immersive learning system that uses large language models and virtual avatars to simulate accurate conversations with historical figures [17] or 3D avatar companions that act as interactive tutors to improve student engagement in mathematics learning [18]. In our scenario, instead, students actively build the script of the avatar by interacting with a chatbot rather than passively listening to predefined sentences. To produce this podcast, students use AI tools (such as Google NotebookLM, or similar tool of other companies) to provide curated source materials, generate summaries, design effective prompts, and create AI-assisted scripts and audio content through four sessions that combine scientific research, storytelling and ethical reflection. It involves research and curation, interaction with AI, podcast production and critical evaluation.

This scenario serves as a concrete and adaptable model of how teachers can integrate AI literacy into STEM subjects while fostering engagement, creativity, and inclusion. It translates the project's pedagogical foundations into classroom activity and supports both teachers' and students' development of critical AI competences, integrating principles from digital competence frameworks [7, 9, 10, 11, 12] and STEM/STEAM pedagogies [4,13]. It emphasizes the importance of educators moving beyond simply the use of AI tools to the developing of a deeper understanding of AI systems—their limitations, ethical implications, and influence on knowledge. At the same time, it draws on hands-on, project-based, and interdisciplinary approaches that encourage learners to engage with AI both as a subject of exploration and as a tool for creative problem-solving and reflection.

In designing STEM Voices, three interrelated perspectives were adopted:

- **AI literacy as a socio-technical competence**: we promote a vision of AI literacy that extends beyond technical knowledge to include ethical reasoning, design practices, and critical interpretation [6,7,14]. In this scenario, students explore mechanisms such as natural language processing and prompt engineering while reflecting on the credibility, bias, and authority of AI outputs.
- **Narrative and identity in STEM education**: research in Science Education has shown that storytelling can foster deeper engagement and support learners by connecting scientific content to personal meaning and human experience particularly among underrepresented

groups. By reconstructing historical narratives through AI, students are invited to consider issues of voice, representation, and diversity in science [5,13].

- **Design-based and reflective learning**: students co-construct content with AI iteratively, refining their prompts, and critically reflecting on the technology affordances and limitations. This constructionist and design-based learning approach supports students' agency and metacognition by encouraging them to engage in cycles of creation, reflection and improvement to develop their knowledge of both: subject matter and AI mechanisms [16].

Together, these principles align with the EU's vision of digital education as a pathway to inclusion, innovation, and civic agency [15].

4. Learning scenario: *STEM Voices*

STEM Voices is a classroom scenario which follows the pedagogical framework designed in an earlier phase of AI2Schools. The Ai2Schools framework identifies four key dimensions of AI education to be addressed through teaching and learning. These include a human-centered mindset, understanding of AI techniques and applications, system design, and ethical reflection. The plan of activities is structured in four sessions, each dedicated to one of these dimensions. Together, they guide learners in creating an AI-assisted podcast, supporting interdisciplinary, reflective, and inclusive engagement with AI.

The scenario aims to make AI education accessible, interdisciplinary, and ethically grounded:

1. **Human-Centered Mindset** - Students select a significant historical STEM figure (e.g., Ada Lovelace, Marie Curie, Alan Turing…) and curate a diverse collection of resources, including biographies, scientific articles, theory explanations, and interviews. The goal is to develop historical awareness and empathy while exploring the societal impact of scientific discovery. This choice foregrounds narrative, identity, and cultural relevance, helping students connect with science through personal and social lenses.
2. **AI Techniques and Applications** - Using a Natural Language Processing (NLP) tool, students prompt the AI tool to analyze their curated documents, generate timelines and thematic maps, summarize theories, and even simulate explanations from the perspective of the scientist. This session introduces students to core AI mechanisms such as NLP and data modeling. In doing so, students actively learn to evaluate sources, control data inputs, and assess AI outputs, skills essential to AI literacy, but also deepens scientific content by reframing it in their own words and through AI mediation.
3. **AI System Design** - Students design prompts to instruct the AI tool in generating a podcast script that tells the story of their chosen scientist. They experiment with tone, voice, and structure, and use text-to-speech synthesis to produce an audio file. This stage emphasizes how input design influences AI output. It empowers students as content creators and illustrates the role of design in shaping communicative and technical outcomes.
4. **Ethical Reflection** - After listening to the AI-generated podcasts, students critically evaluate the accuracy, completeness, and possible biases in the narratives. They reflect on the implications of allowing AI to "speak for" historical figures and articulate the responsibilities involved in science communication through AI. The final reflection connects AI literacy with digital citizenship and helps students interrogate the authority and limitations of generative systems.

