Identifying the Roles of Embodiment in AI Literacy Interventions

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ABSTRACT

Although embodiment and tangible interaction are widely recognized as beneficial for learning, their specific role in AI education remains underexplored. This paper investigates how embodied and tangible interaction can support AI literacy among audiences with limited technological exposure. Drawing on existing literature and our experience designing AI literacy interventions for informal learning spaces, we identify seven roles that embodiment can play in fostering AI literacy. These findings offer practical design angles for future researchers and exhibit designers, and contribute to the theoretical grounding of embodiment as a central—rather than incidental—consideration in AI literacy design.

CCS CONCEPTS

• **Applied computing → Interactive learning environments**; • **Human-centered computing → Human computer interaction (HCI)**.

KEYWORDS

Embodied interaction, AI literacy, Embodiment, Education

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1 INTRODUCTION

Improving the public's AI literacy is ever more pressing as AI becomes increasingly embedded in everyday life. Embodiment and tangible interaction are well-established supports for learning [19]—lowering barriers to entry, encouraging discussion, and enabling collaborative sense-making—benefits that are especially valued in informal learning settings [16, 24]. Yet despite this promise, the specific contributions of embodied interaction to AI learning remain poorly understood. Notably, one of the most widely adopted AI literacy frameworks explicitly highlights embodied interaction as a recommended design strategy [15].

Unlike many areas of scientific knowledge, AI is a highly abstract domain spanning statistics, computer science, and mathematics, making it particularly challenging to communicate to general audiences. To understand how embodiment has been applied in this space, we surveyed existing AI literacy interventions and analyzed their use of tangible and embodied interaction. While such interventions target a broad range of populations, this paper focuses primarily on those with limited technological exposure–specifically, children aged 12 and older, and adults with limited technical backgrounds.

Through a review of existing tangible and embodied AI literacy interventions, including those developed by our team and by other researchers, we identify seven distinct roles that embodiment plays in supporting AI literacy. Our guiding research question is: *What are the different roles of embodiment in AI literacy interventions?* We hope these seven roles offer practical and theoretical angles for future researchers and exhibit designers working in this space. In the following sections, we first review relevant literature on embodiment and existing AI literacy interventions, then present each of the seven roles in turn.

2 RELATED WORK

2.1 Different Definitions of Embodiment

The concept of embodiment has philosophical roots stretching back to Descartes' mind-body duality. Embodied cognition later reframed this debate by foregrounding the physical body's role in cognition—arguing that the body does not merely causally influence cognitive processes, but constitutes part of the cognitive system itself [1, 20]. This perspective gained significant traction in HCI: Dourish [9], for instance, championed an embodied approach to software interaction that emphasizes skilled, engaged practice over disembodied rationality, drawing on the phenomenological traditions of Heidegger and Wittgenstein.

More recently, Hellström et al. [11] developed a five-aspect taxonomy of embodiment specifically for the AI era, spanning agent, mediator, environment, degree of body, and degree of intertwining—providing angles for analyzing embodiment across diverse technological products including robotics, AI chatbots, smart home devices, and virtual reality applications. Ziemke [28] further broadens this picture, arguing that embodied systems are those structurally coupled to their environment, and cataloging multiple categories including historical, organismic, and social forms. Taken together, these accounts make clear that embodiment is not a single stable concept but a family of related ideas whose meaning shifts across disciplinary contexts—underscoring the importance of treating it as a spectrum rather than a fixed category.

2.2 Embodiment as a Spectrum, not a Binary Concept

The diversity of embodiment definitions reinforces the view that embodiment is best treated as a spectrum rather than a binary category. This is supported both by psychometric research [13]—in which

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participants rate their sense of embodiment along a continuum—and by the wide range of tangible and embodied exhibit designs found in practice. Even screen-based interactions, which afford the least physical engagement relative to full-body, full-sensory experiences, retain an embodied dimension through hands-on manipulation of on-screen elements. Rather than drawing a hard line between "embodied" and "not-embodied", we adopt a low-to-high embodiment continuum as our analytical lens.

Hellström et al. [11] operationalize this spectrum by parameterizing the degree of body and intertwining as a quantifiable dimension, enabling cross-application comparisons. VR research similarly treats embodiment as a measurable continuum: Debarba et al. [8] used questionnaires covering agency, body ownership, and self-location to assess degrees of embodiment across first- and third-person perspectives in both synchronous and asynchronous settings. These frameworks reinforce the view that embodiment is best understood not as a binary toggle but as a graded, multidimensional property—a framing we carry forward in our analysis of AI literacy interventions.

