

Learning math through a game-based personal excursion

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Abstract: This case study explores how middle-grade learners use a game-based app for math learning at an informal site, the Nature Center. We apply distributed and self-directed learning theories, emphasizing learning in specific contexts, social settings, and through tools like an iPad app. We employ the embodied action conversation framework to analyze critical interactions. Two cases emerged: (1) learners followed MathExplorer app rules, and (2) learners went on personal excursions, creating their own rules to improve their MathExplorer rankings. We discuss implications for designing technologies for informal math learning.

Conceptual Framework

We draw on self-directed learning theories (Azevedo, 2006) to understand how learners engage and stay motivated in activities. Personal excursions, a construct within these theories, highlight learners' self-initiated activities when connecting to content (Azevedo, 2006). Gamification for learning is a growing field, and video games can be a powerful tools for education (Ke, 2016). Educational games should intrinsically integrate game mechanics with academic subjects (Ke, 2016; Walkington, 2021). However, the gamification of mathematics introduces the token economy, potentially controlling skill acquisition and emotions (Jablonka, 2017). The MathExplorer app utilizes an adventure game format to enhance problem-posing skills through math walks (Wang & Walkington, 2023), employing a credit-based token system to incentivize progress. This approach combines intrinsically integrated mathematical tasks with gamified rewards, balancing deeper engagement with surface-level incentives (e.g., video interactions, picture-taking). Toward this end, the research question guiding this study is: How do youths' emotional, interactional, and technological stances come up in discussions surrounding the gamification of mathematics within an informal learning environment?

Methodology and Analysis

This case study (Yin, 2014) examined how middle-grade youths used a game-based app to facilitate their excursions, in tandem with and sometimes in contradiction with the planned purposes of the technology-enhanced math walk. This manuscript focuses on a single group of learners on the first day of the camp, consisting of five middle-grade learners, an adult facilitator, and a researcher. This manuscript focuses on a single group of learners on the first day of the camp, consisting of five middle-grade learners, an adult facilitator, and a researcher. We utilized embodied action conversation analysis (Heath & Luff, 2013) as our analytical framework for this manuscript. This framework encompasses three tenets: interactional construction of a turn-at-talk, expression of feeling and emotion, and how tools and technologies feature in collaborative action.

Findings

Before entering the Nature Center, the learners were briefly introduced to the purpose of math walks and were provided an iPad to choose their in-game names and create their avatars. After the learners were comfortable using the MathExplorer app, each group began exploring the Nature Center. The first case took place approximately 45 minutes into the first day of the camp. The learners walked through a portion of the Nature Center and captured photos of things they noticed in their surroundings. The group arrived at the entrance of the Nature Center, sat on the ground, and decided which picture they wanted to annotate and pose a mathematical question. Jack's attempt to steer the conversation towards mathematical inquiries about snail shells ("What do you got?") is hampered by pauses, indicating his struggle. Neptune briefly engages, highlighting shell size with gestures ("Um, why are the snail shells so big...") but his flat tone suggests waning interest. Jack encourages Neptune to articulate observations ("Like, how big..."), emphasizing size importance. Neptune responds, mentioning "average size" ("°Average size of a snail shell?°"), integrating mathematical terms. Phoenix's enthusiastic input ("Like, finding the average size...") is ignored by Neptune, who redirects Jack's attention to larger shell sizes ("It's like this"). emphasizing their mathematical significance. Jack tries involving Phoenix ("So, what was your..."), but Neptune interrupts ("°Average size of a snail shell?°"), leaving Phoenix seeking validation. Neptune flatly completes Phoenix's question ("°Average size of a snail shell?°"), showing disengagement. Jack's slow, dismissive response ("<Yyyeah>") signals dissatisfaction. Jack's struggle to lead towards a mathematical perspective on snail shells,

emphasizing size, prompts Neptune's response. Phoenix seeks validation but is interrupted, leading to Jack's dismissive acknowledgment, signaling dissatisfaction.

Case two comes from the end of the first day. The learners arrived in the classroom to debrief and share their mathematical noticings with their group. The discussion quickly shifts into a conversation related to aspects of the game. During a discussion on elevating ranks, Jack animatedly engages with the learners, highlighting a flaw in the MathExplorer game, "((Gesturing towards Neptune and facing Oberan)) That might be something they have to work through so you don't scroll through it ((turns back to look at Neptune while smiling)). (...) Just get points (.), rack up a bunch of points," which suggests his pride in the discovery. Neptune responds defensively, indicating discomfort and avoiding eye contact, as he denies watching the game, "~No, I, I, I am~ ((continues to say defensively))." Meanwhile, Aries contributes to the discourse by emphasizing keywords, aligning with both Neptune and Jack's perspectives, "He's watching for key:::words (.)." These interactions provide insights into the evolving group dynamics and individuals' reactions, showcasing active engagement and differing viewpoints.

Discussion

In the first case, we observe balanced discourse influenced by the adult facilitator, emotions somewhat disconnected from math, and technology aiding learners. We see increased math discussions when immersed in the Nature Center. Collaborative efforts, interruptions from Jack, and varied emotions like curiosity contribute. Group dynamics, including Jack's involvement, Neptune's changing responses, and Phoenix's contributions, are vital. A range of emotions, from uncertainty to excitement, reflects challenges in engaging with math concepts. Interactional stances drive progress by encouraging image capture and math questions. Notably, Neptune, despite emotional detachment from math, plays a significant role, contrasting with his emotional investment in game discussions in the next section. The second case, dissects interactions that are predominantly focused on the game itself, where learners took charge, directing conversations with the MathExplorer app as the central topic. They discussed strategies to improve their game rankings and credits in the virtual "token economy" (Jablonka, 2017). They navigated discussions about game points, revealing complex emotions through Neptune's pride, guilt, and embarrassment, as well as Cybele's relief and insecurities. Their interactional stances primarily focused on gameplay and peer interaction (Azevedo, 2006), with emotions shifting between excitement, confusion, and hints of jealousy. These interactions and emotions were closely tied to the game, highlighting the drawbacks of incorporating a "token economy" in learning gamification (Jablonka, 2017; Ke, 2016).

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