Fostering AI Literacy with Embodiment & Creativity: From Activity Boxes to Museum Exhibits

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ABSTRACT

Fostering young learners' literacy surrounding AI technologies is becoming increasingly important as AI is becoming integrated in many aspects of our lives and is having far-reaching impacts on society. We have developed *Knowledge Net* and *Creature Features*, two activity boxes for family groups to engage with in their homes that communicate AI literacy competencies such as understanding knowledge representations, the steps of machine learning, and AI ethics. Our current work is exploring how to transform these activity boxes into museum exhibits for middle-school age learners, focusing on three key considerations: centering learner interests, generating personally meaningful outputs, and incorporating embodiment and collaboration on a larger scale. Our demonstration will feature the existing *Knowledge Net* and *Creature Features* activity boxes alongside early-stage prototypes adapting these activities into larger-scale museum exhibits. This paper contributes an exploration into how to design AI literacy learning interventions for varied informal learning contexts.

CCS CONCEPTS

• **Human-centered computing** → Interaction design; Interaction design process and methods; Interface design prototyping; Human computer interaction (HCI); Interactive systems and tools; • **Social and professional topics** → Professional topics; Computing education; Informal education.

KEYWORDS

informal learning, museum exhibit, AI literacy, at-home learning, prototyping, design research, tangible user interfaces, AI education

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1 INTRODUCTION

Artificial intelligence (AI) mediates many of children's daily activities—from unlocking phones, to scrolling through social media, to AI surveillance in schools. The unique role that AI plays in making decisions that affect children's lives creates a need to improve public understanding of AI. We assert that it is critical for children to have *AI literacy*: a set of competencies that enables individuals to critically evaluate AI, communicate and collaborate effectively with AI, and use AI as a tool online, at home, and in the workplace [8]. However, there is a gap in public education about AI. Most current K-12 AI education (an area which has developed within the past few years) focuses on K-12 elective computer science (CS) and career and technical education (CTE) courses, excluding many children who are not enrolled in these courses. Our research takes steps to address that gap by developing informal learning experiences to broaden AI literacy.

In this paper, we present two activities we have developed for family groups to learn about AI in their homes—*Knowledge Net* and *Creature Features*. These activities were developed to safely study how to design AI literacy learning experiences during COVID-19. The activities aim to communicate AI literacy competencies such as understanding the steps and practices of machine learning, what a knowledge representation is, and recognizing that computers learn from data [9]. We have previously presented findings from

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studies of these activity boxes, which have indicated their capacity to support family group dialogue about AI [9]. However, we have yet to demo the activities at a conference, as they were designed during the pandemic. We are currently exploring how to adapt *Knowledge Net* and *Creature Features* into museum exhibits, in collaboration with the Museum of Science and Industry, Chicago. We are focusing on three key goals when adapting the activity boxes to the museum context: 1) centering learner interests; 2) allowing learners to generate creative and personally meaningful outputs; and 3) incorporating embodiment and collaboration on a larger scale.

In the remainder of this paper, we will review related work on AI education, present the activity box designs, and elaborate on our plans for expanding them into museum exhibits, sharing several early design sketches. This paper contributes an exploration into how to design AI literacy learning interventions for children in varied informal learning contexts. This connects to the conference theme of "rediscovering childhood" via playful, collaborative learning experiences designed to foster children's agency as they increasingly interact with more AI technologies throughout their lives. It also connects to the underlying theme of returning (and adapting) to in-person research contexts with children following the COVID-19 pandemic. A link to our video demonstration is available here.

2 RELATED WORK

2.1 AI Education Overview

Most research on AI education for novices has focused on K-12 classrooms. The AI4K12 initiative is working with educators and researchers to develop a set of standards for K-12 AI education [11]. The Center for Integrative Research in the Computing and Learning Sciences has formed a working group on AI and education policy. Companies like AI4All, ReadyAI, and the Concord Consortium are expanding access to K-12 educational materials via integration with classrooms, summer programs, online learning, and development competitions. Educators and researchers are also working on developing lesson plans for teaching about AI in classrooms (e.g., [1, 3]).

