Prompt Machine: Enabling Physical LLM-Interactions for Learning

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Abstract

As generative AI technologies enter school settings, educators face uncertainty around how to meaningfully integrate these tools into teaching and learning. We present *Prompt Machine*, a tangible learning tool designed to support AI literacy, scaffold curriculum-aligned writing activities, and spark critical reflection on the role of AI in education. Informed by interviews with secondary school teachers and grounded in theoretical design considerations, Prompt Machine enables learners to input text, modify it using a physical prompt language, and receive AI-generated rewritings in tangible form. This demo showcases how physical interaction and collaborative exploration can make AI technologies more accessible, explainable, and reflective in classroom contexts. In line with DIS 2025's theme of *Designing for a Sustainable Ocean*, this demo features customised tangible blocks and example texts centred on ocean sustainability, inviting conference participants to engage in hands-on exploration and dialogue around AI and environmental themes.

CCS Concepts

• **Human-centered computing → Empirical studies in HCI**; • **Applied computing → Education**.

Keywords

Learning; Secondary School; AI Literacy; Children; Tangible interaction; Generative AI; Sustainability

ACM Reference Format:
Rune Møberg Jacobsen, Martin Lindrup, Joel Wester, Niels van Berkel, Dimitrios Raptis, and Peter Axel Nielsen. 2025. Prompt Machine: Enabling Physical LLM-Interactions for Learning. In *Designing Interactive Systems Conference (DIS '25 Companion), July 05–09, 2025, Funchal, Portugal.* ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3715668.3735602

1 Introduction

Education is continuously shaped by societal change and emerging technologies. Much like the introduction of calculators once sparked debate about their place in classrooms [2, 13], today's generative AI (GenAI) tools such as ChatGPT and Gemini, raise new questions on how such technologies should be integrated into teaching and learning [6]. While AI tools are often already being used by both teachers and students, their role remains underexplored—raising concerns about overreliance, learning efficacy, and meaningful integration into school curricula [9, 12]. To address these concerns, researchers have called for early development of AI literacy that concerns a set of competencies that enables learners to use, understand, and reflect on AI systems and their implications [8, 10]. Yet introducing AI in responsible, engaging, and age-appropriate ways remains a challenge, especially given the technical complexity often required to understand how these systems work [1, 8]. For younger learners in particular, hands-on and problem-based approaches have been shown to be essential [10].

We introduce Prompt Machine, a tangible and collaborative AI learning tool designed to support pupils' engagement with GenAI in language and writing activities. Prompt Machine enables learners to physically assemble prompts using a custom-designed tangible language, send those prompts to an AI system, and receive AI-generated rewritings of their own texts in a tangible format. Through this process, learners explore AI's generative capabilities while reflecting on how prompts shape outcomes. Teachers guide the activity, facilitating discussion around authorship, creativity, and the role of AI in writing. Rooted in research on tangible interaction [3–5, 11], Prompt Machine draws on principles of embodiment, collaborative learning, and tangibility. Tangibility lowers technical barriers and turns abstract AI concepts into manipulable, 'thinkable' objects—what Shaer et al. call thinking props [11]. Designed to align with language curriculum goals, Prompt Machine offers a concrete example of how AI literacy can be integrated into subject-based learning through physical interaction.

2 Prompt Machine

To explore how tangible interaction can support learning *with* and *about* AI, we developed Prompt Machine. Prompt Machine is a custom-built educational tool designed to foster AI literacy, scaffold classroom learning, and spark meaningful reflection on the capabilities and limitations of generative AI (Figure 1). Grounded in both theoretical and empirical design considerations, Prompt Machine is adaptable to different subjects, but in this work we focus on its application in language and writing learning activities. In

DIS '25 Companion, Funchal, Portugal

ACM ISBN 979-8-4007-1486-3/25/07
https://doi.org/10.1145/3715668.3735602

essence, learners input text (e.g., school assignments), modify it using physical prompt cubes (e.g.,), and receive AI-generated rewritings in printed form.

