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SCENECRAFT: Empowering Teachers to Drive Narrative-Centered Learning for Middle School Science

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Abstract: SCENECRAFT is an innovative online application designed to enable middle school educators to create immersive, narrative-centered learning experiences in science education. Leveraging large language model (LLM) technology, SCENECRAFT prioritizes teacher-in-the-loop pedagogical decision making, empowering them to author interactive scenarios aligned with principles of narrative-centered learning and case-based reasoning. With its adaptive authoring capabilities, SCENECRAFT allows educators to craft 2D or 3D scenes that incorporate narrative elements, character interactions, and real-world challenges.

Introduction and context

Narrative-centered learning environments (NCLEs) have been recognized to enhance student engagement and understanding, particularly in STEM education (Plass et al., 2015; Saleh et al., 2020). By embedding concepts within compelling narratives, NCLEs provide relatable contexts for learners to explore ideas, grapple with consequential stakes, or investigate phenomena (Mott et al., 2019). The narrative structures inherent in NCLEs not only immerse students in story-driven learning but also establish meaningful contexts that anchor abstract concepts to real-world applications. This helps learners connect to the content and ideas, fostering curiosity and sustained inquiry.

In addition to their narrative affordances, NCLEs create ideal conditions for learners to engage in case-based reasoning (Kolodner et al., 2003). Within NCLEs, narrative scenarios can function as cases, encouraging learners to draw upon prior knowledge, past experiences, and analogous situations to analyze and address challenges. According to case-based reasoning, cases represent individually interpreted versions of one's experiences, forming the foundation for a repository that an individual can reference when encountering new problems (Tawfik & Kolodner, 2016). Foundationally, NCLEs represent potential to this repository by presenting learners with authentic, relatable scenarios that promote the development of reasoning skills, understanding, and problem-solving (Jonassen & Hernandez-Serrano, 2002). Furthermore, the interactive nature of NCLEs arguably enhances case-based reasoning by allowing learners to explore multiple perspectives and outcomes within a single narrative (Rowe et al., 2011). Through branching storylines, learners are invited to test hypotheses, reflect on their decisions, and adapt their approaches based on the consequences they observe (Mott et al., 2019). This iterative process not only reinforces concepts but also mirrors real-world decision-making, where individuals must navigate ambiguity and draw upon their accumulated knowledge to resolve complex issues. In this way, NCLEs and case-based reasoning can work in tandem to create rich, impactful learning experiences.

One of the challenges in designing deeply relatable narrative-centered environments is that these experiences often depend on locally specific information about learners' interests, contexts, and motivations. As a result, when classroom teachers aim to create narrative scenarios that align with their students' experiences and interests while connecting to content, they often default to text-based cases or stories. While effective, such cases fail to fully leverage the capabilities of today's immersive, visually rich environments more commonly associated with commercial games.

SCENECRAFT: Teacher world-making through interactive narrative generation

With these considerations in mind, we developed the SCENECRAFT prototype learning environment to address the need for accessible, teacher-authored tools that enable educators to design and implement narrative-centered experiences in their classrooms. With SCENECRAFT, teachers become co-creators of interactive storylines, tailoring scenarios to their students' needs and interests. This empowers educators to introduce scientific concepts through engaging narratives that highlight real-world relevance, such as food safety, ecosystem sustainability, or public health challenges. By enabling teacher authorship, SCENECRAFT prioritizes teacher-in-the-loop pedagogical decision-making while leveraging advanced AI-driven tools to simplify the creation process. More

specifically, SCENECRAFT transforms a story summary provided by the teacher into a dynamic, choose-your-own-adventure style interaction that unfolds in a 3D game environment (Kumaran et al., 2023). From there, SCENECRAFT uses large language models (LLMs) to generate narrative scenes for the outline provided by the author for the narrative to display emotions and gestures during interactions (Figure 1).