There are several existing approaches to designing AI education activities for K-12 students. Some projects allow learners to program AI or train ML algorithms using novice-friendly coding platforms such as Scratch or MIT App Inventor [2, 12]. Other projects allow learners to "tinker"—or learn through active experimentation—with existing AI devices (e.g., voice assistants) [12] or connect to their personal interests (e.g., athletics, dance) [6, 13]. Other curricula focus less on technical skills and more on AI ethics [1].

2.2 AI Education in Museums

There have only been a few museum exhibits focused on AI, likely due to the novelty of the field, the expense/fragility of many AI devices, and the fact that the 'inner workings' of most AI are not easily interactive or observable. Most often, AI appears in science centers in the form of displays or demonstrations of robots—for example, MSI's *Robot Revolution* exhibit featured numerous historical robotic artifacts and demonstrations of robots performing feats of intelligence. Some museums have curated exhibits that explore more holistic representations of AI. The Barbican's *AI: More than Human* presents the history of AI. Ars Electronica's *Understanding AI* featured installations where visitors could interactively explore how ML technologies such as image recognition, unsupervised learning, and neural networks worked.

3 AT-HOME ACTIVITY BOXES

The original *Knowledge Net* and *Creature Features* activities were developed during the COVID-19 pandemic as activity boxes for families to engage with together at home. We designed the activities for family groups with kids ages 7 and up.

Knowledge Net (Figure 1, left) is an activity in which learners can use a tangible interface of tiles and arrows to collaboratively build semantic networks (a type of AI knowledge representation). We created three tile sets to allow learners to build networks about different topics—animals, family, and musical instruments. Tiles include concepts, such as cat, paws, mom, viola. Arrows include relationships such as is, has, likes, dislikes. Once learners build their network, they can take a photo of it using an iPad with an Osmo device attached and upload it to a website we developed. They can then interact with a chatbot that uses their semantic network as its knowledge base. For example, a learner could ask the chatbot "What does a cat have?" and it would answer "A cat has paws," if that information was included in their network.

Creature Features (Figure 1, middle) is a prototype in which learners can use a card deck and weight tokens to build a training dataset for a feature-based machine learning bird classification algorithm. Each card depicts a creature (e.g., bluebird) and includes a list of descriptive features (e.g., has beak). Learners are encouraged to look at the features and consider how to place their weights to create a dataset for an algorithm that can recognize many different types of birds. The more tokens that are placed on a card, the more examples of that creature are added to the dataset (e.g., three tokens on a goose and one on a sparrow means the algorithm would be trained with more geese than sparrow examples). Learners can take a picture of their board using an iPad with an Osmo device attached. They can then upload the image to a website we developed which shows them how well their algorithm classifies birds, and which examples it misclassified.

4 FROM BOXES TO MUSEUM EXHIBITS

We are exploring how to adapt the existing *Knowledge Net* and *Creature Features* AI literacy family activity boxes into exhibits that could be installed in a museum space. This will allow us to create a suite of AI literacy activities that span informal learning contexts such as at-home learning, after-school groups, and science and technology museums. Our research team has identified three key goals for adapting the boxed activities into museum exhibits:

Goal 1: Centering learner interests. We plan to center the exhibit content on our target audience (middle school students') interests and concerns related to AI. Towards this end, we have plans to conduct a focus group with middle school age learners in Spring 2023. We plan to incorporate findings from this focus group in the exhibit designs.

Goal 2: Allowing learners to create personally meaningful outputs. Creative activities can increase interest formation and feelings of

