Role of Object Detection in Supporting Observational Inquiry at Museums

Museums and science centers provide vital opportunities for the public to engage in hands-on exploration of real-world phenomena [5]. They enable direct observation and experimentation by making authentic tools of scientific inquiry, such as microscopes [2] and biomarkers [3], accessible. However, without appropriate scaffolding, visitors often struggle to use these instruments productively: they may find it challenging to pose meaningful questions or interpret what they see. As artificial intelligence (AI) increasingly transforms scientific practice [6], it also holds promise for supporting public engagement with scientific inquiry. AI technologies can act as adaptive scaffolds that help learners make sense of complex phenomena.

This work investigates *the roles that AI technologies can play in supporting observational inquiry* in museums. Specifically, we focus on the use of a machine-learning–based Object Classification System (OCS). To examine how OCS mediates observational inquiry, we prototyped and studied an OCS-integrated exhibit that helps visitors observe live microorganisms under a microscope. The exhibit (Figure 1) consists of a touchscreen beside a microscope with a slide containing live marine rotifers, algae, and microplastic beads. The microscope image is captured by a camera and displayed on the touchscreen, where visitors can interact with a digital user interface (Figure 2) that allows them to explore the microscopic world. OCS, activated by visitors during their exploration, identifies specific elements, along with the accuracy of the detection (Figure 3). The exhibit is located at the Exploratorium, a science museum in San Francisco.

For this study, we recruited museum visitor dyads (n=35) to use the exhibit and encouraged them to talk with each other and think-aloud. Their interactions were audio and video recorded. We also captured screen recordings and clickstream data to piece together each dyad's interaction with the prototype.

We conducted *interaction analysis* [4] to examine how visitors and the OCS jointly shaped moments of inquiry. We first identified significant events [1], that we defined as: user journeys where visitors conducted *observational inquiry*, i.e., they (1) *identified various elements* on the screen (rotifer, its parts (mouth, jaw, gut), rotifer poop, microplastic beads, and algae), or (2) *asked questions* about what they see on the screen, including descriptive, comparative, and explanatory questions. Next, we coded whether OCS was activated during a significant event. If activated, we inductively coded the role it played and wrote memos.

Our analysis is still ongoing. So far, we have identified four primary roles OCS plays in microscope-based observation inquiry: identification (e.g., what is this round thing?), finding (e.g., where is algae?), validation (e.g., am I right that this is a plastic bead?), and comparison (e.g,. how are algae and beads different?). We interpret these as recurring practices through which visitors make sense of what they see on the screen in relation to the system's classifications. In these roles, we found that OCS supports *observational inquiry* along the following dimensions: Discovery (identifying or finding elements on the screen), Correction or clarification (correcting incorrect observations), Hypothesis testing or theory formation (testing possible answers to questions), and establishing a foundation for further inquiry (laying out introductory information for deeper inquiry).

We have also identified three contexts in which OCS may limit or be superfluous to *observational inquiry*: (1) It may be erroneous and leave visitors confused or under-confident; (2) the active classification done by OCS may be irrelevant to the inquiry context; and (3) it may be less accessible than other supporting media, such as exhibit labels. We discuss how future work may address these limits by clarifying the erroneous nature of OCS, making the OCS features accessible and user-friendly, or acknowledging the strengths of real-time OCS in relation to other static media.

This study extends ongoing efforts to understand how AI can support scientific inquiry in informal learning environments and makes the following contributions: (1) In the emerging field of human-AI interaction for informal learning, it provides one of the first detailed analyses of how OCS can actively scaffold microscope-based observational inquiry in museums, (2) It identifies the *roles* OCS can play in supporting such inquiry and shows how these roles are enacted in visitor interactions with AI, and (3) It offers implications for the design of interactive AI exhibits that aim to scaffold open-ended scientific inquiry by illustrating how AI can be integrated as a dynamic scaffolding layer that enhances, rather than replaces, visitors' direct engagement with scientific instruments and phenomena. Taken together, these contributions advance the broader goal of understanding how intelligent systems can be designed to foster meaningful human interaction, learning, and sensemaking in technology-rich environments.

Figure 1. (Left) Touch-screen with a user interface (UI) displaying a 40X magnified image of microorganisms. (Right) Live specimen under a microscope.

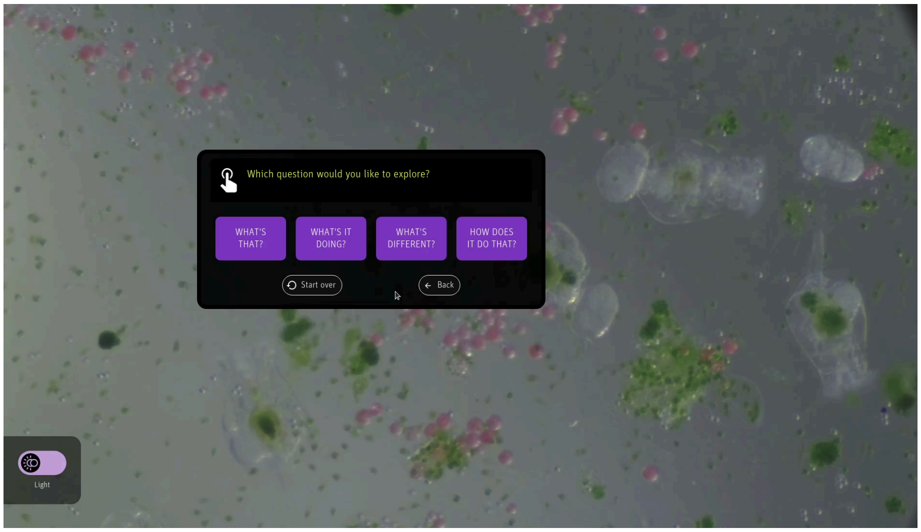

Figure 2. Touch screen with a UI to explore the microscopic image

Figure 3. OCS identifying algae and its accuracy

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