Digital Games for Learning: A Systematic Review and Meta-Analysis

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Purpose

In 2006, the Federation of American Scientists issued a widely publicized report stating their belief that games offer a powerful new tool to support education (FAS, 2006). The report encouraged private and governmental support for expanded research into complex gaming environments for learning. A special issue of Science in 2009 echoed and expanded this call (Hines, Jasny, & Mervis, 2009) as have reports by the National Research Council (NRC, 2009, 2010). These reports also underscore, however, that solid evidence for the contributions of games to learning is sparse.

The purpose of the current meta-analysis involves analyzing the current research on digital games for learning in terms of the cognitive, intrapersonal, and interpersonal knowledge and skills outlined in the NRC's recent report on Education for Life and Work in the 21st century (NRC, 2012). The ongoing meta-analysis is being conducted by educational researchers affiliated with Vanderbilt University under a contract with the Bill & Melinda Gates Foundation.

The meta-analysis surveys research published in peer-reviewed journals between 2000 and 2012. The meta-analysis focuses on four overarching questions. First, what are the effects of digital games on learning for K-16 students? Second, how do these effects vary by learning outcome type in alignment with the categorizations of the recent NRC report on Education for Life and Work (NRC, 2012)? Third, how do these effects vary by learning content discipline? Fourth, how do these effects vary by game type?

Search Criteria

A total of 61,887 articles were identified through online searches of multiple databases of peer-reviewed journal articles. 726 of these studies were eligible for screening at the full text level, and 77 of these studies ultimately met the eligibility criteria for inclusion in the final meta-analysis. All studies were either experimental (i.e., random assignment with treatment and control groups) or quasi-experimental (i.e., not randomized but possessing a pretest and a posttest).

Reviewers identified each study's participants and settings, research questions and results, methodological information, assessment instrument information, implementation information, and a description and characteristics of the digital game and control conditions used in the study.

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Preliminary Meta-Analysis Results

Reviewers extracted 393 effect sizes from these 77 studies, 83% of which were in the cognitive competencies domain (e.g., knowledge, creativity, cognitive processes), 16% were in the intrapersonal competencies domain (e.g., intellectual openness, work ethic), and less than 1% fell into the interpersonal competencies domain (e.g., teamwork and collaboration). These effect sizes were further broken down into narrow categories of learning outcomes, as well as learning outcome discipline.

When digital games were compared to other instruction conditions without digital games there was a moderate to strong effect in favor of digital games in terms of broad cognitive competencies ($g+ = 0.32$, 95% CI [.19, .44]). This is equivalent to a 62% success rate in the digital game groups relative to a 50% success rate in the other instruction conditions (defining success as the median of the other instruction control conditions). This means that the students at the median in the control group (no game) could have been raised 12% in cognitive learning outcomes if they had received the digital game.

In terms of studies comparing multiple game designs to one another, the mean effect size for cognitive learning outcomes was .29, indicating a significant beneficial effect ($g + = .29$, 95% CI [.10, .48]). This is roughly equivalent to a 61% success rate in the digital game groups involving enhanced designs (in terms of learner supports, enhanced interface, etc.) relative to a 50% success rate using only basic designs. This finding underscores the importance of design, rather than merely medium, when discussing the potential affordances of games for learning.

Preliminary Descriptive Results

Findings from studies comparing digital games to non-game instruction demonstrate that games can enhance student learning as measured by cognitive competencies relative to traditional instructional approaches. These beneficial effects on cognitive competencies are primarily based on knowledge outcome measures rather than cognitive processes/strategies outcome measures, of which there are fewer, or creativity outcome measures, of which there are none.

Although there were very few studies reporting findings on intrapersonal knowledge and skills, there was evidence that digital games contributed to increased intellectual openness and positive core self-evaluation outcomes relative to other instructional conditions. The impacts of digital games on interpersonal competencies are less clear due to low numbers of studies focusing on these outcomes.

Findings from studies comparing multiple game-based interventions to one another indicate that certain types of game structures may be more effective for certain types of outcomes, underscoring the importance of design beyond simple choice of medium when discussing the affordances of digital games for learning.

Implications

These preliminary findings will help GlassLab (glasslab-games.org) and other educational game designers make appropriate, research-based decisions in developing new digital games for students. Much of the debate about digital games for learning to date has focused on more simple questions about whether games are good or bad for learning. The findings of this meta-analysis demonstrate that the efficacy of digital games for learning depends on their design. More productive questions for future research by the field focus on which designs and structures optimize which outcomes for whom and how. Ongoing work on this meta-analysis will deepen and broaden what we know about specific design features that contribute to productive learning through digital games. GlassLab and other educational game designers can leverage these findings to develop game designs that are optimized in terms of the specific learning goals pursued.

Ongoing work on this meta-analysis will also examine issues of research quality and game quality. More specifically, reviewers will examine issues regarding the quality of the comparisons made in a study, the quality of the game conditions used in these comparisons, the quality with which the methods were applied, and the quality of the assessments used. These analyses will contribute not only to the ability of GlassLab and other game designers to draw better informed interpretations of existing research, but will also enhance ongoing research on digital games for learning by highlighting the critical aspects of high-quality research for the field.

Conclusions

It is very clear that digital games are an influential and ubiquitous presence in the lives of young learners. A 2008 study by the Pew Internet and American Life Project found that 97% of teens aged 12-17 play digital games, and 50% of them report daily or nearly daily play (Lenhart et al., 2008). With increasing access to computers, consoles, and cell phones, young people encounter opportunities for gaming everywhere. Given the extensive reach and saturation of game playing in modern youth culture (Mayo, 2009), there is an untapped potential for increased learning if games can be successfully designed by GlassLab and other game developers.

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