Games and Virtual Worlds

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Overview

Computer-based games and virtual worlds provide opportunities for learners to be immersed in situations in which they can experience and get close to phenomena and processes. This immersion helps them develop tacit/implicit understanding and intuitions about such phenomena and processes as they think about choices, take action, and see the impact of their decisions in a meaningful context. These opportunities can be applied to school topics, enabling new genres where school learning becomes "hard fun" or a "serious game." Games are increasingly being seen as an attractive use of technology to enhance learning, and researchers and designers are actively investigating the many ways that games and game-like features can be implemented to motivate and increase student learning. Some genres of games motivate learners to work hard at learning; games can also provide opportunities to interact with phenomena and contexts (e.g. the spread of an infectious disease) that would otherwise not be available in a classroom (Barab & Dede, 2007; Rosenbaum, Klopfer & Perry, 2007).

Although games as a medium of teaching are maturing, more extensive research on deeper learning of concepts beyond simple engagement is needed before it can be conclusively established that games are indeed beneficial in learning contexts. As with all learning technologies that have the potential to engage and engender critical thinking and deeper learning, it depends on the specific game and the design of the learning experience with it. It is difficult to get the integration of games and learning right. Without iterative design improvement which incorporates measurement of learning outcomes in addition to measurement of usability and game play characteristics, impacts on learning are unlikely. Some of the best results in recent years have emerged from virtual worlds through thoughtful design of the learning environment that leveraged what we know about how children learn, especially in collaborative, technology-mediated spaces. These required iterative design-based research studies that helped create the right balance of engaging narratives, roles, and inquiry-based learning that incorporates student agency and choice.

The research literature suggests three different perspectives on designing games for learning. In the design perspective with the longest history, games have been viewed as conduits or vehicles for the delivery of curricular content. This perspective first arose in classroom use of titles such as Oregon Trail, Lemonade Stand, and Where in the World is Carmen Sandiego?These games succeeded in large part due to their interesting storylines and ability to provide learners with engaging opportunities to problem solve in authentic contexts. There were also other successful games such as Math Blaster (and many similar games), where game levels were imposed on unrelated content. These provided extrinsic motivation to increase student engagement in mathematics tasks, however pedagogically they were little more than drill exercises (Bruckman, 1999).

Second, with the growing sophistication of game play and its rise in the general population, educators have looked for game elements or "game mechanics" that can be borrowed and transferred to educational settings to improve engagement. One example is gamification (Deterding et al., 2011), which refers to integrating game methods into content and adding badge systems (the use of achievement markers to motivate continued involvement and development). However there is much debate about using this approach versus embedding learning in more authentic game settings (Tuloch, 2014) where the focus is on the core mechanics of the game and not just on the trivial aspects such as reward systems (Bogost, 2011).

A third perspective on the role of games and virtual worlds in education is organic: looking for and exploiting curricular topics inherent in popular games. Two obvious examples are the opportunity for improving reading that arises in almost every quest-based game, such asWorld of Warcraft, or the use of critical thinking or strategizing required in role-playing and real-time strategy games such as Portal, Civilization IV, Starcraft and Dragon Age, where players' decisions affect game outcomes. The recent popularity of Minecraft in elementary and middle school classrooms (Duncan, 2011) has underscored the value of well-designed video games to not only engage, but also help children develop life skills such as creative thinking, and perseverance, in addition to visuospatial skills (as described in several articles in mainstream media, e.g. Smith, 2014).

Virtual worlds are sometimes viewed as a sub-genre of games and sometimes seen as just complex simulations with game elements, but the general principles of games hold. Virtual worlds are typically more focused on exploration than a specific game mechanic and they open up other possibilities for learning. Engaging narratives can further motivate students to explore the virtual world and situate themselves in a historical or fictional context that can include specific learning objectives. Virtual worlds support the placement of curricular concepts in the context of their natural or practical use, bringing concepts to practical life and allowing learners to interact and experiment with the changeable elements of the closed system or world. Unlike many purely playful virtual worlds that may offer a thin background of 'lore,' virtual worlds in the service of education make a point of foregrounding the narrative or unifying story element that creates the motive for investigative and exploratory engagement in the world.

Many popular research-based digital games for learning fall into this category, including River City, Quest Atlantis, and Whyville. Research on science learning in these multi-user immersive virtual environments (Barab, et al., 2010; Dede, 2009; Neulight et al., 2007) suggests that authentic designs and contextual narratives around science phenomena are not only engaging but also help learners acquire deep science inquiry skills and conceptual knowledge. Additionally, as Dede (2009) notes of River City, the digital immersion allows low-performing students especially to "build confidence in their academic abilities by stepping out of their real-world identity of poor performer academically, which shifts their frame of self reference to successful scientist in the virtual context."

Issues

Measuring Learning. For many researchers who are designing and using games to teach specific concepts, some of the most pressing issues are related to the assessment (measurement) of learning, and especially, how the kind of learning that happens in games and virtual worlds maps onto curriculum standards. There is, however, a strand of game-based learning research where the game itself is designed to be an assessment: students' choices during gameplay are measures of their higher-order thinking skills and "preparation for future learning" (Schwartz & Arena, 2013).