2.3 Embodied AI Literacy Interventions

A growing body of AI literacy work incorporates embodied and tangible interaction as a core design strategy. *Creature Feature* invites learners to physically manipulate data labeling to influence an AI's decision-making [17]. *Data Bites* [6] lets participants assemble tangible "sandwiches" and "pizzas" to train a classifier, making concrete the idea that AI models learn from data—and can be shaped by—human-constructed data. *PopBots* engages children aged 4-6 in building and interacting with a social robot to explore foundational AI concepts [23]. *Knowledge Net* has learners construct symbolic networks by hand to understand how rule-based AI systems reason [22]. *LuminAI* teaches AI concepts through full-body improvised dance with an AI agent [27]. In the sections that follow, we examine how each of these interventions deploys embodiment differently, and what distinct learning affordances each approach offers.

3 SEVEN ROLES OF EMBODIMENT IN AI LITERACY INTERVENTIONS

3.1 Enabling Full Body Embodied Interaction

Full-body interaction represents the most immersive end of the embodiment spectrum. *LuminAIx* (Figure 1.1) is a multi-panel museum exhibit in which participants use their whole body to collaboratively dance and improvise with an AI agent [27]. In Panel 1, a participant performs a brief 3-second movement, which *LuminAI* classifies using the Body Action Taxonomy (BAT)—a framework describing movement across four dimensions: space, limb expression, spinal location, and floor support. Panel 2 invites the participant into a collaborative improvisational dance, where *LuminAI* both learns from the user's movements and performs movements in return, drawing from its accumulated knowledge base. Panel 3 then visualizes *LuminAI*'s dataset through animation, showing how movements contributed in Panel 2 were stored and subsequently selected for playback—making the AI's internal process visible and legible. Because dance is an intuitive human activity requiring no prior technical knowledge, full-body interaction provides a uniquely accessible entry point into AI concepts. While Panels 1 and 2 accommodate only one active participant at a time, research supports that observing others' embodied actions is itself an effective mode of learning [1].

3.2 Making Abstract Concepts Tangible

Knowledge Net (Figure 1.3) is an exhibit that teaches semantic networks—a foundational AI algorithm—through hands-on construction. In its original version, learners used a tangible interface of wooden tiles and arrows to physically assemble a semantic network, then queried it with natural language questions [18]. A later touchscreen iteration allowed participants to define the semantic network of four AI agents—specifying what each agent "is," "has," "likes," and "dislikes" [22]—and observe how their choices directly shaped agent behavior on screen. This design instantiates a strategy advocated by Long and Magerko [15]: encouraging learners to "put themselves in the shoes of the AI" and reason about how it makes decisions. By casting learners in the role of AI designer and requiring them to reason from the system's perspective, this form of embodied interaction transforms an otherwise opaque algorithm into something legible and accessible.

3.3 Supporting Embodied Metaphors and Analogies

Embodied and tangible interaction can also make abstract AI concepts accessible through physical metaphor and analogy. *Creature Feature* is an AI game in which learners place tangible dots beneath images of birds and non-birds to represent how many times an AI has "seen" each example—giving physical form to the otherwise invisible process of iterative learning from data [17]. *DataBites* (Figure 1.2) similarly uses paper cutouts of pizza and sandwich ingredients, asking participants to physically assemble datasets by slotting components into designated spaces; an AI model is then trained on these hand-built datasets to classify the two food types, making the concept of a training dataset concrete rather than abstract [6]. Together, these exhibits demonstrate how physical manipulation can ground abstract data concepts in tangible, embodied experience.

In another example, *LuminAI* visualizes datasets by inviting a visualization of the abstract and "black-box" dataset concepts. In Moviz (the representation of *LuminAI*'s dance dataset), the abstract and numerical dataset was embodied and represented as animated figures being visualized in 3D space [14], with the closer data points visualized as animated skeletons while further data points visualized as dots. In the latest version, *LuminAIx* (Figure 1.1) introduced a simpler, more abstract 2D representation that could help reduce mental load. This abstraction and metaphorical representation greatly support understanding sophisticated AI datasets without overwhelming participants with additional data representation.

