Emergent Learning Possibilities and Evolving Design Spaces in Students’ Redesigning the Pandemic Board Game

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Abstract: We discuss a study on grade 7 students’ exploring emergent systems while redesigning the board game Pandemic using mathematics and science topics. We evaluated students’ developing ideas and the unfolding learning possibilities through the redesign process. Our findings show how game redesign supported learners' decision making and their evolving conceptions of problems.

This project used a board game redesign approach to learners’ engagement with emergent systems using mathematics and science. We follow the concept of learning as an emergent phenomenon that expands learners’ capacities to adapt to and participate in novel situations. Complexity perspectives use the notion of enabling constraints: appropriate structures in learning designs free learners from having too many choices, provide shared goals and language, and enable learners’ different responses (Davis & Sumara, 2006). We discuss how the board game redesign approach sets structures that enable students’ collective decisions, which eventually expand their engagement with math and science topics. We attended to the following questions: How did the learners’ co-design spaces evolve through the redesign process? How did learners’ decisions frame their designs and use of math and science in creating game systems?

The literature on design similarly signifies constraints as shaping creative pathways (Sternberg & Kaufman, 2010). Constraints could be external such as materials, or self-imposed emerging from designers’ ideas and decisions. With every decision, designers impose constraints on their work that not only restrain the next actions, but also become tools to think with and to explore new design spaces. Design space is interpreted as a dynamic conceptual space of possibilities that is constructed as designers go through the design process (Biskjaer et al., 2014). Systemic perspectives describe it as continuously developing through the interactions of designers and design conditions. Designing board games, as models of systems, could engage students in developing and shaping the design space with mathematics and science (Kim & Bastani, 2017; Saxe, 1992). Kim et al. (2020) showed structuring game design projects as re-designing board games, in which learners play a common board game and change its elements to create their own games, enabled learners to creatively engage with disciplinary ideas. The common starting point and physical material supported learners’ communication and shared goals. In the iterative process of design, learners’ evolving decisions become frames that direct their further inquiry into design problems. Using our data, we will discuss how learners’ design decisions developed through redesigning the Pandemic board game and enabled them to expand their ideas and use math and science topics, thus their design space.

Research design and data sources
We conducted this design-based research with grade 7 students in a Canadian school, in Fall 2018. We developed the activities with the math teacher (also a game designer) and focused on the topics of numbers, statistics and probability, and the science topics of interactions and ecosystems. We collected ethnographic data through field notes, video-recordings of students’ designs and group interviews. We used the cooperative game Pandemic which models disease spread across the world (Figure1a), as the game to be redesigned. We used it as a model of an emergent global issue. In this game, players work together to treat infected populations and discover the cures. The student groups began by playing the game. Then they brainstormed on design ideas and using learning topics and redesigned Pandemic.

Findings
Our unit of analysis was the critical episodes in which the interaction of learners’ ideas, materials and activities transformed their collective design space. Here, we chose one group whose redesigned game was Reverse Pandemic. The group’s design decisions enabled them to expand their ideas and use of math and science, thus their design space.

The group developed the idea of reversing Pandemic’s narrative, i.e., players would act as diseases spreading around the world, which directed their design process. We observed that the Pandemic’s physical materials, e.g., the cubes representing viruses and board map, mediated their discussions on game redesign ideas.
Initially, they tried to implement their idea of reverse Pandemic by defining opposite functions for the original game’s components (e.g., cubes representing cures instead of diseases). While this approach might not be helpful in reversing the dynamics of a game system it encouraged them to explore the original game system.

It was important for the group to taking the perspective of bacteria and viruses. In a critical episode, their conversation around Pandemic’s and their own game’s theme with a science teacher led to elaborating their game backstory through exploring how bacteria and viruses act. They discussed how bacteria develop resistance against antibiotics and mutate and how viral diseases spread with international travels. Discussing cities’ defence against diseases, they talked about how vaccines could develop widespread immunity. An intentional interaction between students and teachers mediated by Pandemic’s board and other components supported integrating learning topics. The group’s work showed that mathematics can become a tool to materialize ideas. The group found to reverse the Pandemic’s narrative, they needed to understand the game’s system more deeply. They evaluated the infection cards that determine the cities to be infected based on designed probabilities, and the epidemic cards that trigger an outbreak. Their choice of reversing the Pandemic’s story became about reversing its logic: i.e., their design problem evolved so as their choices and design space, exploring more possibilities of using math. They created numeric values for players’ power (diseases) and adopted probability for vaccination cards (one out ten players’ cards were vaccination cards), which made cities’ defence dynamic. The group’s goal of having playable drafts and playtesting (Figure1b) encouraged them to use mathematics in different design stages from the beginning. Students could experience the problems in context by confronting their own designs (Kim et al., 2019) and could develop more holistic views about this complex system.

Conclusions

We structured this project as a board game redesign to limit the vast possibilities of creating a game from scratch, and support learners’ shared conception of their design practices (Bastani & Kim, 2020). Students used the original game’s languages and components and shared the goal of reversing its theme. Game redesign enabled collective decision making, through which learners explored novel paths of integrating learning topics: i.e., expanded their design space.

References

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