# A Synthesis on Digital Games in Education:
# What the Research Literature Says from 2000 to 2010

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This research reports the results of a literature synthesis conducted on digital gaming in education research literature. Seventy-three digital gaming research articles in education were identified through a systematic literature search and were coded across several relevant criteria. Our research indicates trends and patterns from empirical studies on digital gaming in education from 2000 to 2010. Most research literature appears in the context of K-12 and higher education, and most literature appears to rely on experimental methods of research. The results show a steady increase in the number of publications related to digital gaming in education being published since 2004. The results also demonstrate that literature in digital gaming in education lacks completeness in reporting vital information, such as treatment intensity and duration, gaming platforms, or the number of players in a game. The missing information is vital in understanding the scope and direction of digital gaming research in education. Recommendations for future research are provided.

## INTRODUCTION AND PURPOSE

Digital games are dynamic media with desirable characteristics for educational purposes (Wilson, 2009; Squire, 2006; Gee, 2005; Shaffer et al, 2004; Garris & Ahlers, 2002; Prenksy, 2001a). Gaming provides educators and learners with countless media affordances, ample data collection methods, and constant feedback (Wilson, 2009; Garris & Ahlers, 2002). Games provide replicable and effective tools and methods to meet educational objectives (Gee, 2004). The importance of learning through digital games is exponentially growing with the rise in distance education (Moreno-Ger et al., 2008). Traditional face-to-face learning environments are also becoming more accepting of using video games as supplementary and primary educational materials (Squire, 2009).

This review identifies trends and patterns from empirical studies in digital gaming from 2000 to 2010. Digital games radically progressed in the past decade in both game-play and graphics, making their integration into the classroom ever more enticing. We focus on characteristics within digital games and their use in specific environments to see if patterns emerge from the literature. In addition, we examine trends in the research methods used to study digital games.

Educational researchers realize the potential and benefits to using games as learning tools and conduct a plethora of studies on the medium. However, the number of gaming articles using empirical research methods was disappointedly small. Details within articles about the characteristics of the digital games and their implementation are sparse. While there are several other gaming meta-analyses and literature syntheses, our study reviews articles focusing on characteristics relevant to today's educational needs.

Prior literature sythesis articles (e.g., Randel et. al., 1992) examine a multitude of variables in gaming research. However, many of these analyses include studies from up to 40 years ago and do not include many studies about games produced in the last 10 years. Access to powerful computer hardware and broadband Internet increase the capabilities and distribution potential of digital games. An updated analysis of digital games in today's era of enhanced graphics and advanced technology is needed. New computer hardware allows for increasingly complex games with a near unlimited amount of media affordances. Also, the characteristics of the participants in many of the studies are different. Many studies conducted in K-12 environments in the last decade involve "digital natives" subjects which impact how games are effectively designed (Prenksy, 2001b). This review hopes to provide insights on the current state of gaming research and provide meaning-

ful suggestions for future gaming research.This research was guided by the following questions:

- Has research in digital gaming increased in the past decade?
- Which journals publish research on digital games?
- Which digital game genres are most likely to be studied by researchers?
- Which student populations are studied in digital game research?
- What are the common research methods used to study digital games?
- What types of dependent measures are studied as part of research participants playing games for educational purposes?
- How long and how frequently do participants in digital gaming research studies play games?
- Are researchers more likely to study console, computer, or mobile games?
- What type of graphical interface was employed in the studies reported?
- How many players can play the games used in these studies?
- In what context has this research occurred?
- What environments do the participants in these studies use the games?
- What subject areas do research studies focus on?

