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Experiences of Personal and Social Immersion in a Videogame for Middle School Life Science

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Abstract. This short paper presents a description and analysis of personal and social immersion features in a life science educational videogame for middle school students. The paper defines personal immersion in relation to the player taking on a virtual role and engaging with the game as if they are themselves a part of in-game events. Social immersion comes from situating the player within a virtual community, in which the player and other characters in the world interact based on their virtual roles. The research study involved interviews with 24 students who used the game over a two-week classroom implementation. The study explored student perceptions about immersive elements of the game, and their impact on student self-efficacy, interest, and identity in science. Student responses indicated that they experienced personal immersion through engaging with the game narrative as a virtual scientist and doing science tasks, and social immersion through role-based interactions with other virtual scientists. Students described how their self-efficacy, interest, and identity in science were impacted by personal and social immersive elements of the game. The paper contributes to the literature through an analysis of these specific immersive game mechanics and their impacts on student attitudes.

Keywords: Game, Personal Immersion, Social Immersion, Middle School, Life Science, Ecosystems, Identity, Interest, Self-Efficacy.

1 Introduction

Game-based learning environments are a powerful new way to support learning through immersive virtual experiences. Immersion in learning games is not dependent on platform; the essential element is that the player has agency to engage in meaningful activities with virtual elements [1]. Often, these learning games are structured such that the game represents a problem or challenge in a realistic simulated setting, and the learner must engage in the practices to be learned in order to succeed. These "serious games" have been showed to effectively motivate users to learn and practice skills in meaningful and authentic contexts [2], [3]. Science learning games have been shown to provide immersive experiences through a simulated setting and situated, meaningful challenges [4], [5]. Virtual environments and simulations can provide realistic representations, immediate feedback, and challenges that increase as the learner develops more understanding or skill. Many of these games represent to the player that they are taking on the role of a practitioner or professional – e.g., a scientist, a doctor, or an airline pilot. It is rarer to find examples of games for learning in which the player not only takes on a role, but also becomes part of a community of simulated practitioners within the game.

Educational videogames have been described as creating immersion in numerous ways. In this paper, we define and focus on the dimensions of personal and social immersion in an educational videogame. In our definition, personal immersion relates to the player taking on a virtual role and engaging with the game as if they are themselves a part of in-game events. Social immersion comes from situating the player within a virtual community, in which the player and other characters in the world interact based on their virtual roles.

We describe the design of Wake: Tales from the Aqualab, an immersive web-based middle school life science game designed to teach science practices of experimentation, modeling, and argumentation in aquatic ecosystems. Wake was designed with specific attention to immersive elements within the game that had the goal of enhancing

learners' personal and social immersion to help students think of themselves as scientists and engage in authentic science practices as part of a virtual community. Players do not just roleplay a virtual scientist, they experience the game from the perspective of a specific virtual scientist, with her own motivations and feelings, and in that role, the player also continually learns from, and works with their colleagues, other virtual scientists.

A prior study with a beta version of Wake found that after playing the game, students indicated an increase in science self-efficacy, interest, and identity on pre-post surveys of science attitudes [6]. This paper conjectures that student experiences of personal and social immersion in the game may have contributed to their feelings of science self-efficacy, interest, and identity. This study extends the previous work through targeted interviews with students during a large classroom-based playtest experience with the final version of Wake, and present illustrative findings from those interviews, in which student shared insights into their own immersive experiences.

2 Literature Review

Researchers have identified and discussed many types of immersion [7], [8]. Nilsson et al. [7] describe four general ways to think about immersion in game-based media: immersion as a property of the technology mediating the experience, immersion as a sensory perception, immersion in a narrative, and immersion in the challenges of the game. This third category, narrative immersion, describes a focused attention on a story world and events [9]. Immersion in a narrative goes by other names as well, e.g., imaginative immersion [8]. Research on game environments in which the player can freely navigate, make choices, and actively engage with a story has found a positive impact on interest, and to promote feelings of presence, i.e., narrative immersion [1], [10].