Balancing Instruction and Game-Play. Another design challenge for educational games is how to embed instruction in the game while still making the game fun and engaging. One way to address this is to use games as an exploratory space that prepares students for better conceptual learning that follows using more traditional means (Arena & Schwartz, 2014). This allows learners to indirectly encounter targeted curricular concepts embedded in the game, that are then reinforced through more direct instruction. Exploration and instruction remains a challenging balancing act in inquiry-based learning, and getting this timing right is important. This balance also may be achieved when a teacher integrates non-game and game elements of instruction while teaching a particular topic.

Avoiding Superficial "Gamification". While most educators agree that sticking a layer of gamification to boring, poorly-designed curricula that emphasize rote learning is ill-advised, it is an easy trap to fall into as it does provide a convenient way to make classroom learning more motivating. Gee (2003) provides an excellent list of design principles that make the best games so compelling for youth. Educators and game designers would find these useful to keep from adding a layer of gamification without deeper thought to the things that make good video games good and could advance learning simultaneously.

Socio-Cultural Issues. Games and virtual worlds sometimes carry sociocultural baggage owing to long-held beliefs in the public mindset that gaming is bad for youth, addicting, violent, and without redeeming social values. Further, in some cases, gaming communities have perpetuated negative stereotypes of women and rejected non-male designers. How do we get past those issues so that educators can bring productive gaming into the classroom? Additionally, how do we design games that appeal to learners who are non-gamers, of different genders, and drawn from diverse sociocultural backgrounds?

Data Analytics, Sharing & Privacy. As big data and game-based analytics become increasingly the go-to means of analyzing student actions and pathways in games, issues of data sharing and privacy become pertinent. There is a need for resolution on these issues as well as cloud-based data sharing protocols for research purposes. There is perhaps a need also for new psychometric models for assessing student learning in such environments as well as models of learning through games and simulations.

Ethical concerns. People can have strong emotional reactions after they leave immersive environments. Unanticipated psychological effects created by the strong illusion of virtual worlds may pose new risks. Researchers (such as Madary and Metzinger) are beginning to raise awarness of possible risks and propose recommendations for reducing them.

Teacher Training and Buy-In. Due in part to the social taboo associated with video games, K-12 teachers have been slow to adopt games for classroom teaching and learning. With the growing pervasiveness of iPads (along with educational games designed specifically for tablets and phones) and the viral popularity of games such as Minecraft among children, educational games are seeing increasing adoption in K-12 classrooms. Just as online resources are now rapidly shifting from being seen as standalone to being a component of a system for learning with strong teacher as well as strong technology roles, games are unlikely to be standalone learning components in the future. As of yet, too little is known about how to blend game-inspired experiences with other instructional genres so as to maximize the opportunities for learning targeted content. Further, understanding how to blend games with other types of instruction is likely to be essential to achieving wider teacher adoption of games into the classroom.

Projects

Examples of NSF Cyberlearning projects that overlap with topics discussed in this primer (seeproject tag map).

Games and Virtual Worlds

- Towards Virtual Worlds that Afford Knowledge Integration Across Project Challenges and Disciplines
- EXP: Learning Parallel Programming Concepts Through an Adaptive Game
- EXP: Teaching Bias Mitigation through Training Games with Application in Credibility Attribution
- DIP: Potential for everyday learning in a virtual community: A design-based investigation
- CAP: Towards Inclusive Design of Serious Games for Learning

More posts: games-and-virtual-worlds

Modeling and Simulation

- DIP: Extending CTSiM: An Adaptive Computational Thinking Environment for Learning Science through Modeling and Simulation in Middle School Classrooms
- DIP: Modeling in Levels
- DIP: Developing Crosscutting Concepts in STEM with Simulation and Embodied Learning
- INDP: Collaborative Research: Coding for All: Interest-Driven Trajectories to Computational Fluency
- DIP: BioSim: Developing a Wearable Toolkit for Teaching Complex Science Through Embodied Play

More posts: modeling-and-simulation

Virtual and Remote Labs

- EXP: Transforming High School Science via Remote Online Labs
- DIP: Collaborative Research: Taking Hands-on Experimentation to the Cloud: Comparing Physical and Virtual Models in Biology on a Massive Scale

- DIP: Using Dynamic Formative Assessment Models to Enhance Learning of the Experimental Process in Biology
- DIP: Collaborative Research: Mixed-Reality Labs: Integrating Sensors and Simulations to Improve Learning
- EAGER: A Prototype WorldWide Telescope Visualization Lab Designed in the Web-based Inquiry Science Environment

More posts: virtual-and-remote-laboratories

Resources

Doug Clark: Designing Games to Help Players Articulate Productive Mental Models
Chris Dede on Cyberlearning and Games
MindShift Guide to Digital Games and Learning
KQED articles on game-based learning

Associations and groups:

- Games+Learning+Society Conference (GLS)
- Digital Games Research Association – General games research and games for learning)
- Game Developers Conference – Education Summit
- TERC''s Educational Gaming Environments Group
- Games+Learnng+Society (GLS) Games
- Higher Ed Video Game Alliance (HEVGA)

Example game collections:

- Learning with Portals and Teach with Portals – A resource for teachers who want to use the game in their classroom, and a good example of a commercial game adapted for use in the classroom.
- NetLogo
- GlassLab games and Research and Evaluation on GlassLab Games and Assessments – an evaluation of the qualities, features, inferential validity, reliability, and effectiveness of the assessments embedded in the Games Learning and Assessment Lab (GlassLab) products
- AAA Lab, Stanford University

- DragonBox games

Readings

This section includes key readings documenting the thinking behind the concept, important milestones in the work, foundational examples to build from, and summaries along the way.

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