## REVIEW OF RELEVANT LITERATURE

Digital games have come a long way in terms of technology and popularity since the advent of Pac Man and Pong. While these first digital games were bulky machines confined to gaming arcades, digital gaming has since proliferated on computers, consoles, and mobile devices. These smaller, more convenient platforms for digital gaming have increased both accessibility and popularity. Educators and researchers are increasingly examining the implications for teaching and learning (Squire, 2002; Prensky, 2003; Shaffer et al, 2005).  In addition to increased popularity, the digital game medium has garnered more scholarly interest for a variety of other reasons. Gee (2003) posits that many digital games contain elements of learning that encourage players to gather, synthesize, and reflect upon many different sources of information. Advocates of using digital gaming in education maintain that not only can they "lead to better cognitive, skill-based, and affective outcomes" (Wilson et al., p. 259), but that players can also

transfer what they learn and experience to other contexts (Shaffer, Squire, Halverson & Gee, 2005; Kirriemuir & McFarlane, 2004). Garris, Ahlers and Driskell (2002) note that the game cycle - an iterative process of evaluation, action, and feedback - can produce a state of "persistent reengagement" (p. 454) in players that increases interest, motivation, and enjoyment.

While there is certainly potential in using digital games in education, their influences have not been concretely decided. The empirical evidence about how digital games influence education, teaching, learning, and achievement is often mixed, complex, and lacking completeness (Hays, 2005; Mitchell & Savill-Smith, 2004; Kirriemuir & McFarlane, 2004). Mitchell and Savill-Smith (2004) specifically note how the amount of research studying digital gaming and its implications for education remains relatively small and sparse. Meta-analyses and literature syntheses of digital gaming in education can be helpful in understanding the literature and the overall state of the research. Unfortunately, as with digital gaming and education research in general, there is also a lack of detailed and systematic meta-analyses and literature syntheses. This means that a relative few number of studies are regularly cited (e.g., Randel et. al., 1992; Vogel et. al., 2006) in gaming research articles because of the lack of other studies. On closer inspection, these meta-analyses and literature syntheses tend to have significant issues and concerns that can limit their usefulness in shedding light on the exact link between digital games and learning. Therefore, researchers are placed in a difficult situation where the lack of good gaming research limits the ability for them to conduct high quality meta-analyses and literature syntheses. Logic dictates that high quality meta-analyses and literature syntheses cannot be created from subpar gaming research studies.

The first issue is that some frequently cited gaming meta-analyses and literature syntheses examine studies of both traditional games and digital games. Randel et al's (1992) literature synthesis examined 67 studies over a 28 year period and found that 38 of those found no significant difference between using gaming and traditional instruction, 22 favored the use of games, 5 favored games, but had questionable control groups, and 3 favored traditional instruction. However, it is important to note that while most of the games covered in this study were digital in nature, not all were. This is significant because playing a game and playing a digital game can be very different and have differential effects on learning. When studying the effects of digital gaming, it is important to not automatically assume that digital game play is the same as traditional non-digital game play. Hays'(2005) literature synthesis is also often cited in digital gaming research. This literature synthesis examined 48 empirical studies about the effect of instructional games

and determined that games are not necessarily the preferred method in all situations. Rather, specific instructional tasks and contexts play a major role in determining if games facilitate effective learning. Again, because this study examines non-digital gaming, the results must be approached with caution when discussing the implications of digital gaming.

A second issue concerning often cited gaming meta-analyses is the small sample sizes which reduce the significance of findings. Vogel et al. (2006) looked at 32 studies and found that the use of digital games and simulations led to increased cognitive learning and improved attitudes toward learning. However, they caution that the "research base is insufficient to draw this conclusion with much confidence" (p. 238) due to the small sample size of articles that were eventually used in their meta-analysis.