Some researchers have looked more deeply into various ways in which players might be immersed in narrative. Ryan [11] identifies one subcomponent of narrative immersion to be "emotional immersion, the response to character." Gee [12] describes the player's videogame avatar as their "projective identity"; through acting as their virtual character, the player is supported in developing an empathetic connection with the virtual environment. Similarly, researchers have found that there is significant value in roleplay for learning. Virtual technologies can promote identity exploration through role-play, e.g., allowing students to "try on" the role of a scientist, which can contribute to a sense of science identity [13] and even inspire thoughts of future STEM careers [14], [15].

For purposes of this paper, we choose to focus specifically on two kinds of narrative immersion. The first, personal immersion, involves the player experiencing immersion through the act of taking on a role in an unfolding, interactive story. The second, social immersion, refers to moments where role-play is enhanced by interactions with other virtual characters who react and respond to the player. Relatively few science games involve the latter, though one example [16] describes a study in which students played as scientists working to solve a water-quality problem, including interactions with non-player scientist characters, and found that these students showed greater learning gains than comparison students in a non-narratively immersive condition.

We posit that learning games which aim to bring learners into new roles benefit from strong narrative immersion, having a storyline to situate the learner in their role, and are particularly further enhanced when there are other virtual characters in that same role who interact with the player, e.g., scientists who converse with the player as a fellow scientist. In this paper, we seek to explore the connection between student perceptions of their role in Wake and their relationship with personal and social elements of the design to answer the research questions, how do students describe their experience of personal and social immersion in Wake, and how might this experience relate to feelings of real-world science self-efficacy, interest, and identity?

3 Methods

3.1 Description of the Intervention

Overview. Wake is an immersive, open-world, web-based adventure game for middle school learners. The game is aligned with Next Generation Science Standards [17] for practices of experimentation, modeling and arguing from evidence in the context of life sciences topics. The game represents fourteen locations across five ecosystems: kelp forest, coral reef, bayou, arctic, and deep sea. Each location is based on real-world, realistic environments and species.

In Wake, players take on the role of a young scientist, Olivia, as she helps the non-player character research scientists at five ecosystem-based stations. At each station, Olivia takes on "jobs" for these scientists who ask her to help with their various research activities. The game includes a total of 53 jobs, each designed to be 5-15 minutes in length. Jobs may include exploring a site (Fig. 1), identifying new species, estimating populations, conducting experiments, and developing models (Fig. 2). Each job concludes with the player going back to the

job-issuing scientist where they are asked to make a claim and provide evidence through a conversation. Players are paid in money and experience points, which in turn let them buy new equipment and make new jobs available. In this way, players have agency to make choices about where to travel and which jobs to choose, with in-game scaffolding for the complexity of science practices.

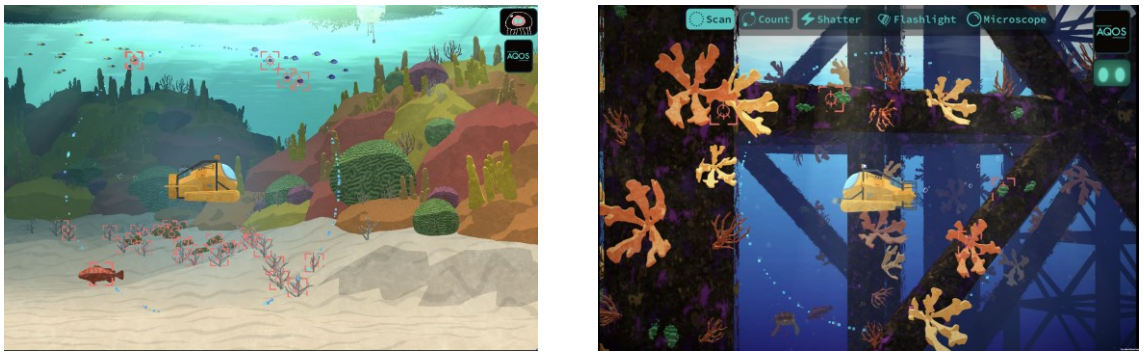


Fig. 1. Submarine diving into the Coral Reef Edge (Left) and Bayou Oil Rig (Right).

