Community for Advancing Discovery Research in Education

**GAMING SIG WORKSHOP**

Education Development Center, Inc. (EDC)
1025 Thomas Jefferson Street NW, Washington, DC
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**Facilitator:** Diane Jass Ketelhut (University of Maryland)

**Participants:** Jodi Asbell-Clarke (TERC), Marilyn Ault (University of Kansas), Barbara Berns (CADRE), Amy Busey (CADRE), Barbara Chamberlin (New Mexico State University) Bob Coulter (Missouri Botanical Garden), Teon Edwards (TERC), Michael Hacker (Hofstra University), James Lester (North Carolina State University), Mark Loveland (WestEd), Uma Natarajan (Temple University), Brian Nelson (Arizona State University), Edys Quellmalz (WestEd), Debbie Denise Reese (Wheeling Jesuit University), Frieda Reichsman (Concord Consortium), Greta Shultz (CADRE), Sharon Tettegah (NSF)

**Purpose:** CADRE's Gaming SIG is one of a number of working groups organized around topics of common interest among DR K-12 awardees. The overriding context for discussions at this workshop was the rapidly growing field of educational gaming and the National Research Council's 2011 report (Learning Science Through Computer Games and Simulations). Participants representing NSF-funded research and development efforts involving educational games and virtual environments gathered to discuss and synthesize the evidence emerging from their respective projects. The workshop was scheduled around 'conversations' grounded by specifics from 2-3 projects that saw their research as lending insight into an area, and followed by a whole group conversation about that topic led by two discussants who at the end, helped synthesize and summarize the conversation. Topics were chosen based on participant interests and areas of project experience/expertise identified in a pre-workshop survey.

## CONVERSATION 1: GAMING IN STEM

**Key Questions:** Do games offer a platform to impact STEM subject-specific topics? What next generation science education standards are games most suited to address better than "conventional" instructional methods?

**Presenters:**
Barbara Chamberlin | Math Snacks: Addressing Gaps in Conceptual Mathematics Understanding with Innovative Media
Michael Hacker | Simulation and Modeling in Technology Education (SMTE)
Frieda Reichsman | Geniverse: A Student Collaboratory for Biology Cyberlearning
**Discussants:** Jodi Asbell-Clarke, Brian Nelson

**Discussion:** Discussants noted that the three presenting projects highlighted three aspects and considerations of using games in STEM – evidence-based argumentation in Geniverse, preparing teachers for this mode of teaching in Math Snacks, and translating the physical world into a virtual world in SMTE. The discussions that followed centered around the following themes:

- **Evidence of Effectiveness**

  Participants indicated that in general, the current political and funding climates demand evidence of effectiveness. While in some cases, there may be increasing openness to innovative approaches (e.g., superintendent panel at Wireless EdTech conference), participants noted the

difficulties with gaining political traction without linking to classroom evaluations or forms of assessment accepted by decision-makers. In addition, participants noted IES is currently taking a critical look at the evidence for technology use as a whole, with a small group looking at games in particular.

Participants argued that games make use of innovative pedagogies and provide opportunities for different kinds of learning that are not always captured using conventional tests, e.g., phenomena driving grassroots level enthusiasm/commitment. They suggested several alternative or supplemental forms of evidence including product-oriented evidence (e.g., Foldit) and convincing examples of what kids might do/learn annotated with data. They also indicated a need to develop methods for capturing phenomena that aren't measured well by conventional tests, e.g., accidental/incidental learning or the phenomena behind grassroots level enthusiasm and commitment for these materials/technologies.

Participants agreed that whenever using evidence to make an argument for using games, it is critical to articulate the pedagogies used, the criteria for learning, the value added by using gaming technologies, and links to the physical world.

- **Pedagogical Affordances & Next Generation Science Standards**

Participants cited several affordances offered by gaming technologies: a more efficient means for teaching many STEM concepts, environments for both intensely personal and social learning experiences, and an engaging context for learning. Participants also noted that many of these affordances address the Next Generation Science Standards, arguing that the "something more" that games offer are what the frameworks are really about. For example, they noted that well-designed games have the potential to model good pedagogy, and that when accompanied by good professional development, can help teachers to do more inquiry in their classrooms.

