

Generative AI Unlocks the Power of Interactive Storytelling for Science Teachers and Learners

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Abstract

The National Science Board highlights the importance of STEM education to human flourishing. To address the need for increased student achievement and broader participation, EngageAI explores generative AI's potential to create engaging science learning experiences. Building on narrative-centered learning, EngageAI develops AI-powered interactive stories where students apply STEM concepts to solve realistic problems. Generative AI enables the creation and adaptation of these stories, including plots, characters, and dialogue, tailored to specific curricula and classrooms. EcoJourneys, a sample product, immerses students in a scenario involving a failing fish farm ecosystem. Classroom studies evaluate engagement and learning, analyzing collaborative learning. Recognizing the need for readily accessible tools, EngageAI is developing SceneCraft, which allows teachers to create short, interactive story-based lesson starters using AI prompts. SceneCraft places the teacher in control and in the loop. This research aims to boost engagement in science learning by empowering teachers to create customized, interactive learning experiences. SceneCraft will be widely available in the 2025-2026 school year.

Introduction

In its report "Vision 2030," the National Science Board (NSB) calls attention to the importance of science education to the future of the United States's economy, scientific progress, and national defense (NSB, 2020). To overcome stagnation in US students' Science, Mathematics, Engineering, and Technology (STEM) achievement scores and the breadth of participation of citizens in science, NSB states: "Improving K-12 student performance in STEM will require mechanisms to bring the best research-based STEM pedagogy and practices to the classroom in every school in the country."

Over decades, the best research-based pedagogy has shifted from (a) transmission of facts and theories to (b) hands-on and lab-based science to (c) learning these specifics of science in the broader context of cross-cutting scientific concepts and inquiry practices while also nurturing students' STEM identities and sense of belonging— that is, helping students see themselves as people who can do science, whether as a career or as informed citizens. One influential summary

of the research, ICAP theory (Chi et al., 2018), states that students who learn via interactive, highly engaging pedagogies learn more than students who learn via more passive or less engaging pedagogies, thus focusing attention on cognitive engagement and collaborative learning. Yet, it is difficult for individual teachers to design classroom materials and activities that achieve the right levels of cognitive engagement and student collaboration. Our NSF-funded AI Institute, the NSF AI Institute for Engaged Learning ([EngageAI](#)), investigates how to use generative AI to create materials and supports that hit the mark for cognitive engagement and collaborative inquiry.

Generative AI for Cognitive Engagement in Science Stories

Our institute's approach builds on a long-standing research subfield called "narrative-centered learning" that has investigated the use of AI both before and with generative AI. The central idea is that AI can power the creation of interactive stories in which students play a leading role in applying STEM concepts to solve realistic problems introduced through the narrative. The institute's AI-driven classroom materials enable students to interact with virtual characters in an experience driven by a plot, allowing students to navigate particular scenes of the unfolding story and placing them in dialogue with each other and virtual characters. The plot motivates students with an issue or challenge to solve by gathering and analyzing information using scientific inquiry processes. The bottom line commitment is stronger engagement in science learning via student participation in interactive stories, an approach supported by prior research (Lester et al., 2014).

What can generative AI enable? In short, creating coherent interactive stories for all the curricula, classrooms, and community contexts in which students learn is expensive. Generative AI is a story machine. Below, we give examples from EcoJourneys, one of the institute's products (see Figure 1). Early in the EcoJourneys storyline, students travel to a fictional island in the Philippines, where they encounter a dilemma: a local fish farm is reporting that tilapia are falling sick at an alarming rate. This science inquiry-based problem-solving scenario centers on ecosystems, moving from understanding relevant system components, processes, and mechanisms to more complex ecosystem interactions.



Figure 1: A scene from EcoJourneys, an interactive narrative-centered learning environment

In the case of EcoJourneys and other similar story environments, Generative AI can help by:

- Aiding instructional designers in creating overall plots with multiple scenes to fit the specific needs of a particular curriculum or classroom.
- Supporting graphic designers in producing or refining characters and art for the experience, for example, shifting from a tropical island to an inner city hospital.
- Enabling virtual characters to participate in context or learner-specific story adaptations to scaffold student problem-solving as interactive narratives unfold.
- Supporting adaptivity to students' strengths and needs as the experience unfolds.
- Allowing scientists to analyze the multimodal data that results as students interact with this complex environment to improve the experience for future classrooms.

