

Point of View:

Learning from Serious Games?

Arguments, Evidence, and Research Suggestions

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My goal in this column is to offer a brief view of the current state of the evidence for the educational benefit of games, discuss a few problems with existing studies, make some suggestions for the design of game studies, and suggest a possible application of games in order to invite a discussion about the design of future serious game research, evaluation, and implementation.

Evidence for the Learning Benefits of Serious Games

The widespread interest in the learning and motivation benefits of serious* video games has not been balanced by a robust discussion about evidence for their pedagogical effectiveness. The argument in favor of their educational use is very appealing. Games are enormously popular among adolescents and young adults—the age group who have arguably posed the greatest challenge to educators. In 2005,

*The “serious” qualifier indicates a game that is intended to support learning and/or motivation to learn. The Wikipedia definition suggests that serious games are “games used for training, advertising, simulation, or education that are designed to run on personal computers...or video game consoles (such as the Xbox or PlayStation 2).”

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the sale of approximately 248 million computer video games was a 10 billion dollar market. No reliable figures are available for the serious games sales, but Sawyer (2005), who has authored books on game development, provides estimates permitting a guess that their gross revenue is about 500 million dollars. Games appear to offer a very appealing environment in which to provide individual problem-solving practice and competitive, team-based challenges. Advocates for games suggest that they are highly motivating vehicles that could support learning, problem solving, and collaborative skills.

Yet the use of games for education is apparently not widespread at this point. People who support the use of games in education have noted that the large audience for the more complex, interactive video games tends not to include the older adults who make educational decisions. The implication is that educational decision-makers may, out of bias and/or a lack of understanding, discount or discourage an investment in serious games and so ignore an innovative way to motivate, teach, and train.

On the other hand, the development cost of serious video games is considerable (*eSchool News online* in 2006 estimated a development cost of between 1 and 10 million dollars for commercially viable serious games) and the state and federal funds available to support education and training are limited, so it seems reasonable to ask for evidence to support increased investment in games. Sawyer (2005) in an essay directed at entrepreneurs who invest in serious games offers an analysis of serious games research titled “Research gap exists but isn’t hurting things yet,” where he goes on to write:

We still are dealing with a huge research gap in serious games, but so far it hasn’t hurt things because people are still getting new projects online. At some point, however, the justification and design issues related to determining the return on investment and outcomes from game-based approaches may become too hard to overcome without more and better research. There is, at this time, not nearly the same fervor for research as there is with building, and it will continue to be this way for a while. We can only hope to pick up some important pieces with the amount of research that is taking place.

The “important pieces” will come from research that asks some very direct questions about the motivation and learning benefits of serious games, such as: Do people who play serious games learn enough from them to justify the investment when games are tested against viable and less expensive alternative ways to teach the same knowledge and skills? Do games

motivate players to learn more than other, less expensive alternatives? Are some skills or knowledge most effectively and/or efficiently taught via serious games?

Empirical Research on Learning and Motivation from Serious Games

A number of individual studies, reviews, and meta-analytic studies of the benefits of games have been conducted, and a few of them have been published recently in peer-reviewed journals (for example, Chen & O'Neil, 2005; Gredler, 1996; Mayer, Mautone, & Prothero, 2002; Moreno & Mayer, 2005; O'Neil, Wainess, & Baker, 2005). All of the different reviews currently available have reached almost identical conclusions. One way to state the common conclusion in the reviews of serious games research is that people who play serious games often learn how to play the game and some factual knowledge related to the game—but there is no evidence in the existing studies that games teach anyone anything that could not be learned some other, less expensive, and more effective way. More surprising is that there is no compelling evidence that serious games lead to greater motivation to learn than other instructional programs.

One of the most comprehensive and helpful reviews of serious games was conducted by Chen and O'Neil (2005) and O'Neil, Wainess, and Baker (2005), who located over 4,000 articles published in peer-reviewed journals, yet found only 19 studies where either qualitative and/or quantitative data about learning or motivation from games had been assessed. They provide a detailed analysis of the learning and transfer measures used in all 19 studies and concluded that "...positive findings regarding the educational benefits of games...can be attributed to instructional design and not to games per se. Also...many studies claiming positive outcomes appear to be making unsupported claims for the media" (O'Neil *et al.*, pp. 461–462). Their use of the term "instructional design" was intended to highlight the occasional use of instructional methods such as providing examples, classification practice, and problem-solving routines. They make the point that all of the methods used in games could (and have) been used effectively in non-game instructional programs and are not unique to games. A similar result was reported in an earlier review by Gredler (1996). None of the peer reviewed studies reported compelling evidence that games produced significantly more learning or motivation than other instructional platforms.

Industry, Government, and Military Evaluation Studies

One might expect a less conservative and more optimistic view from industry, government, or military sponsored surveys of gaming research because of the high level of investment in those sectors, most especially the military. Military trainers in many countries have invested in serious games for training. Yet an excellent technical report by Hayes (2005) for the Air Force training command provides a very thorough review of the past 40 years of research and reviews of research on instructional games and "simulation games." He concludes that "...the research shows no instructional advantages of games over the other instructional approaches (such as lectures)... The research does not allow us to conclude that games are more effective than other well designed instructional activities" (Hayes, 2005, p. 43). He makes the point that only poorly designed studies find learning benefits from games. In most cases, poor design implies that the learning benefit of a game is compared with not receiving any game instruction or engaging in a non-educational exercise. What, he asks, can you conclude about the "relative" benefit of games when you do not compare them with any other way to teach or learn?

