Exploring student engagement in an augmented reality game

MINNESOTA HISTORICAL SOCIETY

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Abstract

It has been argued that approaches to education should embed learning in activities that reflect the social and physical environments in which the knowledge is relevant. Only recently, did it become possible to situate learning in a variety of novel contexts using Augmented Reality (AR) games. This study investigates the behaviors of middle school students during their participation in an AR game called *Play the Past*. The findings of this study show that engagement differed during discrete activities in the game environment and that there was a relationship between the roles that students were assigned and their engagement.

Introduction

Situated Cognition

In order to study how individuals learn, it is necessary to consider how the activity, environment, and social processes interact to affect learning outcomes. Researchers studying situated cognition claim that these factors are integral to the learning process (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991) and have the capability to enhance or depress a person's ability to learn (Hendricks, 2001). Brown, Collins, and Duguid (1989) argue that approaches to education should embed learning in activities that reflect the social and physical environments in which the knowledge is relevant.

Augmented Reality

AR is defined as a "real-time direct or indirect view of a physical real-world environment that has been enhanced by adding virtual computer-generated information to it" (Hugues, Fuchs, & Nannipieri, 2011) that can apply to all senses (smell, touch, hearing, etc).

Today more than ever, it is possible to situate learning in meaningful ways by using new technologies, such as, AR games. In general, AR addresses the major facets of situated learning by providing meaningful context and supporting social interactions. AR further supports learning by helping students to engage in high level cognitive activities such as "authentic inquiry, active observation, peer coaching, reciprocal teaching and legitimate peripheral participation with multiple modes of representation" (Dunleavy, et al. 2009).

Design Principles for AR Games

AR games make it possible to situate learning in a relevant and engaging environment, leverage social processes, and create engaging activities. However, there are several design principles that must be taken into account to ensure students are engaged and are able to learn with the game:

1. experiences should encourage interdependence and interaction between roles to increase collaboration and engagement (Klopfer, Perry, Squire, & Jan, 2005)
2. experiences should "enable and then challenge", by creating environments that acclimate the user to the experience and then challenge them with more complex tasks (Perry, Klopfer, & Norton, 2008; Dunleavy, 2014)
3. experiences should be "driven by gamified story" (Dunleavy, 2014)
4. experiences should allow the users to, "see the unseen", by overlaying information onto the real world (Dunleavy, 2014)

Current Study

In the current study, we examine whether students exhibit different levels of engagement in different areas and roles in *Play the Past*, an AR game at the Minnesota History Center.

Methods

Study Design

This study investigates the behaviors of 7,129 middle school students during their 45-minute participation in an AR game called *Play the Past*. In this study, data analyses are performed on telemetry data collected by the iPod Touch used by each student. Telemetry data is commonly used to study the behavior of large samples of people who play digital games.

Table 1. *Telemetry data sample.*

Group Number	Player ID	Timestamp	Event	Event Type	Event ID
5252-75253	53445	3/13/15 16:51	53445 scanned Beaver Pelt.	ENTER_QRCODE	NA
5252-75253	53445	3/13/15 16:51	53445 viewed Beaver Pelt (Web Page).	VIEW_WEBPAGE	3718
5252-75253	53445	3/13/15 16:51	53445 received 1 Beaver Pelt (Item).	PICKUP_ITEM	47029
5252-75253	53445	3/13/15 16:51	53445 scanned Beaver Pelt.	ENTER_QRCODE	NA

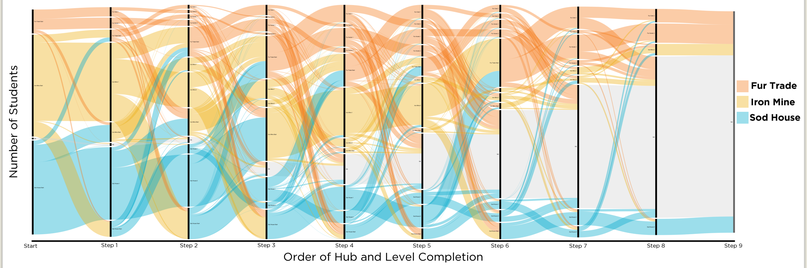

Figure 1. Student pathways through the game (left=game start, right=game end)

Hypothesis One

Level of Engagement. Based on the design principle proposed by Klopfer and colleagues (2005), which states that higher interdependence and interaction between distinct roles increases collaboration and engagement, we hypothesize that students will be most engaged in the Fur Trade hub, then the Iron Mine hub, and the least engaged with the Sod House hub.

