

# “Are You ‘In’ or Are You ‘Out’?” Investigating the Factors Affecting Immersion in a Location-Based AR Game for IBSE

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**Abstract:** It is argued that augmented reality games can promote immersion and feelings of presence, which could support students’ engagement with the learning process. Sustaining presence is crucial but challenging, since immersion is a transient state. As part of a broader design-based research, in this study, we employed a focus group methodology to investigate the perceptions of eighteen 11th graders regarding the factors which affected their immersion during an augmented reality game for inquiry-based science learning.

## Introduction and Theoretical Framing

There is a wide-spread assumption according to which immersive Augmented Reality (AR) games could result to feelings of presence within the game, as a sense of being there. Dede (2009), who defined immersion “as the participant’s suspension of disbelief that she or he is ‘inside’ a digitally enhanced setting” (p.66), argued that immersive games could increase students’ engagement with the learning process. In recent years, we have witnessed a rapid increase in the number of location-based AR games for inquiry-based science education (IBSE). These games respond to the gamer’s position and augment physical landscapes with digital information, thus allowing students to explore the natural environment around them by using mobile technologies (Cheng & Tsai, 2013). However, despite the potential of these games, student immersion and sense of presence should not always be taken for granted. McCall, Wetzel, Löschner and Braun (2011) concluded that sustaining the players’ sense of presence at high-levels is challenging, since presence requires that students are fully immersed in the experience during the full AR experience. According to Reid, Geelhoed, Hull, Cater and Clayton (2005), this challenge could be attributed to immersion being a transient state, since players in AR games move constantly between immersive and non-immersive states, highlighting the need for further investigation of the factors that may affect or sustain immersion. Considering that there is a lack of studies investigating this issue explicitly, the present study focuses on the AR gaming experience of high school students who participated in an intervention involving a location-based AR game for IBSE.

## Methodology

A total of eighteen 11th graders played the “Trace Readers”, a location-based AR game we designed for the purpose of this study. The AR experience lasted approximately 2 hours; according to the scenario, students were asked to work in pairs sharing a tablet, in order to investigate an authentic environmental science problem regarding the decline of the mallard duck population at the lake. In order to accomplish their mission, students had to visit several stations by the lake and gather information from several game-based characters on different aspects of the problem. As part of a broader design-based study seeking to investigate what immersion is and how it is related to students’ learning, we collected data on students’ perceptions of immersion through two semi-structured focus groups, each of which lasting for 1.5 hours. Questions aimed at prompting the students about issues of immersion, asking them, for example, to express whether they were feeling as being more in the game world or in the real world while playing the game. The data were qualitatively analyzed, using the Attride-Stirling’s (2001) thematic network analysis to identify perceived factors of immersion. In other analyses, which are still under way, we are also examining videotapes of students’ discourse during the AR game to investigate student engagement and triangulate findings.

## Results

The qualitative analysis employed resulted in the categorization of the factors discussed in four different aspects influencing students’ immersion: (a) the user interface, (b) the narrative employed, (c) the gaming space and (d) unforeseen distractions (see Table 1). Relating to the user interface factor, students positively evaluated the use of an application with a user friendly interface, in order to augment the real world. They negatively evaluated the cartoonish graphics and game-based characters, as well as the text-based information provided, indicating the need for more realistic graphics and characters as well as for the replacement of text-based information with more multimedia content. Moving to the narrative factor, students expressed that since the narrative was structured around a problem-based investigation and included a diversity of data this contributed to their immersion, as they had to investigate and to connect several pieces of data in order to solve the mystery. In addition, students mentioned that they felt a sense of competition, explaining that this made the game more

challenging. As students also indicated, some of the gaming challenges in this narrative were not demanding enough and on occasions the plot lacked surprises; in these cases, students reported that their immersion was decreased. Another point made was that since informational data were provided by the game-based characters, there was a lack of agency, which hindered students' immersion. Where the gaming space factor was concerned, students emphasized the location-aware nature of the game that allowed them to be immersed in and enjoy the natural environment. Nonetheless, the students emphasized the need for a greater coupling between the physical and the virtual world, through the combination of both digital and real artifacts, for the creation of a more immersive augmented reality space. In addition, students disliked the hotspots' circular arrangement by the lake, explaining that they would like to follow a more challenging and complex path of inquiry. Finally, students reported on a number of unforeseen distractions that interrupted their immersion such as the hot weather, screen glaring due to the sunlight, environmental distractions, external noises or technical problems.

Table 1: Categorization and evaluation of factors discussed as affecting immersion.

Theme	Basic themes	Evaluation	Frequency
User Interface	User-friendliness of interface	+	42
	Realism, animation and interactivity of graphics	-	22
	Realism and fidelity of game-based characters	-	32
	Text-based information	-	37
Narrative	Problem-based investigation	+	34
	Diversity of data	+	44
	Competitive nature	+	10
	Level of challenge	-	25
	Agency and first-person perspective	-	17
	Gaming plot	-	18
Gaming space	Nature-based location	+	33
	Mobility and location aware nature of the game	+	8
	Balance between the physical and virtual world	-	23
	Hotspots' arrangement	-	24
Unforeseen distractions	Weather	-	72
	Technical bugs	-	19
	External noises	-	18
	Environmental distractions	-	14
	Screen Glaring	-	8

## Conclusions

There is a wide-held assumption that location-based AR games may afford immersive experiences as well as a sense of presence in the game, which are related to desirable learning behaviors (Cheng & Tsai, 2013). However, immersion is a transient state, provoking a fluctuation in the sense of presence (e.g. McCall et al., 2011; Reid et al., 2005). The present study investigated the factors which high school students reported as promoting or hindering their immersion with a location-based AR game for IBSE. Several factors relating to the user interface, the narrative, the gaming space or unforeseen distractions have emerged as affecting students' immersion. Our future work will attempt to triangulate these findings by analyzing students' AR actions and discourse in an attempt to understand students' feelings of presence and how to sustain students' engagement with the learning process.

## References

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