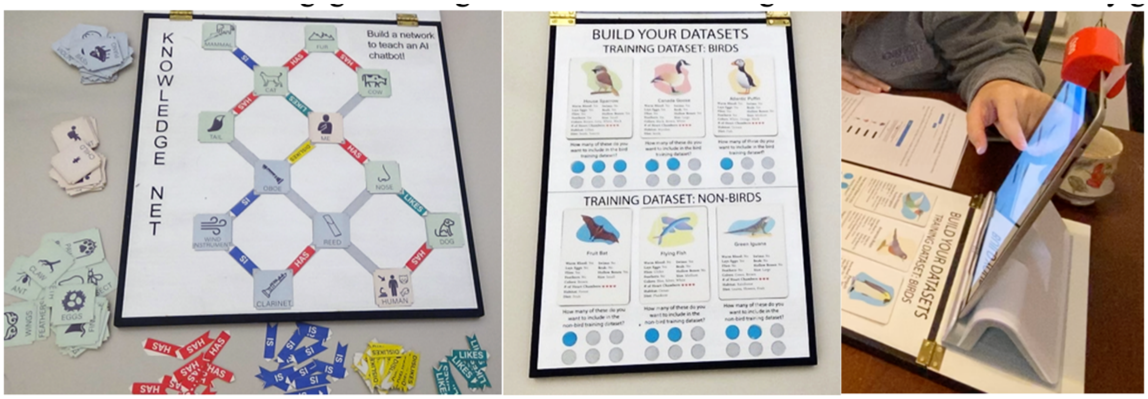

Figure 1: Left: Knowledge Net activity box. Middle: Creature Feature activity box. Right: iPad + Osmo interface.

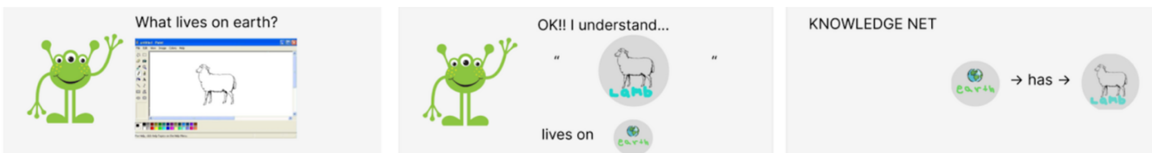

Figure 2: Storyboard of a version of Knowledge Net that allows learners to draw their own tiles to represent concepts in the network.

belonging in computer science [4, 10]. Based on these findings, we are iterating on the designs to allow learners to ideate and improvise, engage in artistic practices, and generate personally meaningful artifacts during their interaction.

Goal 3: Incorporating embodiment and collaboration on a larger scale. Knowledge Net and *Creature Features* were designed to fit in 13x13in. boxes and need to be scaled up to support collaborative group learning in a museum. In addition, we seek to build on the success we had with using tangible interfaces to reduce intimidation and foster collaboration in the at-home environment [9]. We plan to incorporate embodied interaction in the museum exhibits, allowing learners to engage in bodily sensemaking by engaging with tangible interfaces or full body interactives.

In the remainder of this section, we present design ideas exploring how to incorporate these goals into the exhibit design.

4.1 Centering Learner Interests

As mentioned above, we are planning to incorporate findings from our upcoming focus group in the exhibit designs. We are considering centering *Knowledge Net* tile topics and *Creature Features* classification domains around common interests that come up in the focus group that we conduct. For example, we could include common hobbies or interests (e.g., basketball, painting) as *Knowledge Net* tiles, or create a *Creature Features* card deck focused on classifying characters as heroes or villains (if we found that, say, superheroes were highly interesting to our target audience).

One early design we have explored as a way of allowing learners to incorporate their own interests in *Knowledge Net* is pictured in Figure 2. This sketch proposes allowing learners to draw their own tiles. This would allow them to center the activity around topics that excite them, rather than engage with prescribed topics like family, animals, and musical instruments. This design sketch additionally presents the AI as a creature that has no knowledge of our world, which is intentional to address learner misconceptions about the amount of information AI knows before it is trained/taught (some learners conflate their own knowledge of a topic with the AI's knowledge of the topic) [9].

4.2 Embodied Interaction & Collaboration at a Larger Scale

We are exploring how to scale up the activities so that they can facilitate collaboration amongst groups visiting museums. Figure 3, left shows a design sketch of an exhibit setup that uses an Ideum tangible touchscreen tabletop combined with a wall projection to allow a larger group of learners to collaboratively manipulate a tangible interface that affects a large, visualized output. Such a setup could be used for either *Creature Features* or *Knowledge Net*.

We are also considering designs that go beyond the form of the tangible interface + visualization paradigm. We propose an alternative version of *Knowledge Net* in Figure 3, middle. In this version of the activity, learners can create a network on a worksheet and feed it into a machine resembling a server, which will then print out a story generated using the network. A large wall of "servers" could be present to allow multiple learners to interact simultaneously. Another design sketch we have generated for *Creature Features* allows learners to use figurines with NFC bases that the computer can recognize (rather than cards) to create datasets (Figure 3, right). Multiple connected podiums or stations could allow multiple learners to create datasets at once, and potentially even compete to see who can train the most effective algorithm.