A third area that warrants a brief discussion when evaluating digital gaming in education is the difference between literature reviews (Emes, 1997; Dempsey et al., 1996; Hays, 2005; Randel et al., 1992) and meta-analyses (Vogel et al., 2006). When discussing the generalizable effects and implications of digital gaming in education, researchers should note and make a clear distinction between the results from each type of study. Literature reviews examine results from each individual study, while a true meta-analysis attempts to determine overall statistical effects between a number of studies as a whole. While individual studies may find significant effects, meta-analyses examine many studies and analyze them statistically based on effect sizes can provide a much more complete picture of digital gaming in education. While Emes (1997) noted that there is no clear causal relationship between video game playing and academic performance" (p. 413) it should be noted that this is a literature review of digital gaming research rather than a meta-analysis that examines overall effect sizes of various studies chosen with a systematic search framework. While these results were gleaned from three studies included in the literature review, they were not from a systematic statistical analysis of multiple articles and were only combined from the individual findings of each study. Emes (1997) does not elaborate on methodology of the study other than that a computer search was made and the results were organized into different categories based on effects to players. Similarly,Dempsey et al. (1996) is a literature review looking at specific categories. In this case, the authors looked at types of games, learning outcomes, function of games, gaming environment, media, measurement, and learner characteristics. Dempsey et al. (1996) found that most of the studies that did state learning outcomes tended to link gaming with problem solving. It is important to note that both literature reviews and meta-analyses are useful in providing an overall picture of digital gaming

research. However, meta-analyses and their focus on examining overall statistics across multiple gaming studies have the additional benefit of providing a systematic analysis and more generalizable empirical evidence. Literature reviews and meta-analyses have distinct differences and these should be kept in mind when evaluating and analyzing results from each type of study.

Vogel et al. (2006) make a notable observation about the state of the research of digital gaming in education. While conducting their meta-analysis, they discovered that much of the gaming research they were reviewing was characterized by methodological flaws such as having no control group, including no statistical or demographic data, and not providing enough information regarding the games or interventions themselves. This finding is corroborated by previous research (Hays, 2005). It is because of these flaws that many of the articles they initially selected were unusable and therefore unable to be included in the meta-analysis sample. Kirriemuir and McFarlane (2004) note the difficulty of finding concrete conclusions in the digital gaming literature and that due to the complex nature of digital games and the fast pace of technological advances, "there are few hard and fast findings in the literature" (p. 2). Mitchell and Savill-Smith (2004) also found a need for more longitudinal studies that study digital gaming and education.

As with any new research field, there needs to be much more systematic study of digital games and their implications for teaching and learning. One way to achieve this is to ensure that future studies are systematic, methodologically robust, include demographic and statistical data, clearly define research procedures, and also describe and categorize the games being studied. Following these simple procedures can go a long way in improving the quality and significance of the research on digital games and education. Creating new high quality gaming research will inevitably provide researchers with more material to conduct high quality meta-analyses. Only then can a broader, more accurate picture be taken of the field of digital gaming and education. Our research aims to demonstrate a systematic approach to gaming research and represents a first step to improving the state of the research of digital gaming in education.

## METHOD

### Search Process

In Fall of 2011, the research team assembled a comprehensive bibliography of studies involving games used for educational purposes. One of the

research team members was a library and information specialist. A total of 8,128 articles were located in a wide range of databases for education, including Education Resources Information Center (ERIC) (4,814 records), Education Full Text (682 records), Web of Knowledge (2,545 records), and Social Sciences Full Text (87 records). Initial keyword searches in each of these databases focused on the terms "educational games", "electronic games", and "computer games." These keyword searches were then mapped to controlled vocabulary terms specific to each database to target the search and make full use individual databases' structures. After conducting the searches, the following limits were imposed: publication type (article), article type (peer reviewed, scholarly, or refereed), date range (2000-2010). Articles that remained in the results list after the controlled vocabulary search and met the limits were exported into the citation management tool RefWorks where duplicate articles could be easily identified and removed. This resulted in a list of 801 unique peer-reviewed articles on the topic of educational gaming.

### Inclusion and Exclusion Criteria

After thorough examination, studies were included in the analysis if the met the following inclusion and exclusion criteria:

1.  The article must be a peer-reviewed publication within the years of 2000 to 2010.

2.  The article must include a digital game as an intervention within the study.

3.  The article must have been written in the English language.

4.  The article must have collected primary data about a game intervention used for educational purposes.

5.  The article must have had a clearly identifiable population under investigation (e.g., K-5 Elementary).

This resulted in 73 published manuscripts that met our inclusion and exclusion criteria.