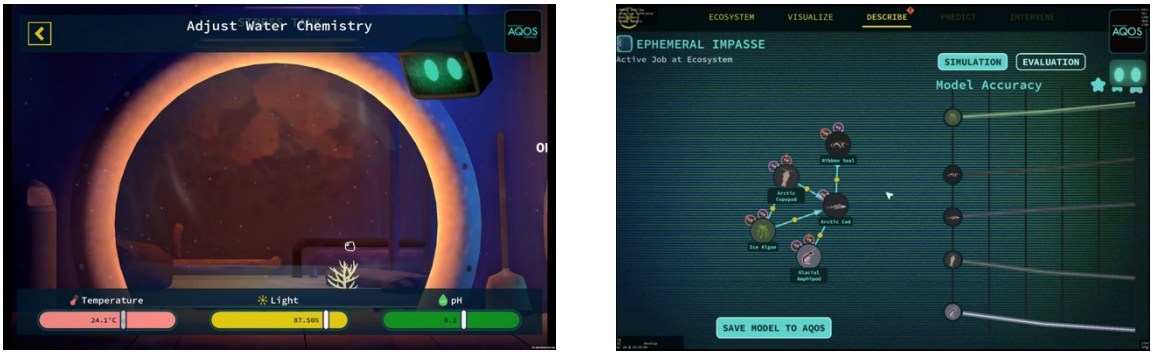


Fig. 2. Experimentation (Left) and Numerical Modeling (Right).

Roleplaying as Olivia within a rich cast of characters. The game design takes up the philosophy that science is conducted by complex human beings, complete with their subjective drives, fears, histories, and families. As such, in Wake, players take on a specific and complex character, Olivia, who is also called "Ollie" or "O." Olivia is written as a 22-year-old, multilingual Latine character. She recently lost her sister, Mer, in a tragic accident that haunts her dreams and reinforces the idea that nature is wondrous, but not safe. Over the course of the game, one of Olivia's primary arcs is one of facing her fears and coming into her own as an expert ecologist.

Olivia's mother is a brilliant scientist and principal investigator at the Kelp station. She has a vision to establish a kelp refuge as a memorial to her late daughter, Mer. She can become overprotective for Olivia's safety, while Olivia is eager to spread her wings. O and her mother are part of a cast of fourteen characters spread out among the research stations, each with their own quirks, verbal styles, and backstories, and varied in gender, race, and ethnicity. Through player interactions with these characters, the design team aimed to create personal and social immersion for the player (Fig. 3).

Fig. 3. The cast of Wake including the player character, Olivia Ramirez (far right).

Olivia's world is influenced by the professional practices of scientists. In her interactions with other scientists, O discovers the vast diversity in the kinds of people that do science, and why they do science, what they're excited about, and how they have conversations with O about phenomena, theories, and problem-solving. O adds notes to a journal after each job, noting science facts, and her feelings as a scientist – expressions of curiosity, excitement, fear, and awe. In one job sequence, she searches for a missing whale, finds its remains, discovers and studies the species that are fed by its nutrients, and learns how they in turn provide energy for other organisms living on the ocean floor. O comments to herself about how fascinating the experience is, saying "Wow! Prof. Whalen was right about this place. I mean, snow crabs? Zombie worms?? I never even dreamed these things existed!" (Fig. 4).

Fig. 4. Olivia expressing excitement and awe, "I never even dreamed these things existed!".

When O reports back on each job, dialog tree conversations allow the player to select and "argue" from evidence (Fig. 5). In the player's converses with the other scientists as colleagues, O and the other researchers' personalities are expressed. For example, when scientists at the oil rig ecosystem are trying to determine whether to remove an artificial reef. Dr. Harper asks O to build a predictive model to show how removing the oil rig would affect the sea turtles, and then asks her whether the rig should be removed. Dr. Harper then tells O they will go with her recommendation, O is startled by that trust in her work, and Dr. Harper praises O's thoughtful use of data to make choices (Fig. 6).