2.1 Design Considerations

The design of Prompt Machine was motivated by the need to introduce GenAI in ways that are not only age-appropriate but also align with actual classroom practices and educational goals. To inform our design, we drew on established design principles for fostering AI literacy, particularly Long and Magerko's framework [8], which emphasises interactional qualities such as embodied exploration, low barriers to entry, and opportunities for critical reflection. These theoretical considerations shaped our ambition to create a educational tool that encourages students to experiment with AI through hands-on interaction.

To ensure the design was grounded in real-world educational contexts, we complemented this foundation with empirical insights from interviews with **10 lower secondary school language teachers**. These interviews revealed concerns around the control and pacing of AI tools in the classroom, the need for analogue-digital balance, and the importance of teacher facilitation. Teachers also emphasised the value of collaboration and having learners work with their own texts to promote engagement and ownership. These contextual insights directly influenced design decisions—from using tangible components to slow down interactions, to building in

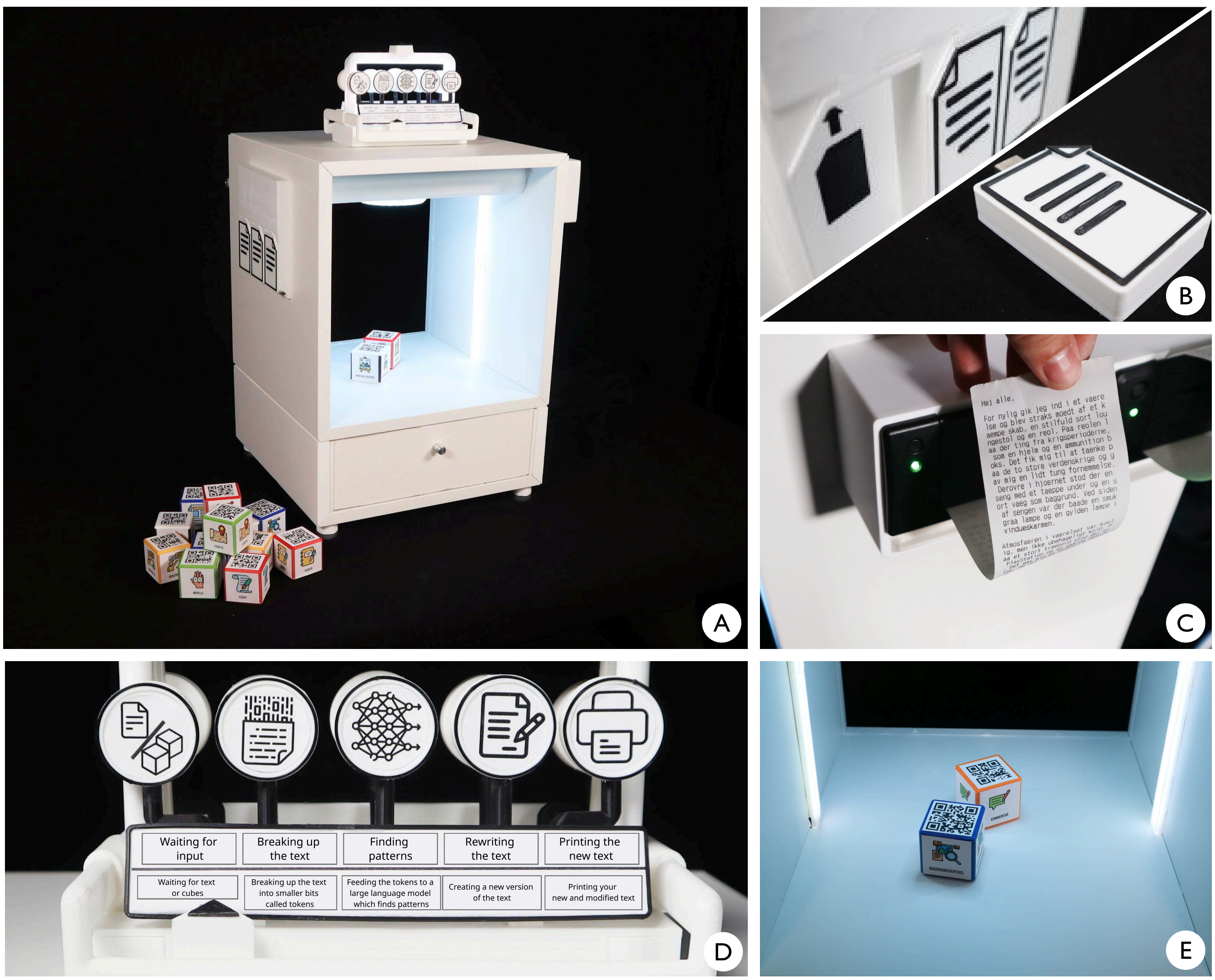

Figure 1: (A) The Prompt Machine. (B) Input module with three custom-made USB sockets and USB-textfiles for insertion. (C) Output module with two thermal printers. (D) Five-step tangible display. (E) Modification Canvas for inserting prompt cubes. From [7].

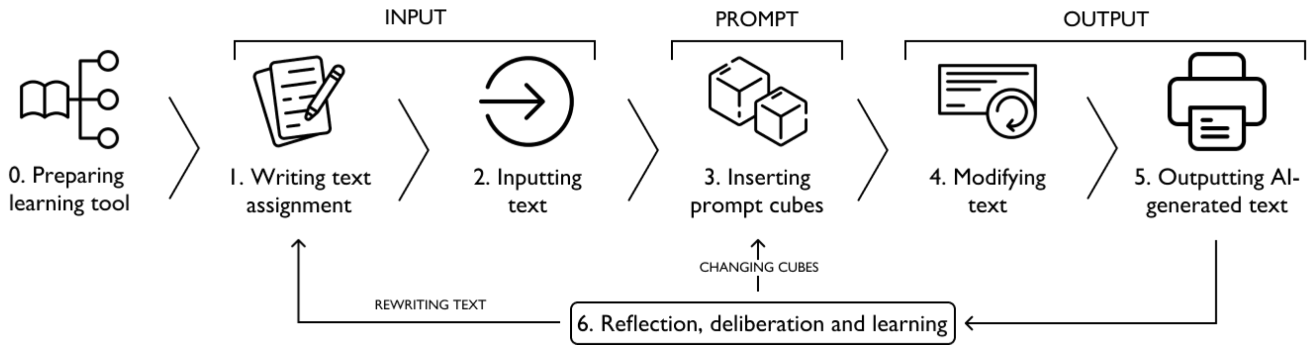

Figure 2: A step-by-step process of the high-level usage of Prompt Machine.