## Coding Procedures

To facilitate the coding process, a standard template form was generated in Microsoft Access 2007. A screen shot of this form is shown in Figure 1. Each member of the research team used the coding form to code their respective articles. The coding procedure started with member of the research team independently coding three articles randomly drawn from the sample. Next, the research team met to discuss the codes and rectify any disagreements. To assure the quality of the coding procedures, a small ($n=5$), random sample of the articles were coded by all members of the research team. The inter-rater agreement was calculated from this sample and exceeds 90% agreement across the several coding categories.

### Game Article Form

**Open Ended Items**

| | |
|---|---|
| Sample Size: | |
| Author(s) Name: | |
| Subjet Matter: | |
| Year Article Published: | |
| Journal/Proceeding Name: | |
| Intervention Intensity: | |
| Number of Screen Shots: | |

| | |
|---|---|
| Game Platform: | |
| Game Publisher: | |
| Game Availability: | |
| Game Purpose: | |
| Game Graphics: | |
| Installation: | |
| Number of Players: | |

**Game Genre**
- Skill-and-action game
- Adventure game
- Role playing game
- Strategy/simulation game
- Racing game
- Fighting game
- Puzzle game
- Virtual world game

**Population**
- Early childhood (<K)
- Elementary (K-5)
- Middle (6-8)
- High (9-12)
- Undergraduate
- Graduate
- Informal Adult

| | |
|---|---|
| Learning Envrionment: | |
| Publication Type: | |
| Context: | |
| Research Method: | |

**Dependent Measures**
- Behavioral
- Affective
- Achievement

**Figure 1.** Standard article coding form.

### RESULTS

Our sample consisted of 73 published manuscripts that met our inclusion and exclusion criteria. The 73 manuscripts analyzed contain data from 10,145 research participants. The average sample size in the manuscripts was 140.90 ($SD=284.31$). As can be seen, there was a pronounced variability in the sample sizes across the studies reported here.

## Publication Frequency over Time

Over the past decade, manuscripts published on games in education have seen a tremendous increase. In particular, since 2004, we have seen a steady increase in the number of articles published on the topic as shown in Figure 2. In the most recent year, 2010, we had 24 published articles that met our inclusion and exclusion criteria. This demonstrates an overall amplified interest in the topic of games in education - a notable trend.
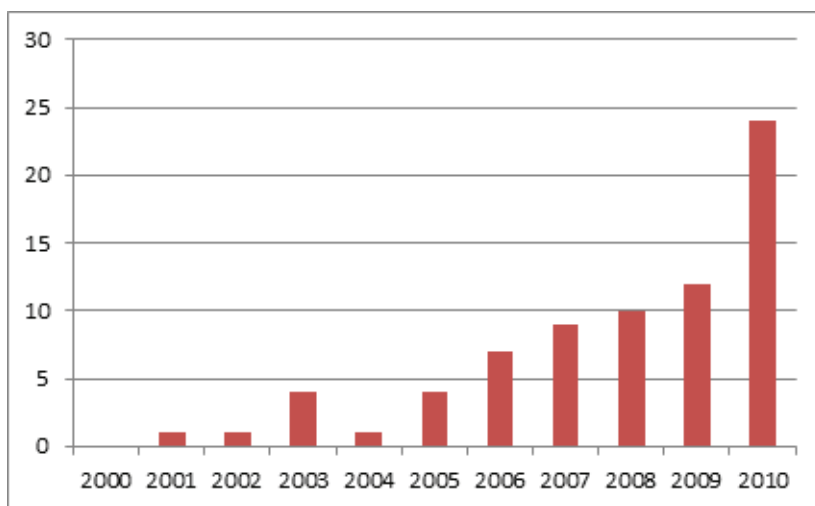


**Figure 2.** Digital gaming articles published from 2000-2010.

## Publication Venues

Another important consideration is where the research on games in education is being published. In Table 1, we show the journal names that had at least three journal articles published on the topic over the past ten years. As can be gleaned, the journal *Computers & Education* appears to publish most frequently on the topic of digital games in education. The *Australasian Journal of Educational Technology* and *Journal of Educational Technology & Society* had the next highest frequency. However, only about one-third the frequency of *Computers & Education*.