Participants also noted the importance of making connections between various learning experiences and environments, where games offer a powerful additional approach and learning experience for students. For example, there are opportunities for transfer and making connections between formal and informal learning experiences and between virtual and physical worlds.

- **Motivation & Engagement**

Participants discussed several aspects of motivation/engagement in terms of a natural affordance of well-designed games, but noted that this factor isn't necessarily highly sought after by funders. They raised questions about whether students are engaged in educational games in the same ways they are in commercial games and what expertise is necessary to design engaging games while maintaining their educative value. They also emphasized the multidimensionality of the term "engagement", noting that it does not always mean "fun", but can indicate a "flow" experience.

- **Professional Development**

Participants highlighted professional development as an important factor contributing to effective use of gaming technologies both during and following the life of a project. They noted because many teachers (and other adults) often don't know how to play the game, there's

tendency to treat games as replacement activities, where there are lost opportunities to make connections between what students are doing inside and outside of the game. Well-designed professional development might help address these issues, and improve the likelihood that games will be effectively used beyond the life of the project.

**Summary:** Discussants and participants highlighted the following as takeaways from the presentations and discussions:

- Games can feature varying levels of "situatedness". How important is it to design games that facilitate transfer to the real world?
- Games can be the most efficient means to get kids to learn the kinds of things that we think are important based on standards.
- Games are great problem solving spaces.
- Games are very strong as inquiry-based learning environments across different domains (math, engineering, genetics, etc.).
- Games encourage collaboration both inside the game and in affinity groups and communities formed around the games.
- Transfer from games to the real world is important.
- Games offer good models of practice and pedagogy for teachers, i.e., a way to transfer good instruction into the real world.
- Games are highly engaging (which doesn't always mean "fun"). They're good at engaging learners in challenges that they're willing to work through to achieve something.
- Games provide cultural space that correspond more closely to what kids are accustomed to doing in their lives outside of the classroom.
- Games support the kinds of interdisciplinary team-based learning environments that match what students are likely to do in the workplace.
- Need to broaden the definition of "fun" and investigate ways to improve players' "flow" or engagement in games.
- Need to define what is meant by "games" and "learning". Different kinds of games and pedagogies require different conversations.

## CONVERSATON 2 – PEDAGOGICAL AFFORDANCES

**Key Questions:** What makes games in education unique from other pedagogies? What are the affordances of games for promoting educational outcomes (writ large) that go beyond traditional pedagogies? Are those affordances well-suited to the classroom or better suited for informal environments? What are the types of pedagogies in games and ones unique to games that will improve STEM learning? What evidence do we have and should we be gathering?

**Presenters:**
Marilyn Ault | The Evidence Games: Collaborative Games Engaging Middle School Students in the Evaluation of Scientific Evidence
Uma Natarajan, Brian Nelson | SAVE Science: Situated Assessment using Virtual Environments for Science Content and Inquiry
Debbie Reese | CyGaMEs: Cyber-enabled Teaching and Learning through Game-based, Metaphor Enhanced Learning Objects
**Discussants:** Bob Coulter, Marilyn Ault

**Discussion:** Discussants noted the variety of contexts and genres represented among the presenting projects and the resulting variety of affordances, opportunities and constraints. They prompted

participants to consider design features that might be common across projects. During the discussion that followed, participants addressed the following themes:

- **Range of Purposes and Genres**

  Participants noted that pedagogical affordances are in part determined by the context and content of a particular game. For example, the affordances and constraints associated with a game providing an exploration space would be different than those associated with a game offering a defined linear path. Participants discussed other design tradeoffs related to pedagogical opportunities including simplification (e.g., What are the implications of simplifying content for the purpose of simulation or game play? Will students still be able to apply what they've learned in a different context? ) and designing for in-school vs. out-of-school use (What kinds of games can you fit into a 45 minute segment?). Different games might also have different purposes, e.g., games for learning vs. games for assessment.

  Given the diversity of opportunities, constraints, goals, and purposes of games in education, participants identified a need to classify different genres and articulate the key design elements within the classification system (see NSF's Taxonomy of Virtual Worlds as a past effort).