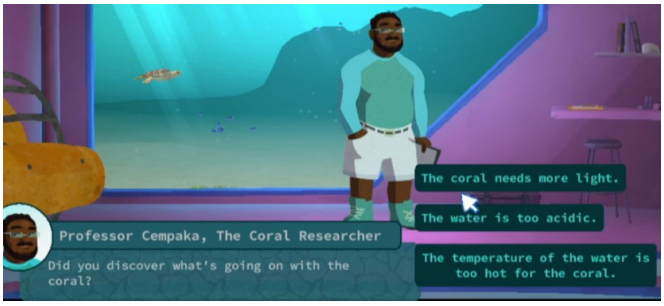
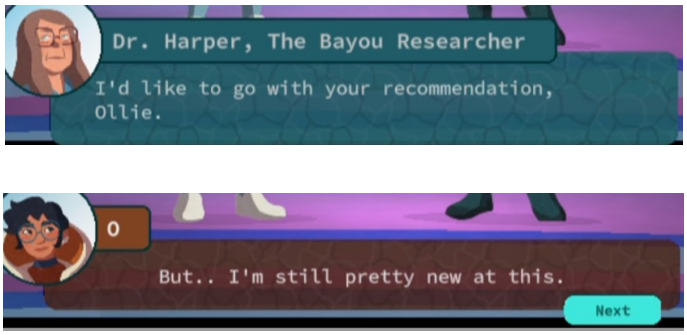


Fig. 5. Making evidence-based arguments.



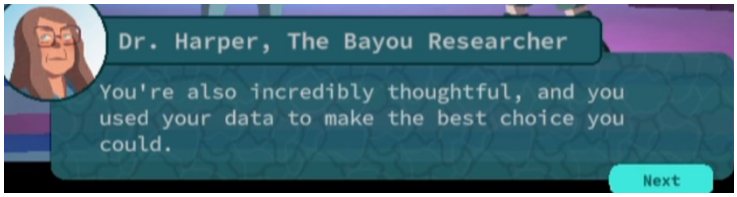


Fig. 6. Olivia (nicknamed "Ollie" and "O") being respected as a scientist by another scientist.

3.2 Study Design and Data Collection

A prior classroom study of a beta version of Wake found that students indicated increased feelings of science self-efficacy, interest, and identity after playing the game [6]. That study measured attitudes through a previously validated pre-post survey that contained three constructs, self-efficacy, science identity, and interest, each consisting of multiple Likert scale questions. For questions pertaining to self-efficacy, students were asked to respond on a scale of 1 to 6, for example, "How confident are you that you can investigate what causes change in an environment." Questions about science interest and identity similarly used a scale of 1-6, in which students were asked, "Click the button that best describes how true or false each statement is for you," followed by statements such as "I consider myself a science person" (identity) and "I am interested in learning about ecosystems" (interest).

This study extends the previous work as follows. The research team conjectured that the design of personal and social immersive elements in the game may have been a contributing factor towards these attitudinal shifts. This study was designed to gather preliminary data around student experiences and potential impacts of personal and social immersion through targeted interviews with a sample of students during a playtest experience.

The data for this paper comes from student interviews during a classroom-based playtest experience of the final version of the game. It should also be noted that the beta version of the game from the prior study did not include the final artwork, so this final version of the game included more visual immersive elements, including representations of the diverse population of virtual scientists (in the beta the dialogs were all represented through text only).

The playtest involved four 7th grade science teachers and approximately 300 students. The students used the game during the last few weeks of the school year, for a total of about eight class periods, each about 40 minutes long. During the last few days of gameplay, a researcher visited classrooms to conduct interviews. Teachers asked students if they were willing to be interviewed about the game, for whom prior consent had been obtained for interviews. Volunteer students went individually to talk to the interviewer in the back of the classroom. Audio recordings were made of each interview; interview duration was approximately 3-6 minutes. The students (n=24) were asked the following questions:

Immersive elements:

1. Did you feel like a scientist when you were playing the game? If so, what about the game might have helped make you feel that way?
2. What did you think of the way we represented scientists in the game?
3. What did you think about playing as Olivia in the game?
4. What did you think about getting to travel around and choose jobs to do?
5. What did you think about the storyline and mystery elements of the game?

Science attitudes:

1. Do you feel like the game affected how confident you feel about doing science? If so, what about the game might have helped you feel more confident about doing science? (self-efficacy)
2. Do you feel like the game affected your interest in science? If so, what about the game might have made you more interested in science? (interest)
3. Do you feel more like a "science person" (somebody who is into science) after playing the game? If so, what about the game might have made you feel more like a science person? (identity)

Students' open-ended interview responses were analyzed using an emergent coding methodology. An initial read-through of the responses was used to note affirmative or negative responses as appropriate and students' descriptions of game elements. A second phase of analysis was used to categorize and group common elements into codes.