3.4 Detaching Human Characteristics from Embodied Components

A common misconception among the public is the tendency to anthropomorphize AI—attributing human intentions, emotions, or



Figure 1: Four embodied AI literacy exhibits discussed in this paper. (1) *LuminAIx*: participants use full-body dance to interact with an AI agent; (2) *DataBites*: learners assemble tangible food ingredients to construct a training dataset; (3) *Knowledge Net*: learners build semantic networks on the Ideum touchscreen table; (4) *Chatbot of Truth*: high-embodiment (left) and low-embodiment (right) versions displayed side by side in a museum setting.

agency to AI systems. For instance, children have been observed asking ChatGPT "Are you a boy or a girl?" [2], and non-expert users often treat AI as though it retains memory across interactions, failing to account for the absence of persistent context [25]. Public perception data further reflects this pattern: a recent poll found that one-quarter of respondents associated AI primarily with robots [3]. These misconceptions share a common thread—people map human social and cognitive characteristics onto systems that operate on fundamentally different principles.

Embodied interactions that deliberately avoid human-like representations may help counter this tendency. When learners engage with AI through abstract physical components—as in *Knowledge Net* and *DataBites*—they encounter the system as a data-driven algorithm rather than a social actor, supporting a more accurate understanding of both how AI works and the role humans play in shaping it.

3.5 Sparking Curiosity and Supporting Interest Development

Embodied exhibits are generally more effective than screen-based ones at sparking curiosity and drawing learners in. *Chatbot of Truth* (Figure 1.4) is an interactive installation that responds to yes-or-no questions and explains whether each question is appropriate to ask a chatbot—designed to help children develop critical, reflective habits when interacting with systems like ChatGPT [26]. In a recent museum deployment, we directly compared a tangible version of the exhibit with a screen-based counterpart, holding all other interaction variables constant. Observational data showed that when both versions were placed in the same space, learners consistently approached the tangible installation first. Although the learning objectives and interaction logic were identical across versions, the physical presence of the exhibit served as a more effective attractor—suggesting that embodiment plays an important role in initiating engagement, which is particularly consequential in informal learning settings where participation is entirely voluntary.

3.6 Acting as Embodied Teaching and Learning Companion

Embodied AI agents can also serve as social companions that motivate and scaffold learning. *PopBots* is a social robot designed to introduce AI concepts to children aged 4–6 [23], using a smartphone mounted on a tangible stand as its expressive face and a tablet as the control panel. The physical, socially responsive presence of the robot enables young learners to form a natural relational bond with it—lowering affective barriers and creating an engaging context for exploring AI ideas. This design strategy is supported by broader evidence on educational robotics: studies document both a moderate positive effect on learning outcomes in STEM settings [21] and improvements in overall learning interest and motivation [4]. Together, these findings suggest that an embodied learning companion can serve as an effective vehicle for conveying AI literacy concepts to young audiences.

3.7 Facilitating Dialogues and Collaboration

Embodied exhibits with shared, visible states naturally invite dialogue and collaborative sense-making. When all participants can see and respond to the same physical or on-screen configuration—such as a jointly built semantic network in *Knowledge Net* [17], or a shared dance movement dancing with *LuminAI* [7]—it creates a common ground for discussion, negotiation, and joint reasoning. This social dimension is particularly valuable in informal learning settings, where conversation among visitors is often a primary vehicle for meaning-making. Moreover, the dialogues that emerge around embodied exhibits can themselves serve as rich data for analyzing and iterating on exhibit design—providing a feedback loop between learner interaction and intervention improvement [18].

4 DISCUSSIONS

Compared to more established fields such as scientific literacy and computational literacy, AI literacy is a relatively young and rapidly evolving domain. In this paper, we surveyed existing public-facing AI literacy interventions and identified seven roles that embodied and tangible interaction plays in supporting AI learning. We acknowledge two limitations of this review. First, it does not cover all forms of embodiment applicable to AI literacy–immersive formats such as virtual reality and augmented reality remain underexplored. For instance, a liminal blend approach could use the learners' bodies and allow learners to physically enact components of an AI algorithm (e.g. neurons in neural networks), which proved effective in other scientific literacy education [10]. Second, the interventions we examined tend to foreground technical understanding of AI algorithms, with comparatively little attention to the sociotechnical dimensions of AI–such as its environmental impact, its effects on the labor market, and the skills it demands of workers [5]. Research has shown that physical and tangible representations convey information more effectively than 2D and virtual alternatives [12], suggesting that embodied exhibits are well-suited to making these abstract concepts concrete. For instance, a tangible manifestation of the power and water consumption of AI inference would likely convey its environmental cost more effectively than plain language or screen-based visualizations.

We hope these seven roles offer productive angles for future researchers and exhibit designers working on embodied AI literacy experiences. One practical consideration worth noting is that tangible and embodied interventions are generally more resource-intensive than screen-based alternatives, requiring greater investment in hardware development, logistics, and transportation. Future work should therefore explore how these roles can be realized in more lightweight and transmissible formats, broadening their reach beyond well-resourced museums and informal learning contexts.

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