- **Affordances of Games Writ Large**

  Participants discussed several pedagogical opportunities afforded by gaming technologies and environments writ large. They also argued that research from related fields, e.g., multimedia and perception/spatial reasoning, could lend evidence to support the pedagogical affordances of games.

  Engagement/Motivation: Games can provide environments that keep learners uniquely engaged, and participants discussed possible framings for these experiences. For example, some games might offer meaningful exploration or play spaces that students don't have access to in the physical world (see David Sobel's work).

  Connecting Content & Practices: Games offer opportunities for learners to connect science and math content with the critical skills and practices outlined in the Next Generation Science Frameworks and used by scientists and mathematicians (e.g., problem solving, inquiry, habits of mind, etc.).

  Assessment (Esp. Formative): Games provide opportunities to collect, aggregate, summarize, and share data with players, students, and teachers. Participants noted that games designed as formative assessments can allow for flexible and dynamic game play that responds to user experience. Participants noted several issues and challenges that must be addressed in order to take advantage of these opportunities, including the practicality of making timely and meaningful use of the vast amounts of data collected and deciphering what students do or do not know given the potentially numerous paths/choices available during play.

- **Design Considerations**

  Participants agreed that design and layout are critically related to games' pedagogical affordances, where the structures and design choices should reflect the intended purpose. They also described the particular challenge of navigating the tension between the designers'

influence and that of teachers, focus groups, and other sources of triangulation when enacting a theory or curriculum into a game's design. They identified multimedia and spatial research as areas to draw from and noted that articulating the various design features and their related purposes would be a helpful product for the field.

**Summary:** Discussants highlighted the following as takeaways from the presentations and discussions:

- A taxonomy of game genres and purposes would be a helpful contribution to the field.
- Within game design, projects are using a variety of methodologies to engage players and signal them towards goals.
- Validating the unique kinds of learning that take place in games is a challenge.
- Engaging learners in a meaningful (if not "fun") experience is a fundamental affordance of games.

## CONVERSATION 3 – EVIDENCE OF IMPACT

**Key Questions:** Do we have credible evidence that learning outcomes are impacted positively? What assessment tools/methodologies allow us to provide these claims? What constraints are there for these outcomes?

**Presenters:**
James Lester | Developing Science Problem-solving Skills and Engagement through Intelligent Game-based Learning Environments
Mark Loveland, Edys Quellmalz | Calipers II: Using Simulations to Assess Complex Science Learning
**Discussants:** Debbie Denise Reese, Uma Natarajan

**Discussion:** Discussants noted the power of story in each of the presenting projects, the distinction between games for learning vs. games designed to assess learning, and the challenge of providing evidence that these innovations can be taken to scale. In the discussion that followed, participants addressed the following themes:

- **Measuring and Validating Different Kinds of Learning**

  While acknowledging the importance of demonstrating learning transfer between game and other environments, participants agreed that traditional assessments are not always good at measuring the kinds of learning phenomena (e.g., different types of engagement or self-efficacy) that take place in games or simulations (i.e., skills not measured by standardized tests). In addition, they noted that games offer new opportunities to gather evidence of cognitive and affective outcomes from actions taken during game play, rather than relying on static and external conventional tests. Participants recognized that it may be difficult to validate students' performances in virtual environments where the field has not fully articulated these learning constructs or developed the measures needed to validate them. However, they cited affordances of simulations for measuring understanding of science system components, interactions and emergent system behaviors, and active-inquiry cognitive outcomes. They emphasized the importance of continuing to develop these measures and methodologies in collaboration with each other, in order to build a body of evidence and support the field in developing more effective games. Participants mentioned cognitive labs and self-report types of assessments that the field might pull from and build off of.

- **Using Data in the Classroom**

  Participants noted that games offer the ability to collect and track measurements in unprecedented ways, and while some projects/games are able take advantage of this affordance, the realities of classroom logistics make it a challenge to translate this data to meaningful feedback for teachers and students.

**Summary:** Discussants and participants highlighted the following as takeaways from the presentations and discussions:

- While the group discussed several types of evidence, there are still questions around what "counts".
- It is important to look at learning transfer, but also to consider the learning value of engagement/confidence-building.
- Triangulating data is important.
- The design process should include a plan for assessment (e.g., evidence-centered design framework) and feature a combination of top-down and bottom-up processes.