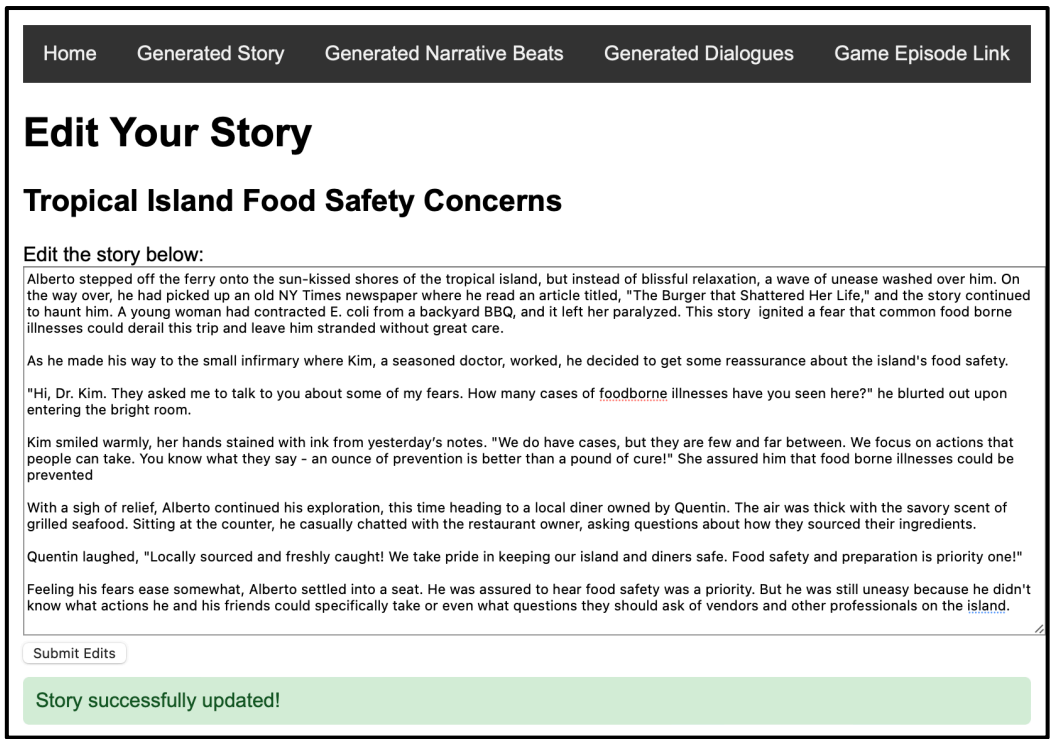
Figure 1
Generated 3D scene and characters in SCENECRAFT

Core Features

Adaptive authoring with large language models

SCENECRAFT enables teachers to input simple prompts that the system uses to generate detailed storylines, complete with narrative beats, character arcs, and branching dialogues. For example, a teacher could input a scenario about food safety, prompting the system to create a story in which students investigate contamination risks and safe practices on a tropical island (Figure 2).

