Games and Learning Research
Provocation: How do we study learning transfer and problem solving practices through games?
Discussant: Andrew Phelps

Failing Up: The Role of Difficulty and Failure in an Educational Video Game
Craig Anderson, University of Wisconsin - Madison

Productive failure is described at the tendency for learners to develop a deeper understanding in problem solving scenarios if placed in a learning environment without support structures (Kapur, 2008, 2012). While these learners initially fail, their consequential struggle through content helps them come to a better understanding of the underlying concepts.

Video games are designed for players to master new skills, often while struggling through failure. In a game context, this failure "forces [players] to reconsider what [they] are doing, to learn"(Juul, 2005). Gee (2005) describes well-made games as benefiting from being "pleasantly frustrating"–a design attribute which keeps players "at the outer edge of, but within, their 'regime of competence'"(p.6), which is theorized as a way games help players learn within the game. However, it is unclear what role failure plays in a game designed for educational means.

During an educational video game camp, 88 middle-school students in groups of 3-4 played Virulent, a game designed to teach about virology. Designed to become increasingly challenging, Virulent tests a player's skills frequently, providing many opportunities for in-game failure. Collected data includes pre/post assessments on virology content, clickstream data from gameplay via the Assessment Data Aggregator for Game Environments (ADAGE, as per Stenerson et al., 2014; Owen et al., 2014), and discourse across each group's activities.

Analysis of pre-post measures shows overall learning gains, as reported by Anderson et. al (2016). Further analyses show that number of failures before initial success of levels predicted post assessment measures given pre assessment measures [$F(1,82)= 7.152$, $p<0.01$], whereas total level attempts [$F(1,82)= 1.714$, $p>0.1$] and number of levels completed [$F(1,82)= 2.203$, $p>0.1$] did not.

These results suggest that repeatedly failing before success at Virulent may actually be beneficial to learning virology concepts, contrary to theory that suggests success and overall progression in-game would be a more salient predictor of assessment success (Chen & Michael, 2005). This talk will explore the nature of the game, the assessment, and reasons for our counter-intuitive findings.

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Smarter and Faster: Integrating Intelligent Tutoring Systems Into Video Games

Elizabeth Whitaker, Georgia Tech Research Institute

Video games can be used to support player learning and decision-making strategies, and the training power in games can be increased by incorporating intelligent tutoring system (ITS) approaches. ITS can structure the learner's environment, provide learners with tailored feedback, support spaced and focused practice, and provide opportunities for in-game learner reflection. Each of these strategies are aspects that help the learner master the material faster (Whitaker et al., 2013) and are effective techniques used by human tutors (Van Lehn, 2011). In this paper, we describe how we implemented and integrated several ITS strategies into a serious game and examined their effects on learning. While the focus of this paper is on how a game designer might use several different ITS methods to support learning in games, we describe these design alternatives in the context of a serious, 3D-immersive game with the objective of teaching people to recognize and mitigate several common, decision making biases. The game, Heuristica, provides a set of scenarios within a space station narrative where the player can interact with game characters to perform tasks such as diagnosing and repairing problems, and evaluating game characters performing tasks (Mulinix et al., 2013; Veinott et al., 2013). The intelligent tutoring system approach tailored the learning experience based on the student's prior knowledge, performance in gameplay, and personal preferences. It did so using two computational components, a student model of the current state of knowledge and a game content selector, which made decisions based on the state of the student model. Game activities were modularized, enabling game content to be selected and ordered to support the student's need for extra practice in certain areas and less in other areas. We empirically evaluated a set of alternative ITS functionalities and interactions, including experiments evaluating mixed-initiative opportunities (combination of tutor and learner driven content), depth vs. breadth practice, and in-game reflections left in the form of hints for future game players. Descriptions of how these were implemented, empirically evaluated, and recommendations for game designers and game researchers will be discussed.