To determine if this approach is successful, the EngageAI team is conducting classroom studies in which both engagement and student learning are measured. The studies include analyses of the collaborative learning process to improve the materials and pedagogy. Building on the NSB's recommendations cited above, the studies attend to learner variability so that the team can understand for whom and under what conditions the stories can be made more effective.

What is different about this approach? In a phrase, interactive stories have greater opportunities for deep cognitive and socio-emotional engagement in scientific concepts and practices than traditional lessons or labs. In traditional practice, teachers create lesson plans and then deliver the plan to the classroom. Indeed, generative AI is becoming more widely used to help teachers create or customize lesson plans. Yet the output of this use of AI is still a traditional lesson plan, with traditional activities like lectures, problem sets, and discussions. These forms of activity often do not rate highly in terms of the ICAP framework. In EngageAI's vision, teachers create interactive story-based activities. Although a lesson plan is still needed, the centerpiece activity now includes role play in motivating stories with characters and dialogue. The plots can be adjusted to feature different aspects of scientific inquiry, such as exploring phenomena and generating questions, planning data collections and analyses, discussing interpretations, and developing explanations.

SceneCraft: School Implementation and Policy Implications

The research of the EngageAI institute is primarily concerned with extensive curricular stories that will enable the broadest expression of the narrative-centered learning idea as well as broad investigations that advance knowledge of how interactive collaborative learning works.

Meanwhile, the institute team has recognized that schools, teachers, and classrooms are slowly adopting large changes (i.e., a week or more of new curriculum). Thus, we are simultaneously developing a minimal viable product (MVP) that educators can more easily incorporate into their existing curriculum materials and lesson plans. The focus of the MVP is a tool called SceneCraft (Kumaran et al., 2023).

SceneCraft is a tool that allows a teacher to write a "prompt" to create or customize a short interactive story which will be delivered as a set of interactive two-dimensional (cartoon-like) scenes giving students choices and immersing them in the topic. The intention is to provide teachers with the ability to create lesson starters that engage students for 7-10 minutes. An

interactive story can engage students around the topic of the lesson, help them take on appropriate roles, activate prior knowledge they will use, and stimulate their initial thinking about the topic. Many lesson plans have warm-up activities, and our Practitioner Advisory Board has suggested that many teachers would welcome the use of generative AI that helped them engage their students without requiring major changes over the course of days or weeks of instruction.

A major policy concern is the ethical use of AI, and to this end, SceneCraft focuses on involving the "teacher in the loop" of all instructional decisions (US Dept of Ed, 2023). After writing a prompt, the teacher can review an AI-generated plot overview and make changes as needed. The teacher can also choose characters and background settings for the art, preview the instructions for each scene and the character dialogue, and make any necessary edits.

Another ethical consideration is data collection. Except in schools where the Engage AI team has Human Subjects approval to conduct research as well as appropriate participant consent, the software will not collect any identifiable data and the plan for storing usage data is very minimal. We will, of course, invite teachers to submit ideas for improvement as well as involve our Practitioner Advisory Board throughout the process.

Conclusion

In the United States and worldwide, there is a broad need to increase student cognitive engagement in science learning. Generative AI is already being used by teachers to create variant lesson plans, but the classical components of a science lesson plan do not create high cognitive engagement. Interactive stories do lead to high student cognitive engagement in science learning—but are expensive to make and difficult for teachers to customize. Generative AI can empower teachers to incorporate custom interactive stories that support their local contexts, student identities, pedagogy, and curriculum, thereby increasing their students' engagement in appropriate roles, concepts, and practices for their classroom. Our SceneCraft-based scale-up will be available nationwide in the 2025-2026 school year, and the research program on narrative-centered learning continues through the Institute's full range of research activities. To be notified when SceneCraft and other EngageAI products are available, readers can provide their email address at <https://engageai.org/get-involved/>

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