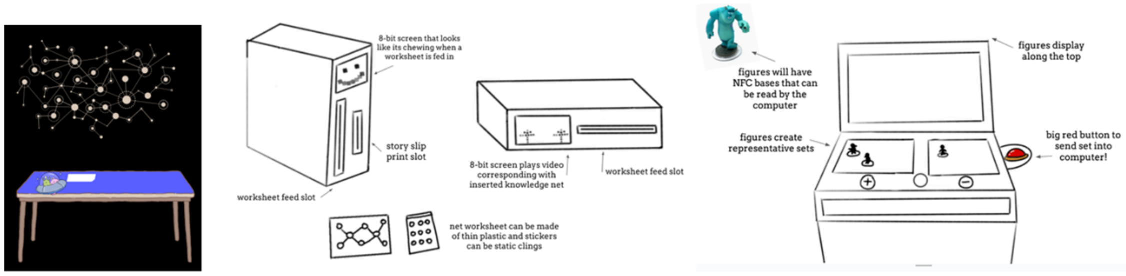

Figure 3: Left: tangible tabletop with projection; Middle: Knowledge Net story printer; Right: Creature Features using 3D figurines.

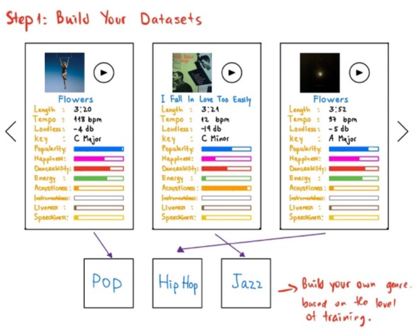

Figure 4: Design sketch of a version of Creature Features that uses music/genre classification rather than bird classification as a context.

4.3 Meaningful Creative Outputs

As discussed above, allowing learners to create personally meaningful outputs has the potential to engage a diverse group of learners in learning about AI. However, neither *Knowledge Net* nor *Creature Features* currently result in a personally meaningful creative output that could be shared with others (e.g., a visual art piece, musical composition, dance performance, etc.). We are exploring options for making the activities more creative and meaningful to learners.

One design possibility we are exploring with *Knowledge Net* is generating an output that is more creative than a chatbot, such as a creative story or visual that changes when learners alter the network. We have developed an early implementation of a version of *Knowledge Net* in which a story is generated from the network constructed on the board by the user. Using the Text-To-Text Transfer Transformer (T5) developed by Google Research[1], we have trained a language model on a curated dataset of semantic networks (e.g., friend is part of Team Hedgehog, sibling is part of Team Cobra, sibling beats friend) and the possible textual outputs associated with each network (e.g., My sibling is on Team Cobra and beats my friend on Team Hedgehog). Then, when users upload a picture of their semantic network to the *Knowledge Net* server, the model outputs a simple text describing that network. With this output, users can more intuitively observe how the individual facts in the network they build are compiled into a comprehensible AI knowledge representation, mimicking how humans piece together facts to understand an idea.

For *Creature Features*, we are exploring alternative machine learning classification contexts that may incorporate creativity and learner interests in a more significant way than bird classification. Figure 4 shows an early design sketch of a set of cards for creature features that includes popular songs and features describing those songs (e.g., length, tempo, popularity). Learners could create training datasets to train an algorithm to classify songs into different genre categories. A playlist could be generated using the learner's algorithm for learners to send to themselves to listen to at a home.

5 SUMMARY OF DEMONSTRATION

We will present an interactive demo of the *Creature Features* and *Knowledge Net* activity boxes alongside early-stage prototypes and sketches of the designs we are creating to scale the activity boxes up into museum exhibits. Our demo should fit on a card table. The demonstration should provide an opportunity for attendees to consider how embodiment and creative making can be used to foster AI literacy, and to consider how to build an ecosystem of informal learning experiences to foster AI literacy. We are eager to receive feedback from conference participants on our ongoing work.

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