Elizabeth Veinott, Michigan Technological University

From Dragon Slayer to Problem Solver: Video Games As a Warm-up for Problem Solving
Beth Veinott, Michigan Technological University

Problem solving is a key skill developed in video game play over time. Only in video games may slaying a dragon in one room lead to finding the key in another. This constant shift in objectives and strategies is one aspect of video game play that has the potential to transfer to problems outside of video games (Gee, 2003; McGonigal, 2011; Veinott et al., 2013). In this paper, we describe research we are doing to evaluate the following thesis. Can video game play develop sensemaking strategies and perspective shifting cognitive strategies that transfer outside the game? In an experiment, we examined the effect of game play on improving participant's problem-solving ability for ill-defined problems(e.g., initial state and the goal state was clear, but the method to get from one to the other was unclear). In a 2 Game (Game vs. Control) x 2 Time (Pre/Post problem tasks) experimental design, 62 participants either played Atari's RollerCoaster Tycoon or were in the control condition and filled out a series of decision style questionnaires. In the game condition, players had to build an amusement park and maintain it. This required the players to manage resources and look at the situation from multiple different levels in order to be successful in the game. Participants in both conditions tried to solve one insight problem at time 1, then either filled out a series of questionnaires (Control condition) or played RollerCoaster Tycoon (Game Condition) for about 30 minutes, then tried to solve a new similar insight problem at time 2 (Dunker, 1942). Problem order was counterbalanced across participants within conditions. Our results indicate that while there was no difference in problem solving abilities at pretest as expected, participants in the game condition increased their problem solving ability at post-test by 27% compared to the control condition which improved by 3% on average. This result provides initial support for the idea that video games that practice certain higher-level cognitive strategies, such as analogical reasoning and perspective taking, can serve as a potential warm-up for problem solving activities outside of the game.

Kaitlyn Roose, Michigan Technological University

Games as Complex Spaces: Operationalizing Steinkuehler's Six Modes of Participation in MMOs
Jeff Kuhn, Ohio University

This investigation builds upon the in-game and in-room methodology of Stevens, Satwicz, and McCarthy (2008) to document the collaborative problem solving activities of five World of Warcraft players. Each were simultaneously recorded in-game, in-room, and within their Vent voice server to create a complete documentation of how the players, the software, the hardware, and their social community interacted during the problem-solving process. This rich descriptive account of game play indicates players move through two distinct cycles of learning during gameplay: one at the game level, and another at the Game (Gee, 2008) level. Steinkuehler's (2008) six modes of participation are operationalized at distinct stages of these learning cycles that occur during problem-solving in games. This presentation will highlight the findings of this study and explore how Steinkuehler's (2008) six modes of participation manifest within gameplay and how these can be leveraged by educators to design more authentic game-based learning experiences.

Where the Wild Things Are: Call of Duty, Boys
Jason Engerman, East Stroudsburg University

Teachers today feel increasingly pressured to control all measurable learning outcomes of their students. This in turn has left the classroom a place where students and teachers are pushed further apart in terms of agendas, motivation and engagement. Studies on student engagement consistently show that students are at a precipitous decline in their academic engagement, which continues into their careers (Gallup, 2013; Olson & Peterson, 2015). The current presentation reports on a longitudinal study at the

intersection of adolescent boys and the commercial digital games they play. This ongoing study led towards a discovery on a user design element that combines learning ecosystems and social play.

The current study took on an ethnographic phenomenology that emphasized student voice. The researcher observer collected game play, interviewed parents and teachers, captured digital photographs, observation notes and captured dozens of hours of online video game play. Cultural Historical Activity served as the lens to illuminate the social meaning making intentionalities and how social and material practices were developed. The researcher was able to illuminate private and inner speech patterns (Vygotsky, 1978) of meaning making by using the three-interview process (Seidman, 2013). The researcher used a Thematic Analysis (Clark, 2006) to analyze the data after an Expansive Learning Matrix parsed the Cultural Historical Activities through the activity network.

Findings fall around New Literacy Development in Cultural Literacies, Critical Literacy and Operational Literacy narrated through a playcology. Tech Crunch, Wired and other tech connoisseurs are touting a new age beyond the information age called the experience age. The presenter will discuss the ways in which a playcology can be used as a User Design Tool for integrating and developing more authentic forms of literacy development within the Experience Age.

Playcologies can be helpful as a user experience design tool especially around immersive gaming experiences. Playcologies within a permeable boundary of game play can provide an authentic addition to the development of learning experiences that are truly student centered. Ultimately this research presentation will advance the notion of a playcology as a new paradigm for user experience design through the permeable boundary of commercial game play.