teacher mediation as a core element. A full account of the theoretical and empirical design considerations is presented in our full paper [7].

2.2 Interacting with Prompt Machine

We tailored Prompt Machine to support a language learning activity in lower secondary school (see supplementary material for a short demo). The interaction begins with teacher preparation (Figure 2, 0. Preparing learning tool), where teachers define relevant assignments and suggest suitable tangible cubes that align with learning goals (see Section 2.3 for details).

Next, learners write their assignments based on the teacher's instructions (1. Writing text assignment). These are saved onto USB drives encased in custom-designed, textfile-inspired enclosures (Figure 1-B). Learners insert these USBs into slots on the machine (Figure 1-A, left side), initiating the text input phase (2. Inputting text). This design reinforces our goal of tangible and deliberate interaction. The system can hold up to three text inputs simultaneously, with the most recent input made being next in line for modification.

Learners then define how the AI will rewrite their text using a set of tangible cubes (3. Inserting prompt cubes). These cubes represent a tangible prompt language based on rhetorical devices and genre transformations (e.g., fiction) aligned with curriculum objectives (see Section 2.3). Learners place the cubes on the Modification Canvas (Figure 1-E; also visible in Figure 1-A, center). A camera detects the arrangement and translates it into structured prompts for the language model. Cubes can be rearranged and reused, enabling comparison between different prompt configurations and texts, supporting hands-on experimentation and collaboration.