Figure 2
The editable storyline in SCENECRAFT

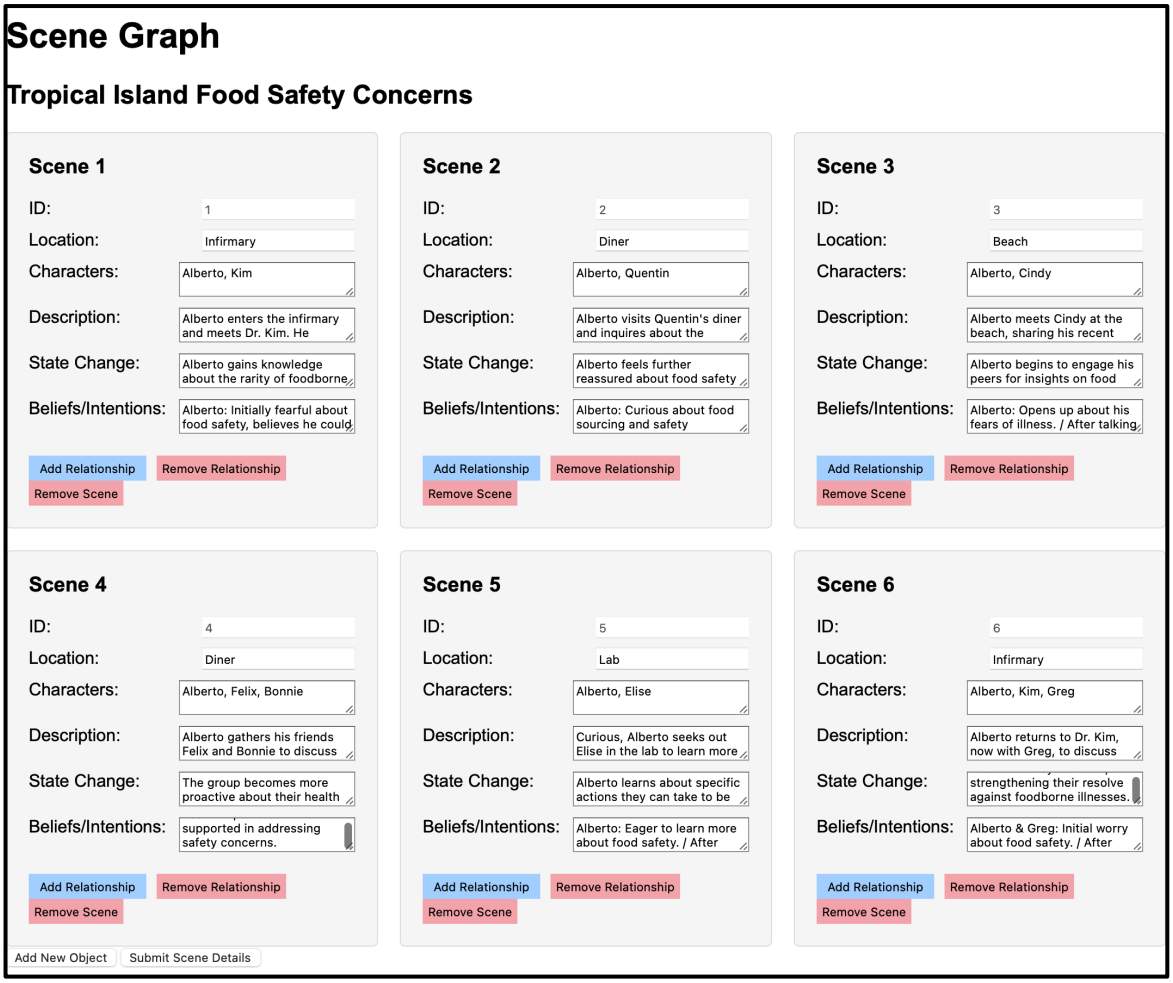


Scene customization

To further tailor the narrative, teachers have the flexibility to edit generated content on a scene-by-scene basis. This includes adding or modifying locations, such as the infirmary, lab, diner, or beach, to align with the types of location-specific conversations the characters can engage in (Figure 3). Teachers can not only customize where events take place, but also tailor the characters involved, the events that unfold, the shifts in understanding or emotions, and the underlying beliefs or intentions driving the narrative. This customization allows teachers to design scenarios that are relatable to their students, grounding the narrative in contexts that resonate with learners' experiences or interests. For example, a scene at the diner that focuses on food safety can include specific events, foods, or references that will feel familiar to students. Thus, teachers can create immersive, place-based learning experiences that not only highlight real-world applications of scientific concepts but also connect to learners' cultural and community contexts. Furthermore, this scene-specific editing enables teachers to scaffold content in ways that build toward broader learning goals, ensuring the narrative progression remains both engaging and customized as the teacher specifies.