Problems with Existing Serious Games Research

Readers may be able to point to other publications where reviewers have presented evidence that serious games result in increased learning or motivation. This includes early attempts at meta-analysis of studies (see, for example, the studies referenced by O'Neil, Wainess, & Baker, 2005). Yet when the specific studies or meta-analytic reviews supporting these more optimistic claims are examined, they tend to ignore most of the issues listed below:

- (1) *Prior Knowledge Differences Are Important:* Chen and O'Neil (2005) note that most empirical studies of games avoid giving pretests of knowledge so that we are in the dark about whether people whose game-inspired learning was actually known before the experiment began or whether people in the game knew more at the start than people in a control group.
- (2) *Comparing Games with Nothing Is Useless:* As Hayes (2005) concludes, most studies claiming learning benefits from games tend to compare a group learning from a game with another group who receive no instruction or engage in an activity unrelated to the learning that is being measured. Nothing is learned about the

relative benefits of games as instructional tools from this approach.

- (3) *Serious Games Are Often Confused with Simulations*: Nearly all reviewers mention this problem and remark that it makes the interpretation of studies nearly impossible. Gredler (1996) provides a very useful set of operational definitions for serious games, simulations, and related constructs that are often confused by researchers. We can't compare the results of serious game studies where different definitions of games are employed.
- (4) *Opinions About Learning and Motivation Are not Reliable*: Chen and O'Neil (2005); O'Neil, Wainess, and Baker (2005); and Hayes (2005) all suggest that most studies that report learning or motivation benefits from games only ask students whether they learned or were motivated—they do not provide any direct measures of learning (such as recall of facts or the application of problem-solving strategies) or motivation (such as increased persistence or mental effort). Student opinions about learning and motivation have been found to be highly unreliable and often in conflict with direct measures when both are gathered.
- (5) *Pedagogy Decisions Are Critical*: Chen and O'Neil (2005) note that many games appear to employ unguided, discovery, constructivist, or problem-based learning pedagogy (as opposed to more structured, fully guided, direct instruction). This practice leads many reviewers to wonder if people who design serious games have an adequate grounding in pedagogical methods. Reviews of research on these unguided, discovery methods for the past half century have concluded that they are less than half as effective and efficient as guided, direct instructional methods (see, for example, Mayer, 2004; Kirschner, Sweller, & Clark, 2006).

Four Suggestions for the Design of Future Serious Game Studies

All rational suggestions for improving learning and/or motivation deserve our consideration. We also have to be open to the possibility that intractable problems might be solved by novel and surprising methods. Innovative programs are often developed before solid evidence is available to determine their impact. Serious games are not new, and we do have well-designed studies to help us make a decision

about the future. At this point and in my view, that evidence clearly indicates that games do not teach anyone anything that cannot be learned more quickly and less expensively some other way. Thus, I personally doubt that a "research gap" exists. When a number of well-designed studies (such as Mayer, Mautone, & Prothero, 2002; Moreno & Mayer, 2005), and reviews of other studies (Chen & O'Neil, 2005; Hayes, 2005) all reach similar, negative conclusions, the only gap remaining is the one that separates enthusiastic expectations and negative empirical results. Yet if readers disagree, the next generation of research on this topic must be designed so that new studies reflect intelligent design criteria that will result in wide acceptance of results. Those criteria include:

- (1) *Measurement*: Use reliable and valid tests of learning and motivation before, during and after games. O'Neil, Wainess, and Baker (2005) provide an excellent discussion of different approaches to measuring learning and offer suggestions.
- (2) *Game Pedagogy*: Build in robust and evidence-based pedagogical and motivational strategies specific to games and design and studied to get evidence about their learning and motivation impact. If an instructional method can be used in a game or outside of a game with the same benefit, explain why we need the game.
- (3) *Comparison Treatments*: Offer a viable, robust non-game alternative way to teach the same knowledge that, if possible, uses the same or similar pedagogical strategy. Avoid comparing games to weak, "straw man" alternatives.
- (4) *Cost-Benefit Ratios*: Provide estimates of the cost of developing and delivering the game and the alternative treatment. Since much of the research in this area yields "no significant difference" results, treatments with the same or similar learning and motivation impact may have very different costs.

A Potential Educational Benefit from Games

As of now, the evidence is solidly against the proposition that games will replace direct instruction. If we can accept that evidence, we might be able to consider other potentially valuable applications. For example, games could provide a critical and currently missing component for education and training by aiding the ongoing practice required for transfer.

Games (and simulations) are promising vehicles that could motivate students at all ages to engage in the extensive, long-term practice that is necessary to tune, automate, and transfer complex skills after direct instruction is completed.

Current views of complex learning and the instructional strategies necessary to support transfer indicate that our failure to support “whole task practice” over time has limited the effectiveness of past instructional design and delivery strategies (see, for example, Clark & Elen, 2006). Games designed to support transfer are ideal vehicles to motivate people to practice and accept corrective feedback. Game-based practice can occur in an increasingly immersive environment where contextual cues, problem difficulty, and novelty can be varied based on the progress made by individuals and groups. Games also provide an ideal setting for group or team practice of analysis and problem solving.

The knowledge integration and transfer goal is very important in industry, government, and military contexts. In work settings, people who are trained often do not have an immediate opportunity to apply what they have learned for some weeks or months after they complete training. Knowledge learned in training decays rapidly if it is not continually applied. Ongoing practice is also critical in formal education settings where complex knowledge must be constantly integrated as mental models and other forms of conceptual knowledge are being constructed by learners. □

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