Uncovering Play Through Collaboration and Computation In Tabletop Gaming

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- Extended Abstract -

Games scholarship has moved beyond principled description of experiences of gameplay to uncovering the ways that players make *meaning* in gaming spaces, be they in digital forms, tabletop forms, or physical games. Uncovering the structures of play within games implies better addressing the ways in which rule sets, the social milieu of a particular game, and even the motivating potential of a game narrative can all interact in the shaping of a game experience. In the present study, we address several of these concerns by teasing out the interaction of two valued practices found within game play: *computational thinking* and *collaboration*.

In this work, we investigate how players exhibit computational thinking and collaboration in delimited play space — the strategic board game *Pandemic* (Leacock, 2007). *Pandemic* is an award-winning, collaborative tabletop game in which up to four players work together to rid the planet of four diseases concurrently spreading across the globe. Involving negotiation, the development (and iteration) of collaborative strategies, as well as a potentially motivating "save the world" framing, the game provides researchers with a rich space in which to study the interaction of computational thinking and collaboration. As studies of collaborative tabletop games (e.g., Zagal, Rick, & Hsi, 2006) have revealed their interesting complexity as play spaces, we see *Pandemic* as a useful testbed in which to study how game rule sets, social configurations, and a motivating theme can combine to provide meaning to their players.

With regards to computational thinking, we hypothesize that *Pandemic* and other collaborative games afford practices within the "cognitive pillar" of computational literacy (diSessa, 2000), in which players use computational thinking in order to solve complex problems (e.g. Papert's, 1980, "procedural thinking"). With the recent emphasis on understanding the dynamics of computational thinking (see National Research Council, 2009), we see collaborative board games as a fruitful domains in which to assess the development of informal computational thinking practices – primarily through the understanding of rules and the iterative development of strategies, "run" by the participants in the game. Additionally, we investigate the forms of collaboration that take place within gaming spaces, focusing on vocalized "help seeking" (e.g., Alevan, et al, 2003; Nelson-LeGall, 1981) or verbalized expressions by participants during the game in which assistance for others is discussed. We hypothesize that tracking the overt vocalizations asking for, receiving, and arguing over assistance within the game can help to capture elements of the game's collaborative play structure.

We conducted a series of eight studies using *Pandemic* to investigate these practices. In this work, we have assessed both the naturalistic play of the game, as well as simple game modifications designed to elicit differential degrees of computational thinking and collaboration through play of the game (Berland & Lee, 2010; Berland & Duncan, 2012; Duncan & Berland, 2012; Duncan, Boecking, & Berland, 2012). By "tinkering" with the game's rule set, we have attempted to isolate and augment certain forms of play already present within the game that, we hypothesize, can bring aspects of computational thinking and collaboration to the fore. Berland & Lee (2010) initially established the presence of several computational thinking practices within the "vanilla," or basic form of the game, and we developed these new modifications of the game to differentially elicit a computational thinking practice for each. See Table 1 below for a description of each of the modifications, the hypothesized changes to computational thinking, and number of game runs per condition. For all conditions, all verbal interactions between participants were recorded, transcribed, and then coded by participant by game turn (if a participant made an utterance that matched a computational thinking code on a given turn, it was marked as occurring on that turn).

	n	Modified Rule	Hypothesized Change in Comp Thinking
Group 1	4	"Vanilla" – No rule change	Control Group
Group 2	3	"Vanilla" – No rule change	Control Group
Group 3	3	"Cheat Sheet" – External notes allowed	Increase in *Strategy Debugging*
Group 4	2	"Cheat Sheet" – External notes allowed	Increase in S*trategy Debugging*
Group 5	3	"Ghost Player" – Additional piece controlled by all	Increase in *Simulation*
Group 6	2	"Ghost Player" – Additional piece controlled by all	Increase in *Simulation*
Group 7	2	"Disease" – Reskinning theme to teach about disease	Increase in *Rules Debugging*
Group 8	4	"Disease" – Reskinning theme to teach about disease	Increase in *Rules Debugging*

Table 1. Each of the eight game groups, with number of participants (n) per game run, modified rule added to the game, and hypothesized change in computational thinking.

Eight total game runs were conducted, transcribed, and computational thinking codes were applied to each transcript (presenting over 95% interrater agreement). As can be seen in Figure 1 below, computational thinking varied quite a great deal between conditions, with some conditions such as the "ghost player" condition, exhibiting very different results than expected — in this case, a high degree of simulation was confirmed, but also quite a bit of "strategy debugging" and "algorithm building." If strategies were being iterated, and algorithms built, what were they being developed *for*? Therefore, we were thus compelled to conduct further analyses of the *collaborative* structure within the game, and how they may be revealed through an analysis of help-seeking (Aleven, 2003; Nelson-LeGall, 1981) in the interactions between players.