4.1. Creating Podcast with AI

The podcast production activity in the *STEM Voices* scenario is supported by the use of NotebookLM, an AI tool developed by Google. NotebookLM allows users to upload and organize a personal library of documents such as articles, biographies, and notes, and interact with the material through AI-

powered summarization, explanation, and content generation. This tool is particularly suitable for educational contexts, as it enables students to work with curated knowledge and learn to prompt the AI meaningfully within a bounded information space.

To create the podcast, students need to follow these steps:

- **Step 1: Access the tool** - Log in to https://notebooklm.google with a Google account. Teachers may provide a shared account if needed.
- **Step 2: Add a new notebook** - Students click on "New Notebook" and give it a name related to their project (e.g., *Marie Curie*).
- **Step 3: Upload sources** - Students upload selected documents into the notebook. These can be PDFs, text files, transcripts, or links to websites. The platform also supports Google Docs, presentations, and YouTube links.
- **Step 4: Ask questions and interact** - NotebookLM provides a dedicated chat space where students can read a summary of their sources and interact with uploaded documents content using natural language prompts. This chat field allows them to ask specific questions or request summaries based solely on the content in their notebook. For example, they may ask, "What are the main scientific contributions of Marie Curie?" or "Create a timeline of Curie's discoveries." Once a useful response is generated, students can save it as a note within the notebook, transforming the AI's output into a structured reference. These notes then become part of the knowledge base they will draw upon to create the podcast script.

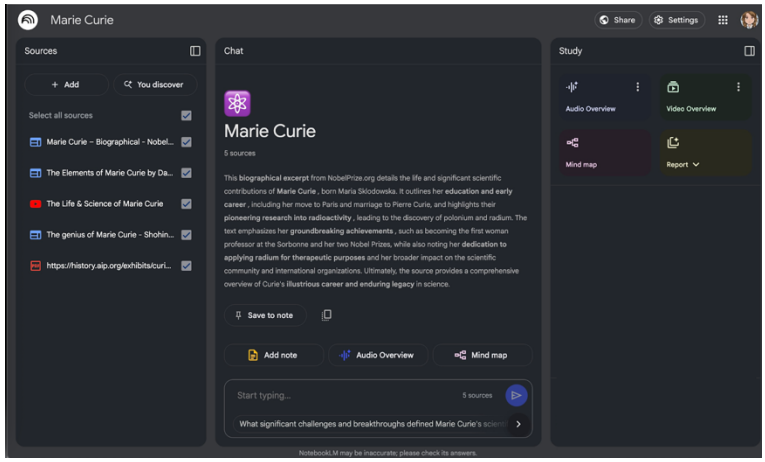

Figure 1: Integrated chat interface

- **Step 5: Generate a podcast** - Students use the Audio Overview feature in NotebookLM to generate a spoken summary of the key topics in their uploaded sources. This tool creates a conversation-style narration between AI hosts, based solely on the documents selected. Students can customize the overview by choosing its length (Shorter, Default, or Longer) and by entering a guiding prompt to focus on specific themes or control the level of detail. For example, they might write: "Create an audio overview where the AI hosts interview Marie Curie's about her main discoveries and why they matter today, in a tone suitable for a school podcast." The generated audio can be played directly in NotebookLM, shared or downloaded. Teachers support students in writing effective prompts and reviewing the accuracy and clarity of the result, using the overview as a reflective moment before drafting their own podcast content.