The AI-modified text is generated based on the placed cubes (4. Modifying text) and printed via two thermal printers (5. Outputting AI-generated text, Figure 1-C and right side of Figure 1-A). Physical output allows learners to examine, compare, and iterate on results (6. Reflection, deliberation and learning), reinforcing critical thinking and interpretive learning. They can compare versions of their own text, contrast them with peers' outputs, or explore the variability introduced by reusing the same prompt configuration,highlighting the probabilistic nature of GenAI.

To support transparency, a five-step status display (Figure 1-D and top of Figure 1-A) guides users and illustrates the AI's internal process, such as pattern recognition and text rewriting. The final step which is triggered by a physical button, activates the rewriting. This addition addresses explainability by making key AI mechanisms visible and accessible, especially for younger learners.

2.3 Tangible Prompt Language

To enable learners to modify texts in meaningful ways, we designed a tangible prompt language consisting of 3D-printed cubes. Each cube features a descriptive label and a QR code on top, which is detected by a camera when placed on the Modification Canvas of the Prompt Machine. This setup allows physical cube arrangements to be translated into structured AI prompts. The prompt language is intentionally open-ended: both teachers and learners can create their own cubes tailored to specific subject areas or curricular goals. This design aligns with theoretical considerations such as "opportunities to program" and "contextualising data" [8]. For our specific case, we developed a curated set of prompt cubes focused on literary genres, drawing directly from interviews with teachers. Several participants described a widely used framework for teaching genre-based writing, which we adapted into a tangible format. As shown on the left side of Figure 3, the framework informed four distinct categories of cubes. The first category () covers genres such as 'fairy tale' and 'short story', often used to introduce narrative structures and imaginative expression. The second category () includes 'letter', 'diary', 'essay', and 'memoir', which emphasise personal reflection and subjective voice. The third category () focuses on argumentation and critical thinking, incorporating genres like 'commentary' and 'debate'. The fourth category () introduces journalistic forms such as 'background article', 'feature story', and 'news article', helping learners understand factual writing and media literacy.

In addition to these core genre cubes, we also introduced three wildcard cubes designed to generate experimentation across and within genres. These included instructions such as 'add more adjectives', 'add more figurative language', and 'rewrite using only independent clauses'. The right side of Figure 3 illustrates how these wildcard cubes can be used independently or layered with genre cubes to shape different aspects of text output. Their inclusion was motivated by a desire to support creative exploration,

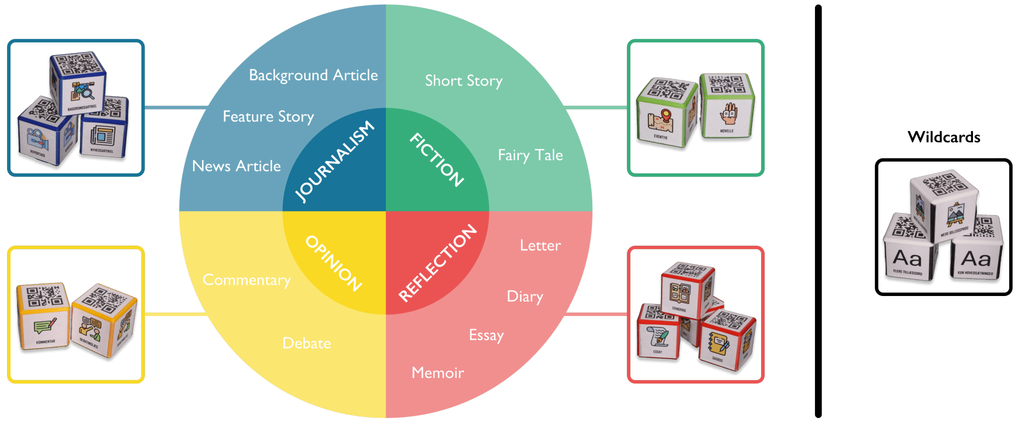

Figure 3: Left side: literary genres framework used in our study and its mapping on prompt cubes. Right side: wildcard cubes. From [7].

comparative reflection, and hands-on understanding of rhetorical devices. Together, the prompt cubes offer a tangible interface to AI prompting, allowing learners to manipulate genre and style in a physically embodied and collaborative manner. This design invites engagement with AI not just as a tool for automation of tasks, but as a medium for critical thinking, creative play, and structured reflection on language and authorship.

