Games for Instruction?

Dick Clark

Center for Cognitive Technology
Rossier School of Education
clark@usc.edu
www.cogtech.usc.edu

American Educational Research Association
Annual Meeting, New Orleans, LA
April 8 – 12, 2011

USC

Four topics

1. What is a game?
2. Learning and Cognitive Load from Games
3. Motivation from Games
4. Research on Games

1) What is a game?

- No agreement about definition of "serious" games.
  - Some limit to "competition" for performance scores
  - Others add or substitute "constructed reality", "discovery of rules", etc.
- Without an agreement about the variables that constitute a game the value of this research is minimal and generally an exercise of enthusiasm over substance.

2) Learning from games?

All current reviews of adequately designed and peer-reviewed research have found NO learning or motivational benefits from games:

- Sitzmann's (2011) meta analysis concludes that when learning benefits are found for games it stems from instructional methods that can be presented in non-game contexts.

- Previous meta analyses of games have failed to include unpublished studies containing NSD results – the most likely outcome in a well designed study.

- Games as constructs obscure and distract us from indentifying and employing the important instructional methods that are compatible with cognitive architecture and lead to learning.

Game Pedagogy

Entertainment games use a discovery pedagogy that is less effective than fully guided instruction for novice to intermediate learners (Meyer, 2004, Kirschner, Sweller and Clark, 2006).

- Sitzmann (2011) coins the term "simulation games" and recommends using games for long term practice, feedback and transfer support rather than direct instruction.
  - She refers to 'interactivity" as an important method that impacts learning in game AND non-game treatments.

- Merrill (2006) describes key methods and Koedinger & Aleven (2007) describe the kinds of interactivity found in cognitive tutors that provide learning benefits and none require games.
  - Koedinger et al (2010) describe methods that should be included in all instruction, including games (next)

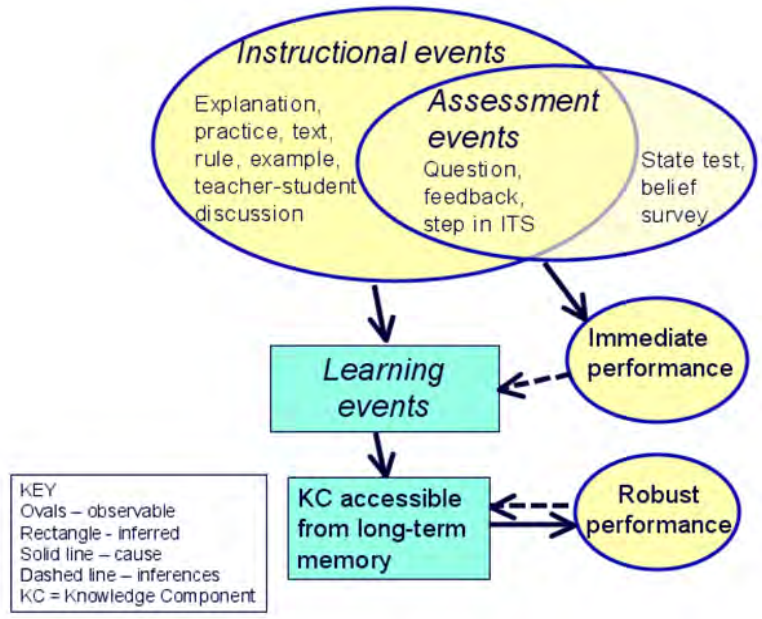
Instructional Research Foundations

First Principles of Instruction

Principle	Description
1) Task-centeredness	Authentic tasks that represent the domain/learning outcomes
2) Activation	Connect to learner's prior experience/knowledge/larger knowledge structure
3) Demonstration	Demonstrate and give examples of correct performance
4) Application	Part-task and whole-task practice with corrective feedback
5) Integration	Reflection, discussion, public performance, exploration of real life uses

Merrill, M. D. "First Principles of Instruction," In C. M. Reigeluth & A. Carr (Eds.), Instructional Design Theories and Models III (Vol. III), 2009

Pittsburgh Science of Learning Center Knowledge-Learning-Instruction Framework



Koedinger, K.R., Corbett, A.T., and Perfetti, C. (2010). The Knowledge-Learning-Instruction (KLI) Framework: Toward Bridging the Science-Practice Chasm to Enhance Robust Student Learning (Draft manuscript from the Pittsburgh Science of Learning Center)