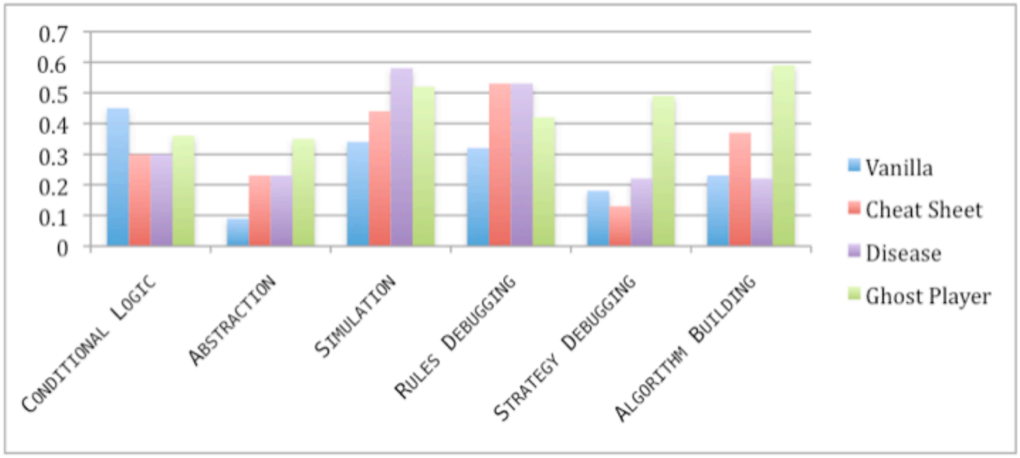

Figure 1. Proportion of computational thinking codes (Conditional Logic, Abstraction, Simulation, Rules Debugging, Strategy Debugging, and Algorithm Building) applied for each of the four game conditions (Vanilla, Cheat Sheet, Disease, and Ghost Player).

In order to do this, we further focused on the "ghost player" condition in which players were asked to control an extra piece on the board together. We isolated eight "help seeking" codes (see Duncan, Boecking, and Berland, 2012) in order to roughly capture the forms of assistance players gave one another in the course of the game (see Table 2 below). These were applied to transcribed data drawn from the two "ghost player" runs in order to better characterize the ways that collaboration played out within this particular condition.

Rules Requested	"And then I take two (cards) right?"
Rules Given	"Yeah. Put them in the discard pile."
Rules Received	"Oh, that's right, only if I am in that city…"
Rules Argued	"What would be the point then? I might as well build it…"
Strategy Requested	"Do we want to do a research station?"
Strategy Given	"Yeah, I definitely still want to do a research station in Cairo, especially since I'm right there."
Strategy Received	"So, build it."
Strategy Argued	"I think he should go here to London and take these out…

Table 2. Help-seeking codes, along with examples of each drawn from "ghost player" data.

Analysis revealed several conclusions about the relationship of computational thinking and collaboration. First, we discovered that the game turns in which players were all collaboratively controlling the "ghost player" exhibited a complete lack of rules-based help-seeking. In the heightened collaborative context that was imposed upon players by the experimenters, no discussion of rules was present at all, and all help seeking was related to player-generated strategies. Delving deeper, we found that there was a proportionally higher degree of *strategy-based argued*, or the help seeking code which captured argumentation and discussion by participants regarding game strategies (player-developed approaches to working within the game's rule system). The heightened collaborative task of the "ghost player" context apparently drove players not just to collaborate more, but to collaborate in a *specific fashion* — arguing and iterating strategies for the successful collaborative goal of "saving the world," and avoiding help seeking activities about the game's rules.

Additionally, Discourse analyses (Gee, 2010) revealed that not only were the collaborative argumentation moments in the "ghost player" conditions revealing of what was being discussed during collaboration in the game, but they also implied specific forms of computational thinking. The "meaning making" of the game space resembled one in which strategies were first actively argued by participants, then individual and group goals were actively negotiated (see Duncan & Berland, 2012). The collaboration present within these "ghost player" cases was one that did not simply evolve from the game's rule sets, but represented social dynamics, individual roles that needed to be balanced with collective goals, and were identifiable through turns of phrase by participants within the game space.

Overall, this series of studies reveals that play within collaborative tabletop spaces is quite clearly complex, but implicates both computational thinking and collaboration as important factors shaping the experience of play. In particular, the forms of play found within the context of this collaborative game illustrate that the meaning that players make of these gaming spaces is inextricably tied to not only the game's mechanics, but the *social environment* that is fostered within the game, the forms of strategy-based reasoning that are developed through the course of the game, and the ways in which certain game spaces can promote critical, evaluative interactions between its players. In other words, to account for the practices players engage within in collaborative games such as *Pandemic*, we need to better understand how in-game collaboration works not just as an interesting game mechanic, but as a means to facilitate deep collaboration, the argumentation of strategies, and the efficacious application of computational thinking.

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