4 Findings

Student interview responses were enthusiastic about many of the elements of the game, including the visually realistic representations of ecosystems and organisms, the many different ecosystems to explore, the autonomy to choose where to travel and which jobs to do, the appeal of figuring things out and completing jobs, the "fun" mystery and "scary" dream elements, and simply the novelty of getting to do science through playing a game.

While most students enjoyed the game, there were also negative aspects of the game as described by some students in a general classroom survey of what students liked and didn't like about the game. The most common criticisms included students finding some jobs and tasks confusing, with not enough in-game help. Some jobs were also described as boring, tedious, or too hard. And some students' interest waned after playing the same game for many days. The study was conducted during the last few weeks of school for the year, a time when teachers report that students are generally less motivated and eager to be done with school. The teachers, however, described students as generally excited and engaged, and noted that the opportunity to use a science game in class was "a treat for kids as an end of year activity."

Here we present a summary and illustrative quotes from student interviews that focus on responses that highlight feelings of personal and social immersion.

4.1 Personal and Social Immersion

Personal Immersion. Students all agreed that they "felt like a scientist" while playing Wake, and their explanations reflected feelings of personal immersion as they described getting to do science, and to learn what scientists do. For example:

- I feel like I'm an explorer and a discovery scientist. Going underwater and scanning things and learning about new species.
- [in Wake] you're an actual scientist. It's what scientists actually do. It's not just doing random things. It actually makes sense. Like with the measurement [taking], how you get all the data and everything. [They use] actual numbers and stuff.
- [Wake] gives you an idea of how scientists figure things out [,..] For example, the modeling lab, that's a new skill I've learned. And then there's exploring and scanning, and why scientists are scanning and counting species and such, so that helped.
- I would say I did feel like a scientist, especially with all of the measurements and observations and stress tanks.
- When you're playing the game, it's more of you interacting, doing stuff that a marine biologist would usually do.

When asked what they thought about playing as the specific character Olivia in the game, most students said they liked it, thought the feature was "cool," and unexpected. One student said "I learned that she thinks about her job a lot, and she dreams about it, and she loves it." Other students said that they didn't think much about being Olivia, "because you're just kind of given the character," and "I just tried to solve the missions… I felt more like it was me in the game than I was playing as someone."

Social Immersion. Student responses pertaining to social immersion centered on interactions with other scientists in the game. Many students said that they liked the way scientists were represented, and often specifically expressed appreciation for the variety and diverse personalities of the scientists. For example, one student said:

- I love it! I think it's very cool that... there's a whole story and they're all different. What I like about the different stations - they're all different. You go to the Bayou; both of [the scientists there] have different personalities, and the Arctic. They're all different, which I really think is cool. Like you're saying, not all scientists are the same, and every single person that you meet is going to have a different field of expertise and want to do different things, and I think that's great.

Students also often mentioned getting to interact with other scientists as something that helped them feel like a scientist themselves, for example:

- It makes you feel in that same kind of role [scientist], that you're the one getting the data and you're the one presenting it to others.
- It's really fun to explore all those different things and feel like you're helping the character scientists figure out different things.

Other students spoke enthusiastically about the relationships between Olivia and the other scientists, and felt that the storyline added to the fun and coolness of the game:

- I like how there's Olivia and there's the adults that help her.

- I think it was definitely better with the character. I liked the relationships you have with your Mom, with your uncle. I like what happened, the story line with [Mer] and Sam.
- I think the storyline was really helpful. I like how when you talked to some of the people that [are] in the other dock, they knew about it and your family. That was really good. In the kelp forest, there's the Tío and then there's the mom. And the Mom works on everything, right? They have the new kelp refuge camp. And it fails. And they make it again.

Finally, students expressed positive feelings about the presence of Spanish-speaking characters in the game. Students who did not speak Spanish said it didn't bother them; they thought it was cool and that it showed diversity. Students who did speak Spanish noted that "I felt included," with one saying:

- It was really cool, because it was like diverse, and I come from a Spanish-speaking household, and it's cool to see that in games. because developers don't do that often, and whenever I saw the Spanish I was like, hey, I know what that means, and it sort of felt like special, you know?