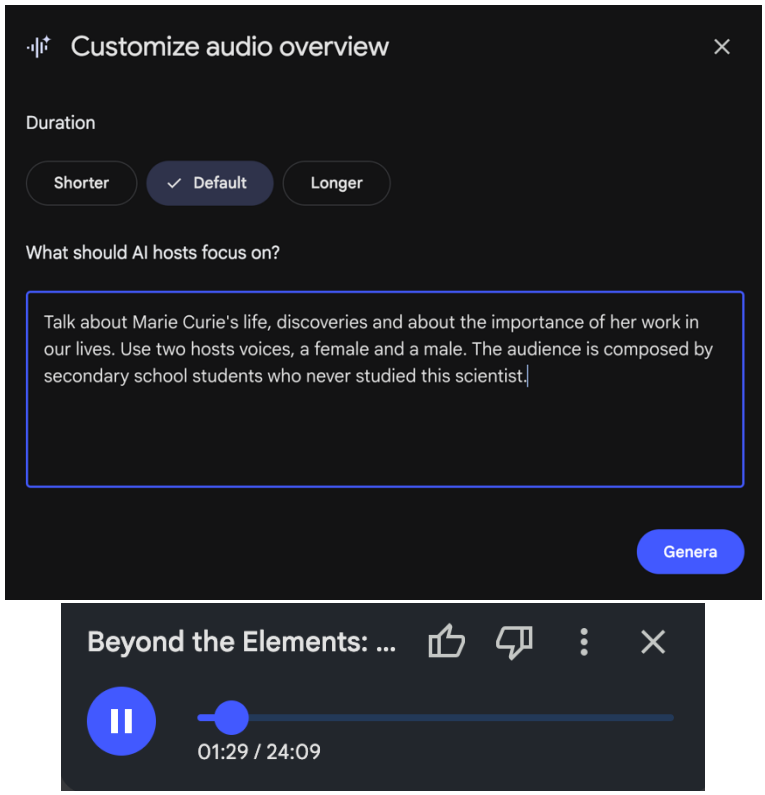

Figure 2: Audio Overview generation control panel and audio playback bar

Summarizing, the main steps and the roles for both students and teachers are the following:

1. **Selection and Research**: Teachers present a curated list of significant STEM figures and explain the research task. Students select a figure and collaboratively gather documents (biographies, articles, videos, scientific explanations) which are uploaded into a shared knowledge repository to serve as the foundation for AI interaction.
2. **Knowledge Processing with AI**: Teachers introduce NotebookLM and model how to prompt the AI to extract structured information. Students experiment with prompts to generate summaries, timelines, and thematic maps, refining their understanding of the scientific content and its historical context.
3. **Prompt Design and Script Generation**: Teachers guide students in analyzing examples of effective prompts and support them in drafting prompts tailored to generate a podcast script in the first person. Students design and refine their prompts, iteratively shaping the voice, style, and structure of the script in collaboration with the AI tool.
4. **Podcast Production**: Teachers introduce a text-to-speech tool and assist students in selecting voice settings. Students finalize the script and generate the audio file, producing a podcast episode that combines storytelling, scientific content, and generative AI.
5. **Ethical Reflection and Evaluation**: Teachers facilitate a classroom discussion to reflect on the reliability and ethical implications of AI-generated narratives. Students evaluate the podcast for accuracy and bias and write personal reflections on the experience of having AI represent historical voices.

Throughout the whole process, students engage with AI as both a learning tool and an object of inquiry. They develop essential skills in source evaluation, prompt engineering, and critical thinking—core components of AI literacy. At the same time, they deepen their understanding of STEM contents by rearticulating complex theories through digital media.

For teachers, *STEM Voices* offers a rich professional development opportunity. It exemplifies how to design interdisciplinary, project-based lessons that embed AI literacy into existing STEM curricula. Moreover, it provides a model of how to shift the role of AI in the classroom from a tool for automation to a partner in critical thinking, co-construction, creativity, and ethical reflection.

By integrating *STEM Voices* and similar scenarios into the training pathway, AI2Schools fosters a professional identity in which teachers feel confident to address AI not only as a set of tools, but as a cultural and ethical domain of inquiry. This alignment between professional development and classroom practice is key to scaling innovative, inclusive AI education ensuring both scalability and pedagogical depth.

5. Conclusion

AI2Schools project suggests that it is both possible and necessary to design meaningful AI education that empowers teachers and engages students across disciplines. By embedding AI literacy within STEM curricula, the project promotes an epistemological shift: AI is not a magic box, but a socio-technical system to be explored, shaped, and questioned through education. In this vision the relation between AI and education is technologically informed, ethically aware, and pedagogically grounded.

The *STEM Voices* scenario exemplifies this approach: it supports interdisciplinary learning, develops students' understanding of core AI mechanisms, and fosters critical reflection on how knowledge is constructed and communicated. For teachers, it serves as a powerful professional development tool that bridges innovation with curriculum relevance.

By situating classroom experimentation within a coherent training strategy and open access resources, AI2Schools creates the conditions for sustained, inclusive, and scalable AI education. It offers not only tools, but also a shared framework and community for reimagining the role of AI in the future of teaching and learning.

Declaration on Generative AI

During the preparation of this work, the authors used ChatGPT-5 and Deepl in order to: Grammar and spelling check. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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