What are visitors up to?: helping museum facilitators know what visitors are doing

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ABSTRACT

In this paper, we describe a tablet application designed around an interactive game-based science museum exhibit. It is aimed to help provide museum docents useful information about the visitors' actions, in a way that is actionable, and enables docents to provide assistance and prompts to visitors that are more meaningful, compared to what they are typically able to do without this interface augmentation.

CCS Concepts

• **Education** → **Computer-assisted instruction** • **Information systems applications** → **Decision support systems**

Keywords

Tablet; Museum; Engineering; Tinkering; Scaffolding; Markov Models; Real-time analysis.

1. INTRODUCTION

There is an increasing number of museum exhibits that are employing digital augmentations as a means of supporting science learning [1]. At the same time, exhibit designers are also exploring how less-structured, open ended designs can foster higher levels of engagement, towards supporting new l learning opportunities. This open-ended exploration, often termed "tinkering", are characterized by exploratory, experimental, and iterative processes of learning, are particularly well suited for STEM-based (Science, Technology, Engineering and Math) reasoning and collaboration [2, 3].

In these kinds of open-ended designs, feedback and timely support are especially important, as visitors often lack the necessary expertise or prior knowledge needed to know how to effectively tinker and explore. A critical component of learning from tinkering involves exploration, failure, and re-exploration [5]. This mirrors the notion of perseverance commonly advocated for in engineering and STEM practices [6]. However, if a participant faces sustained failure without eventual success, they are likely to feel disillusioned with their efforts and the STEM practices more generally, resulting in a reduced chance of persevering in the future [4]. Thus, it is of high importance that we find ways to identify participants' 'states', so that appropriate assistance can be provided when they are stuck in sustained states of 'unproductive tinkering'.

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When museum exhibits supporting these kinds of open-ended tinkering lack well defined start/end points and permit free entry/exit of participants, it can become particularly difficult for museum docents, and even involved underlying technologies, to keep track of the actions, process, and 'states' of individual participants. underlining.

Together, these factors make providing timely assessment and feedback both valuable and hard. In response, we have designed a tablet application that computationally processes data of participants' actions at the exhibit, and presents it to nearby museum docents in ways that support real-time decisions based on accurate models of participants' states.

2. CONTEXT

2.1 The *Oztoc* Exhibit

This tablet app has been designed for use with an existing multi-touch tabletop exhibit in a large urban science museum, which generally has at least one museum docent (called an "explainer",) to assist, guide, and engage visitors. The exhibit, named *Oztoc*, situates visitors as electrical engineers called in to help fictional scientists who have discovered an uncharted aquatic cave teeming with never-before documented species of aquatic life [3]. The participants are asked to lure these fish out for cataloging, by building glowing "fishing lures". Participants manipulate wooden blocks labelled with symbols of electrical components, which are tracked on the digital tabletop interface. Making a successful circuit that has one or more appropriately powered LEDs, causes elusive fish to appear, and get "captured" in the lures.

The tabletop is divided into four "play spaces", which act as boundaries for individuals to play within, allowing multiple people to play simultaneously, as well as interact with each other. This allows for a host of inter-player interactions wherein players can see what others are doing, talk to others, and also notice and learn from others' attempts. These interactions can also be used to inform computational identifications of participants' states as being productive or not.

2.2 ADAGE – Using Play Data

Participants' play actions from the tabletop, are posted to a data aggregation server using the ADAGE (Assessment Data Aggregator for Gaming Environments) system [7]. This data is then available to use for analysis, even in real-time.

The kinds of data events posted by *Oztoc* to our ADAGE system include which playspace blocks are being placed on the table, moved, or connected; when a circuit is assembled: what blocks it is made of, whether the circuit works or not, and what fish is captured, if any. We can use this variety of event logs to obtain a rich picture of each player's actions, and extract meaning regarding the participants' states.

The current version of our tablet application uses real-time data to provide information to explainers about participants' actions and progress the participants have made. We have also used post-hoc data analysis to develop a trained Hidden Markov Model (HMM) that successfully identifies participants' states as engaging in sustained unproductivity [8].

3. EXPLAINER EVENT VIEWER (EEV)

The tablet application, herein called the EEV, is an interface meant to be seen on a handheld device by explainers at the museum exhibit, and gives at-a-glance highlights of events from the different play spaces, and when needed, suggested prompts that the explainer can make use of, if they deem appropriate (Figure 2).

The choice to provide feedback via suggestions to explainers is meant to bridge the difficulty either agent – the explainers or the game table itself – has individually, in making informed decisions about providing feedback. Allowing the explainer to see salient details of the participants' actions at a glance coupled with their knowledge about the context of play – who is actually at the table and who might benefit from assistance – gives them actionable information so that they can be more effective helpers.

Currently, there are five alerts with suggested prompts for the explainers to consider using with struggling participants. These appear in cases such as one playspace, making three circuits to capture the exact same fish, within a span of two minutes. This is a coarse indicator that the participant has attained a certain working state, but is not deviating to try different things at all. Similarly, there is a prompt when a participant makes three consecutive circuits all with the same "error" – repeatedly overpowering LEDs (caused due to lack of resistors and/or excess of batteries), or underpowering LEDs.

4. FUTURE WORK

We have recently developed a trained and tested Hidden Markov Model [9] that can tag each assembled circuit, as "productive" or "unproductive". This identification uses pattern mining across circuits made by over 1400 participants, and analyzing meta-information about the circuits, like complexity (number of components used), functionality (working or not), repetition relative to one's own history (whether the circuit being made is unique with respect to the circuits made earlier by a particular participant), and relative to the history of circuits made in front of them at the table (i.e. uniqueness of circuit compared to all the circuits made by others at the table). This tagging system is able to identify sustained bouts of unproductivity with a high success rate (i.e. multiple consecutive circuits being tagged as unproductive has been seen to co-occur with behavior we can qualitatively call unproductive tinkering in the context of *Oztoc*).

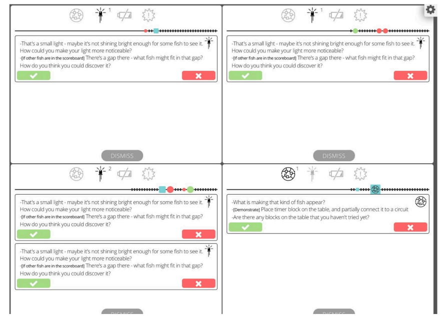

Figure 1. Screenshot of the EEV in action. Each playspace has a timeline of dots (small grey circles), with colored dots (blue square, large red circle, small red circle), indicating the different kinds of fish captured by the players. Playspaces have associated prompts such as – "That's a small light! How could you make you light more noticeable?"

We are excited to integrate this data analysis stream in the tablet interface, to have more reliable and actionable advice for the explainers using the EEV. We aim to have this portion of the tablet completed and tested by the time of the conference and will report on early findings on this work.

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