2.4 Implementation

This section outlines the hardware and software implementation of *Prompt Machine*. The prototype was built into a repurposed bookcase, with custom-designed components including USB enclosures, a physical display, bottom storage compartment, and thermal printer mounts. See Figure 4 for an overview of the system architecture.

Hardware. A Raspberry Pi 5 serves as the main processing unit, connected to a 4-port USB hub to support multiple peripherals. A Raspberry Pi HQ camera detects the QR codes on the tangible cubes. For output, the system uses two Arduino Mega boards: one to operate the two 57mm thermal printers, and one to control elements of the physical display. A set of motorised slide potentiometers represents AI processing stages, and a Teensyduino controls five LED strips for visual feedback. The base of the case includes a drawer for cube storage and power supply.

Software. The software is developed in Python and Node.js. Python manages file access from USB devices, QR code detection (via *zbar* and *OpenCV*), GPT-4o API calls, and serial communication with microcontrollers. Node.js coordinates parallel tasks such as device detection, lighting, and motor control. This architecture ensures synchronised interactions across hardware components while supporting future customisation.

3 Learning about *Sustainable Seas*

In line with DIS 2025's theme of *Designing for a Sustainable Ocean*, we will configure the Prompt Machine with content related to marine environments, sustainability, and oceans. Conference attendees will be invited to explore and modify sample texts about topics such as coral reefs, plastic pollution, and climate change using specially created prompt cubes. These include both genre-based cubes (*e.g., news article*, *opinion piece*) and wildcard cubes

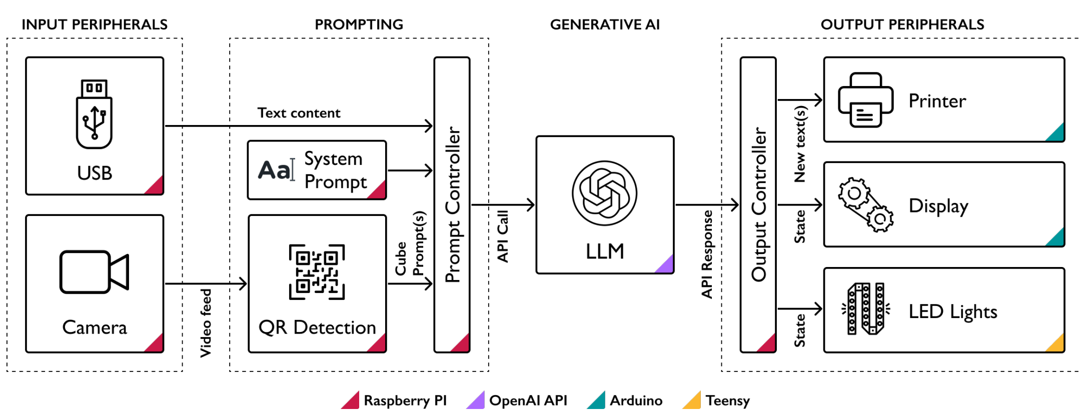

Figure 4: Software and hardware architecture, including input and output peripherals as well as prompt module. From [7].

(*e.g., add emotional language*, *simplify for children*) tailored to this theme. Through hands-on interaction, participants can experiment with how GenAI may transform narratives about the ocean, while reflecting on the power and limitations of such technologies in shaping environmental communication and education.

Acknowledgments

This work was partially funded by IT-Vest, "Computational Thinking in CS" project and by the Carlsberg Foundation, grant CF21-0159.