PSLC Instructional Principles

Instructional Principle	Description	Example References
Optimized Scheduling	Selection of practice instances based on prior statistics and on each students' experience with each target KC.	Pavlik (2007)
Timely Feedback	Providing an evaluative response (e.g., correct or incorrect) soon after a students' attempt at task or step	Corbett & Anderson (2001)
Feature Focusing	Instruction leads to more robust learning when it guides the learner's attention ("focuses") to valid or relevant features of target KCs	Dunlap et al (under review)
Worked Examples	Students learn more efficiently and more robustly when more frequent study of worked examples is interleaved with problem solving practice as opposed to practice that is all problem solving.	Sweller & Cooper (1985)
Prompted Self-Explanation	Encouraging students to explain to themselves parts of instruction (steps in worked example or sentences in a text) yields more robust learning than not prompting or providing such explanations to students.	Chi et al (1994); Haussmann & VanLehn (2007)
Accountable Talk	Encouraging classroom talk that is accountable to accurate knowledge, rigorous reasoning, the classroom community by using some six talk moves (question and response patterns) leads to more robust learning.	Michaels, O'Connor, & Resnick (2008)

Cognitive Load and Games

- Our "mental architecture" has limits on how much we can think about at one time
  - Formerly 7 +/- 2 ideas but now 4 +/- 1 ideas
- If we try to overload our thinking with too much information it overloads & "crashes"
- Crashing is pleasurable - to protect us
- We have to design multimedia so that it does not cause cognitive overload

Mayer's Multimedia Principles (2009)

	Effect Size	Studies
1. Coherence: Eliminate extraneous visuals and sound	.97	14 of 14
2. Signaling: Highlight essential information	.52	5 of 6
3. Redundancy: Graphics and narration – avoid text	.72	5 of 5
4. Visual Contiguity: Text next to graphic it describes	1.19	5 of 5
5. Time Contiguity: Simultaneous words and pictures	1.31	5 of 5
6. Pacing: Learner pacing better than system pacing	.98	3 of 3
7. Pre-training: Advance learning of conceptual information	.85	5 of 5
8. Modality: Graphics + Narration not text + animation	1.02	7 of 17
9. Multimedia: Words + Pictures - not words alone	1.39	11 of 11
10. Personalization: Conversational style - not formal	1.11	11 of 11
11. Voice: Human voice better than machine voice	.78	3 of 3

3) Motivation from games?

Entertainment games are motivating but no compelling evidence exists to support the claim that the same is true for serious games.

- No peer-reviewed studies comparing the motivational benefits of serious games and non-game equivalents.
- Serious games may result in less mental effort invested in learning because of the belief that they make learning "easier" (Salomon, 1984)
- Consider using "game-like elements" such as competition when instruction fails to yield adequate persistence or mental effort (Koedinger et al, 2010).

5) Games research?

Games researchers are contributing to the literature on instruction and learning so should use more robust experimental design.

- Need agreement on the operational definition of an instructional game or no discussion of research is possible.
- Pre test and post test knowledge using using the learning measures suggested O'Neil et al (2005) and motivation measures suggested by Pintrich and Schunk (2002).
- Research should examine variables that are exclusive to games and compare them with variables that are robust competitors.
- Consider studies that modify one variable at a time so that we can interpret the results and apply them in future instruction.
- Ask researchers to reveal any direct or indirect connections to income from games to avoid even the appearance of conflict of interest.

References

Clark, R. E. (May-June, 2007) Learning from serious games? Arguments, evidence and research suggestions. *Educational Technology*. 56 – 59.

Koedinger, K. & Aleven, V. (2007) Exploring the assistance dilemma in Experiments with Cognitive Tutors. *Educational Psychology Review*. 19, 269-274.

Koedinger, K., Corbett, A. & C. Perfetti, (2010) *The Knowledge-Learning-Instruction Framework: Toward Bridging the Science-Practice Chasm to Enhance Robust Student Learning*. Pittsburgh Science of Learning Center.

Mayer, R. (2009). *Multimedia Learning, Second Edition*. NY: Cambridge University Press.

O'Neil, H, Wainess, R. & Baker, E. (2005) Classification of learning outcomes: Evidence from the games literature. *The Curriculum Journal*. 16(4). 455-474.

Pintrich, P. R. & Schunk, D. H. (2002) *Motivation in Education: Theory, research and applications.(2nd Edition)*. Upper Saddle River, NJ: Merrill.

Salomon, G. (1984) Television is "easy" and print is "tough": The differential investment of mental effort in learning as a function of perceptions and attributions. *Journal of Educational Psychology*, 76, 774-786.

Sitzmann, T. (In Press). A Meta-Analytic Examination of the Instructional Effectiveness of Computer- Based Simulation Games. *Personnel Psychology*.