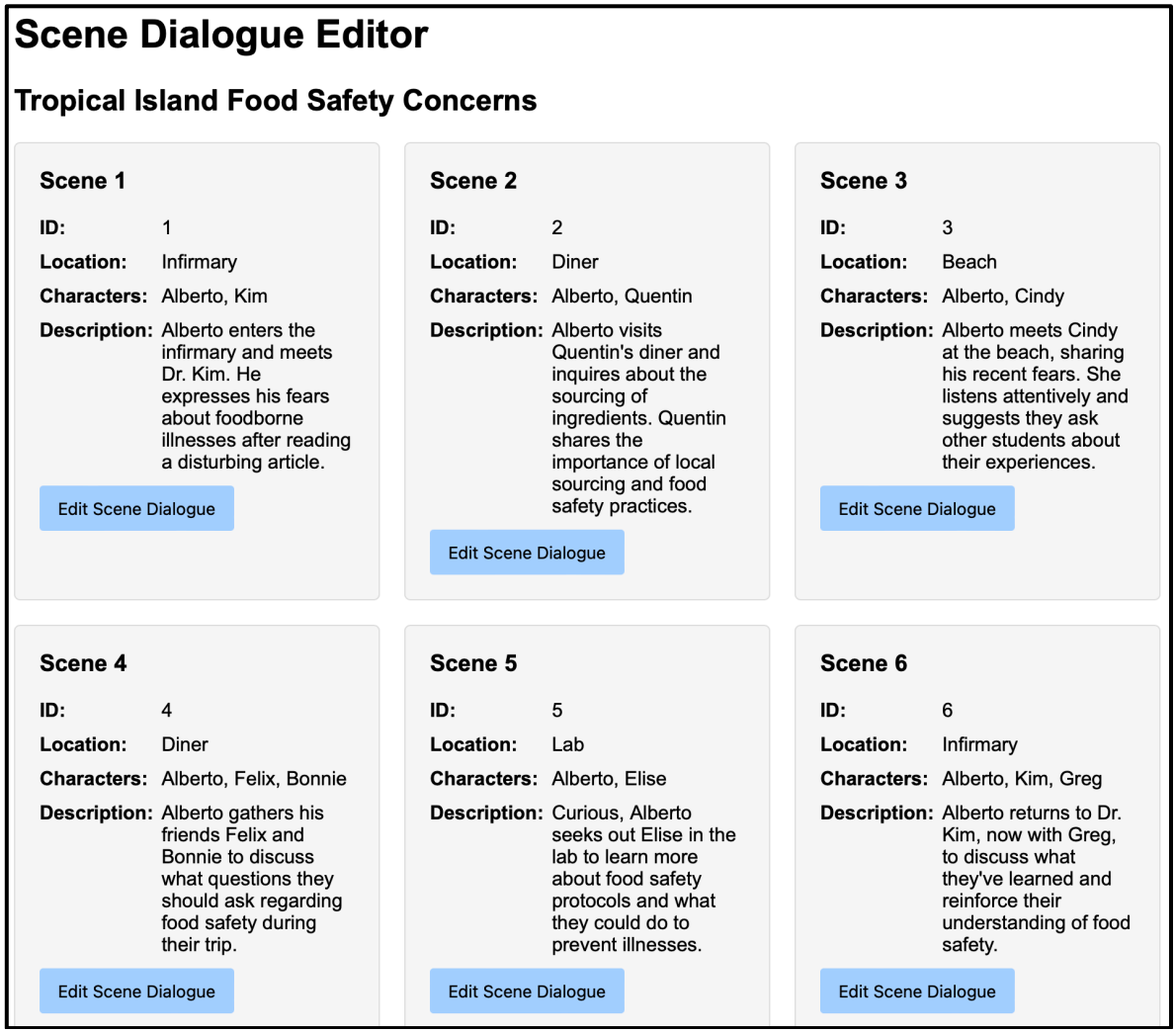
Figure 3

Scene graph customizable for location, characters, events, shifts in understanding or emotions, and underlying beliefs or intentions



Teachers can also refine character dialogue to better align with curricular objectives or to incorporate learner interests and experiences. Additionally, they can adjust the tone and complexity of the story to suit the needs of different grade levels, ensuring the narrative remains accessible and engaging (Figure 4).

Figure 4
Customizable dialogue, tone, and complexity



Applications and future directions

SCENECRAFT is currently used to enhance middle school learning in life sciences, ecology, and microbiology, tackling topics like ecosystems, food safety, and public health (cites). Looking ahead, its flexible architecture will be expanded to other STEM disciplines, such as environmental science, chemistry, and physics, while also serving as a professional development resource for narrative-centered pedagogy that leverages case-based reasoning. Additionally, SCENECRAFT opens avenues for collaborative research with teachers, enabling scholars to explore teachers' design rationales, pedagogical moves, and the associated outcomes in narrative-centered learning, particularly at the intersection of narrative storytelling, AI-driven authoring, and learner reasoning (Riedl & Bulitko, 2013; Pinkard et al., 2017).

Conclusion and impact

SCENECRAFT represents a critical step in narrative-centered teacher authoring, providing educators with the tools they need to create immersive, story-driven experiences with dynamic visuals that inspire case-based reasoning. By placing teachers in control of the authoring process, SCENECRAFT empowers them to tailor content to their students' needs, interests, and experiences while leveraging the power of AI-driven technology. We look forward to showcasing SCENECRAFT, inviting participants to explore its potential, provide feedback, and offer additional uses and applications.

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