Supporting Constructionist Maker Environments with Multimodal AI

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Abstract

In this poster, we examine how multimodal AI can be integrated as support in constructionist environments. Through experiments using ChatGPT and maker documentation, we highlight the importance of being mindful when offloading tasks to AI.

Keywords and Phrases: Artificial Intelligence, Generative AI, Maker Education, Constructionism

1. Introduction

Artificial Intelligence (AI) tools with what we call, "multimodal deduction" capabilities have become more accessible in recent years, with OpenAI's team publicly expressing plans for their widespread adoption (OpenAI, 2023). Building off the early work of Yang et al. (2023), we define "multimodal deduction" as an AI system's capability to analyze forms of data such as text, image, sound, video, etc., and simultaneously process information from these various modes.

In this paper, we begin asking how multimodal deduction and generative AI (GenAI) tools might transform how one sees, understands, and evaluates making practices. We argue that rather than see these tools as teacher replacements or as question-and-answer machines, they might instead be new components of future constructionist socio-technical systems. We present an initial exploration of multimodal deduction on students' documentation of their own maker practices gathered from a constructionist learning environment, highlight surprise findings, and offer a few design considerations for implementing GenAI in these settings. As a step in this direction, we ask: What happens when we invite AI to make sense of multimodal inputs? What does that say about the socio-technical processes at play here?

2. Methods

This study examines data collected as part of an NSF-funded multi-year design-based research project developing a suite of tools and practices to support distributed communities of learners in collaborative making. We use data (photos and videos) uploaded through one of these tools, Make in Progress, which allows makers to document and share their in-process projects collected during two implementations: a camp with youth learners, and a graduate-level maker course.

Danzig, B., Semprun, E., Holbert, N., Voorhis, J. K., & Correa, I. (2025). Supporting Constructionist Maker Environments with Multimodal AI. *Constructionism Conference Proceedings, 8/2025*, 535–537. https://doi.org/10.21240/constr/2025/110.X

We conducted a series of multimodal deduction mini-experiments using ChatGPT-4v and -4o to understand the affordances offered by "out of the box" GenAI systems. Our process consisted of inputting the maker media along with a prompt to the GenAI system, asking what it "sees" concerning the maker, the materials, the makerspace, and their relationships. We captured these experimental exchanges through screenshots of the chats and collaboratively discussed and noted initial takeaways/findings. When working with GenAI, we took steps to safeguard the privacy of the makers and their work, using a private instance of ChatGPT, in which data was not used to train their public models.

3. Findings

Our experiments revealed several promising directions for AI support in constructionist environments. We prompted ChatGPT with an image of a student sketch (Figure 1, left) featuring English and Chinese annotations along with the text "Explain this sketch". Its response included language translation and a breakdown of its observations of the image into five categories, such as "stage/base" and "details on movement or interaction". These notes highlighted elements we did not initially notice, including the numbering of the tentacles and the student question: "Will it move?" ChatGPT's analysis described the sketch as a "fantastical or mechanical octopus-like creature" and provided possible interpretations of movement based on arrows and circular annotations. Overall, the way ChatGPT broke down its observations of the image helped us, as facilitators and researchers, notice what we hadn't noticed before.

In another experiment, imagining students may want to use GenAI to generate shareable artifacts of their making process, we prompted ChatGPT with several images of a maker's project along with the text "put these in chronological order and make a poster." It provided an ordered list of images, each paired with a description of the step being depicted (Figure 1, middle). Then it generated a poster, entitled "Building a Robotics Project" (Figure 1, right). Each step is indicated with a heading followed by the image (step 1: initial assembly, step 2: structure development, step 3: final testing).

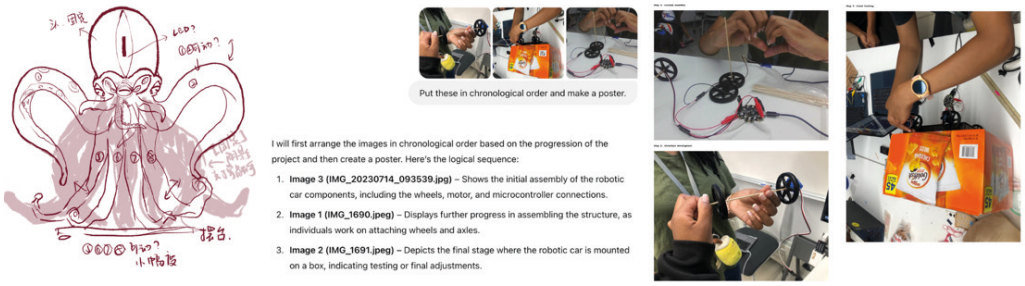

Figure 1: Student's sketch (left); chat with ChatGPT asking it to order maker images (middle); poster generated by ChatGPT (right)

4. Discussion

In these mini experiments, we begin to see how GenAI might support makers and facilitators in dynamic and complex constructionist learning environments. The two examples surface two possible directions for further exploration. In the first example, ChatGPT translated and picked out elements originally missed by the facilitators. This hints at a new role for multimodal AI as a support for facilitators as they engage with makers and their work. In the second example, the ability to create new representations and displays of makers' work, such as ordered image sequences,

indicates the potential for supporting student reflection, making process steps more visible, and creating new "objects-to-think-with" (Fields et al., 2018) such as posters and portfolios.

While demonstrating promising potential for using multimodal AI tools to mindfully offload specific tasks within constructionist learning environments (Salomon et al., 1991), our findings also remind us that we should not take a one-size-fits-all approach to implementing AI in constructionist learning design. We argue it is vital for educators who care about creating meaningful and student-centered learning experiences to approach these algorithms critically. What is possible is not always beneficial. In practice, we need to think about the learning goal, mental and social processes needed to meaningfully engage in these goals, and which processes can be offloaded. How do we design AI as a tool for humans rather than a proxy of them?

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