**Table 1**
Publication venues for educational gaming research

| Journal Name | Count |
|---|---|
| Computers & Education | 18 |
| Australasian Journal of Educational Technology | 6 |
| Educational Technology & Society | 6 |
| British Journal of Educational Technology | 5 |
| Journal of Educational Computing Research | 3 |
| Journal of Interactive Learning Research | 3 |

## Genres of Games Studied

We sought to identify the most common game genres studied in the literature, using the taxonomy provided by Ritzhaupt (2008) to classify the games. The most prominent game genres appear to be skill-and-action games, strategy/simulation games, puzzle games, and virtual world games. Fighting and racing games did not appear at in these data.

**Table 2**
Game genres

| Game Genre | Count | % of Total |
|---|---|---|
| Skill-and-action game | 20 | 27.4 |
| Adventure game | 7 | 9.6 |
| Strategy/simulation game | 18 | 24.7 |
| Racing game | 0 | 0.0 |
| Fighting game | 0 | 0.0 |
| Puzzle game | 21 | 28.8 |
| Virtual world game | 20 | 27.4 |

## Population Studied

What populations have been most frequently studied in games in education research literature? We sought to answer this question by classifying the sample populations in each of the studies under investigation. Our re-

sults clearly indicate that the most frequently studied population is that of elementary school students at 43.8% of the total articles. The second most common population appears to be undergraduate students at 26% of the total articles. Table 3 illustrates the results.

**Table 3**
Populations under investigation

| Population | Count | % of Total |
|---|---|---|
| Early childhood (<K) | 1 | 1.4 |
| Elementary (K-5) | 32 | 43.8 |
| Middle (6-8) | 11 | 15.1 |
| High (9-12) | 14 | 19.2 |
| Undergraduate | 19 | 26.0 |
| Graduate | 3 | 4.1 |
| Informal Adult | 1 | 1.4 |

## Research Methods Used

Another important dimension to games in education research literature is the methodology employed in the studies. We sought to investigate this phenomenon by coding the type of study using the categories provided by Berge and Mrozowski (2001), which include descriptive, case study, correlational and experimental research. As shown in Table 4, the most common research method is experimental (approximately 48%), which includes both experimental and quasi-experimental procedures. The second most common is the case study method, which accounts for approximately 37% of the total articles under investigation. Both descriptive and correlational research methods were used much less frequently.

**Table 4**
Research methods employed

| Research Method | Count | % |
|---|---|---|
| Case Study | 27 | 37.0 |
| Correlational | 3 | 4.1 |
| Descriptive | 8 | 11.0 |
| Experimental | 35 | 47.9 |

**Dependent Measures Examined**

What types of dependent measures are studied as part of research participants playing games for educational purposes according to the research literature? This question is of particular importance because it informs us of the areas most commonly investigated as part of the research studies. As can be gleaned in Table 5, achievement measures (e.g., standardized test scores) are most commonly investigated as part of the studies. Second most frequent was affective measures (e.g., usability or attitudes towards technology) followed by behavioral measures (e.g., on task behavior), which was observed least frequently.

Table 5
Dependent measures studied

| Dependent Measure | Count | % of Total |
|---|---|---|
| Behavioral | 21 | 28.8 |
| Affective | 45 | 61.6 |
| Achievement | 52 | 71.2 |

**Treatment Duration and Intensity**

One area that we sought to further investigate was the duration and intensity of the game treatment conditions. That is, how long and how frequently did the research participants play the games in the studies? Unfortunately, 32% of the studies did not report this information . Among articles included duration and frequency information, there was variability in the details provided. For instance, it was common to state that the duration of the study lasted for *X* weeks. However, the studies would often not report how frequently the game was played during this duration. Some studies were conducted in a matter of several hours while others lasted several weeks. There is very little generalizable knowledge about the treatment duration and intensity.