Results

Students were more engaged with the Sod House hub and Iron Mine hub but did not fully engage with the Fur Trade hub, which provides evidence against the hypothesis. However, this trend is not present at earlier levels in each hub, which means that students have similar levels of engagement across hubs until Level 2.

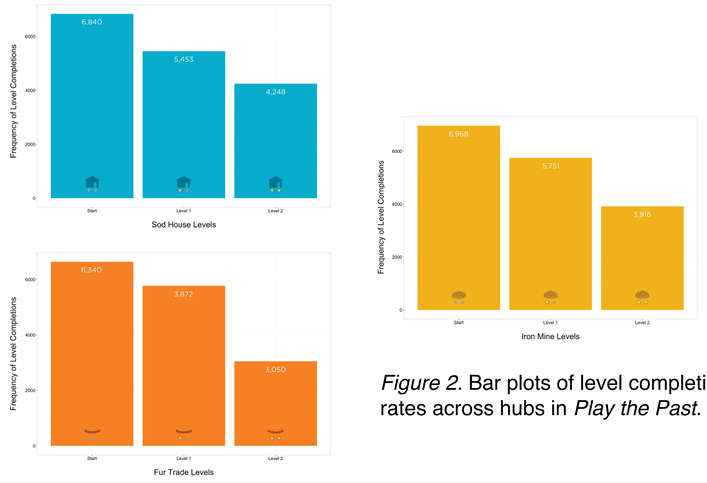

Figure 2. Bar plots of level completion rates across hubs in *Play the Past*.

Hypothesis Two

Effect of Role on Engagement. Due to the difference in the scaling of complexity between the two roles in the Fur Trade hub, we hypothesize that students who are assigned to be hunters will have a higher level of engagement with the game than students who are assigned to be clerks, because the "enable and then challenge" (Dunleavy, 2014) principle may have been violated for students playing the game as clerks.

Results

Only 1,208 clerks complete Level 2 in comparison to 1,842 hunters ($\chi^2 = 131.78$, $df = 1$, $p = <.001$). These findings suggest that there may be an imbalance in the design of the game between roles. To investigate this trend further, we focused on the specific behaviors of students in the Fur Trade. In particular, we focused on their interactions with the trading mechanic. To operationalize trading efficacy, we calculated a trade ratio for each student to reflect their skill at negotiating trades. For example, if a hunter paid one beaver pelt for an item that was worth three beaver pelts, the hunter would receive a trade ratio score of three for this trade.

Table 2. *Trade ratio scores between clerks and hunters across levels*

	Clerks	Hunters	*t*	*df*	*p*
Level 1					
N	1,128	789	9.78	2012	>.001
Trade Ratio Average (SD)	3.26 (2.93)	.58 (.62)			
Trade Ratio Range	.91-24	0-6			
Level 2					
N	1,195	1,835			
Trade Ratio Average (SD)	4.01 (4.59)	.74 (.47)	10.33	3159	>.001
Trade Ratio Range	.7-75.18	.06-9			

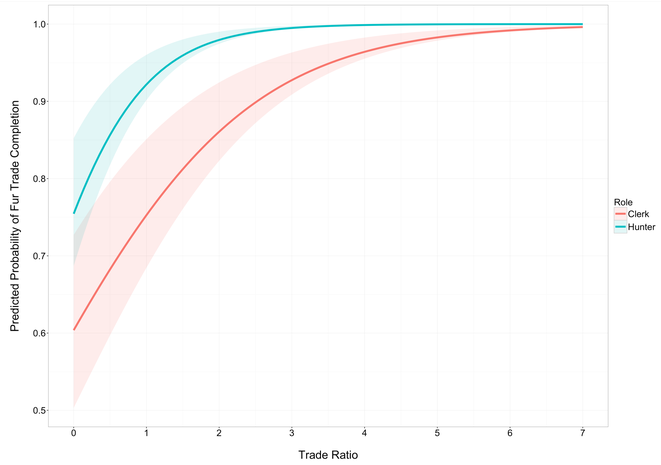

Figure 3. Predicted probability of Fur Trade completion by trade ratio and role

Our results show that the design of the roles employed in the Fur Trade hub (Clerk and Hunter) do not pose equally difficult challenges. Specifically, the students assigned to be a clerk must trade at a much higher profit margin than students who are assigned to be a hunter, which may interfere with the completion of Level 2.

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