4.2 Self-Efficacy, Interest, and Identity

The students in the study overwhelmingly affirmed that the game had positively influenced their science self-efficacy, interest, and identity. When asked what about the game might have affected these factors, their responses often included aspects of personal and social immersion in the game, as follows.

An increased self-efficacy, or confidence in their ability to do science, was most often explained as getting to learn what scientists do by doing the science tasks in the game. Some responses:

- It definitely gives me an idea of what happens during science, like instead of just, oh you have to do this to figure it out, it kind of, gives you an idea of how scientists figure things out.
- I feel like now I am confident in the fact that I can do science, I understand science-y stuff. I think it's got to be the measurement, the stress tank, and the observations.

Game features associated with an increased interest in science were the realistic representations, exploring different ecosystems in the ocean, and specific or unusual sea life and interactions. One students' response specifically mentions personal and social immersion aspects of the game as how the game affected their interest in science:

- I think being able to explore everything. When I finish a job, I just feel so complete. It's really fun to explore all those different things and feel like you're helping the character scientists figure out different things.
- Students' science identity, an increase in feeling like a "science person" was linked primarily with the personal immersion of getting to be a scientist and do what scientists do. For example:
- When I played the game it made me feel like a real scientist, so, I felt like I had a career and I knew what I was doing.

One student also commented that the game activity of reporting findings to the other virtual scientists and making a claim was particularly instrumental in their feeling like a science person, suggesting that social immersion may have also been in play:

- You could go and choose what you want. Do the experiments and you can find the answers and, especially reporting back, you can go through all the information. And you can choose what supports your idea, what supports your claim about what happened.

5 Discussion

Interviews with students who had played Wake identified significant evidence that they experienced personal immersion, engaging with the game narrative as a virtual scientist. Students confirmed that in the game they felt like they were being a scientist, and doing what scientists do. They described engaging in science tasks, completing science jobs, and having the agency to travel to different ecosystems, and choose jobs that interested them.

Evidence of social immersion, narrative interactions with virtual characters who connect with the player in their role as Olivia, was identified in students' comments that they liked helping other scientists and enjoyed seeing the relationships between characters in the game. Students appreciated the aspect of making a claim in the game by presenting your data and conclusions to the other scientists. Students liked the diversity of other scientists, who each had their own personalities and opinions, and described feeling engaged in the storyline.

This work extends the prior study of a beta version of Wake by exploring personal and social immersion as factors that may contribute to students' attitudes about science, through identifying interview responses in which students connected personal and social immersion with feelings about science. These findings provide some preliminary evidence suggesting that playing the role of a scientist, and interacting with, helping, and making

evidence-based arguments to other scientists, can be linked with enhanced feelings of self-efficacy in science, interest in science, and science identity.

In considering limitations of the study, we first note that the sample of students interviewed was not random. Students in the study volunteered to be interviewed, and they tended to be quite enthusiastic about the game, likely more than average. Further, there are limitations of collecting data about feelings of immersion through post-interviews. Outside of the game, it may be hard for students to recollect feelings of immersion in connection with specific experiences like conversing with the virtual scientists in the game.

More significantly, as immersion has been linked with so many different videogame features, it can be a challenge to distinguish different types of immersion. Players may experience perceptual immersion through engagement with realistic visual representations of the undersea world and its fascinating organisms and phenomena. Immersion through playing in the role of a scientist may be conflated with the mental absorption of figuring out science tasks and solving problems. In this way, personal immersion may be hard to differentiate from strategic, challenge-based immersion in the game.

Future research with Wake hopes to use the game as a testbed to understand more deeply how students experience these and other aspects of immersion and how those experiences impact attitudinal measures including self-efficacy, interest, and identity in science. Wake researchers are planning future classroom testing with diverse populations of students and will develop deeper measures and analysis methods to explore these questions, using both qualitative and quantitative methods. A future study will also include a focus on Spanish-speaking students: how Latine students perceive the game characters, story, and translation, and whether any of these design elements may affect science identity and belonging for this population.

Acknowledgments

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