References

[1] Mildred V. Jones Helen Crompton and Diane Burke. 2024. Affordances and challenges of artificial intelligence in K-12 education: a systematic review. *Journal of Research on Technology in Education* 56, 3 (2024), 248–268. https://doi.org/10.1080/15391523.2022.2121344

[2] Shirley Hill. 1976. Issues from the NACOME Report. *The Mathematics Teacher* 69, 6 (1976), 440–446. http://www.jstor.org/stable/27960539

[3] Eva Hornecker and Jacob Buur. 2006. Getting a grip on tangible interaction: a framework on physical space and social interaction. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Montréal, Québec, Canada) *(CHI ’06)*. Association for Computing Machinery, New York, NY, USA, 437–446. https://doi.org/10.1145/1124772.1124838

[4] Hiroshi Ishii and Brygg Ullmer. 1997. Tangible bits: towards seamless interfaces between people, bits and atoms. In *Proceedings of the ACM SIGCHI Conference on Human factors in computing systems* (Atlanta, GA, USA). Association for Computing Machinery, New York, NY, USA, 234–241. https://doi.org/10.1145/258549.258715

[5] Rune Møberg Jacobsen, Patrick Skov Johansen, Lukas Bjørn Leer Bysted, and Mikael B. Skov. 2020. Waste Wizard: Exploring Waste Sorting using AI in Public Spaces. In *ACM International Conference Proceeding Series*. Association for Computing Machinery. https://doi.org/10.1145/3419249.3420180

[6] Luona Lin. 2024. A quarter of U.S. teachers say AI tools do more harm than good in K-12 education. https://www.pewresearch.org/short-reads/2024/05/15/a-quarter-of-u-s-teachers-say-ai-tools-do-more-harm-than-good-in-k-12-education/

[7] Martin Lindrup, Joel Wester, Niels Van Berkel, and Peter Axel Nielsen. 2025. Prompt Machine : A Tangible Generative AI Tool for Supporting Children’s Learning and Literacy. In *Designing Interactive Systems Conference (DIS ’25), July 5–9, 2025, Funchal, Portugal*, Vol. 1. https://doi.org/10.1145/3715336.3735673

[8] Duri Long and Brian Magerko. 2020. What is AI Literacy? Competencies and Design Considerations. In *Conference on Human Factors in Computing Systems - Proceedings* (Honolulu, HI, USA). Association for Computing Machinery, New York, NY, USA, 1–16. https://doi.org/10.1145/3313831.3376727

[9] Davy Tsz Kit Ng, Jac Ka Lok Leung, Samuel Kai Wah Chu, and Maggie Shen Qiao. 2021. Conceptualizing AI literacy: An exploratory review. *Computers and Education: Artificial Intelligence* 2 (jan 2021), 100041. https://doi.org/10.1016/J.CAEAI.2021.100041

[10] Davy Tsz Kit Ng, Jiahong Su, Ka Lok Leung, Samuel Kai, Wah Chu, Jac Ka, and Lok Leung. 2023. Artificial intelligence (AI) literacy education in secondary schools: a review. *Interactive Learning Environments* (2023), 1–21. https://doi.org/10.1080/10494820.2023.2255228

[11] Orit Shaer and Eva Hornecker. 2009. Tangible User Interfaces: Past, Present, and Future Directions. *Foundations and Trends in Human–Computer Interaction* 3 (2009), 1–137. https://doi.org/10.1561/1100000026

[12] Rachel Charlotte Smith, Marie Monique Schaper, Mariana Aki Tamashiro, Maarten Van Mechelen, Marianne Graves Petersen, and Ole Sejer Iversen. 2023. A research agenda for computational empowerment for emerging technology education. *International Journal of Child-Computer Interaction* 38 (dec 2023), 100616. https://doi.org/10.1016/J.IJCCI.2023.100616

[13] William Sugar, Frank Crawley, and Bethann Fine. 2004. Examining teachers’ decisions to adopt new technology. *Journal of Educational Technology & Society* 7, 4 (2004), 201–213. https://www.learntechlib.org/p/75208/