**Game Purpose and Platform**

Which platforms are most frequently used in studies of games in education? Of the studies that met our criteria, as shown in Table 6, approxi-

mately 64% of the games used were facilitated on a computer. Only about 4% of the games were console games. Notably, 26% of the studies did not report the platform the game could be played on. Also important was the purpose of the games employed in these research studies. According to our results, 86% of the games employed were serious/educational games. Approximately 6% were commercial-off-the-shelf games being used for educational purposes. The remaining proportion was not classified in the articles.

**Table 6**
Game platforms

| Platform | n | % |
|---|---|---|
| Computer | 47 | 64.4 |
| Console | 3 | 4.1 |
| Mobile | 4 | 5.5 |
| Not Specified | 19 | 26.0 |

## Number of Players and Graphics

What type of graphical interface was employed in the studies reported? How many players can play the games used in these studies? According to our results, 37% of the games employed 2D graphics, 30% employed 3D graphics, and the remaining were not clearly indicated within the articles. Another significant characteristic of the games studied is how many players can play the game. Unfortunately, as shown in Table 7, approximately 53% of the articles did not clearly indicate if games were single or multi-player.

**Table 7**
Number of players in games

| Number of Players | n | % |
|---|---|---|
| Multi-Player | 17 | 23.3 |
| Multi-Single* | 4 | 5.5 |
| Not Specified | 39 | 53.4 |
| Single | 13 | 17.8 |

*Single player games that allow players to take turns playing.*

**Game Publisher and Availability**

What entity publishes the games used within these studies? Is the game available to others who might be interested in using the game in the classroom? Unfortunately, we can only provide partial answers to both of these questions because the majority of the authors did not provide this information within the manuscripts. Specifically, 60% did not specify who published the game and 81% did not indicate whether the game was available for use to interested stakeholders. Of those that did respond, we know that 18% of the games were published by universities/colleges, 12% were published schools and school districts, and 10% were published by private entities. In regard to game availability, 19% were available to other stakeholders either for free or for a fee.

**Context and Learning Environment**

In what context has this research occurred? As can be gleaned in Table 8, the vast majority of the research conducted on games used for educational purposes has been done in the context of K-12 education at 68.5%. The second most common context was higher education at 30.1%. Only one study was conducted in the context of healthcare. No studies were conducted in business/industry, government, or the military.

### Table 8
Context of game study

| Context | n | % |
|---|---|---|
| Business/Industry | 0 | 0 |
| Government | 0 | 0 |
| Healthcare | 1 | 1.4 |
| Higher Education | 22 | 30.1 |
| K-12 Education | 50 | 68.5 |
| Military | 0 | s0 |

Where do the participants in these studies use the games? Approximately 30% of the articles included studies conducted within classrooms. About 31% of the articles were conducted within computer labs – mostly within schools. Regrettably, around 36% of the articles did not specify the learning

environment. Only two articles occurred within homes and none of the studies reported were conducted in a work environment. Table 9 presents these results.

**Table 9**
Environment for gaming study

| Environment | n | % |
|---|---|---|
| Classroom | 22 | 30.1 |
| Computer Lab | 23 | 31.5 |
| Work | 0 | 0 |
| Home | 2 | 2.7 |
| Not Specified | 26 | 35.6 |

## Subject Areas Explored

The data represented a wide range of subject areas. We coded these subject areas into larger categories as shown in Table 10. Some game interventions were designed to address multiple areas (e.g., math and language arts). As can be seen, the most common areas addressed by the game interventions included mathematics at 20.5% and science at 16.4%. Some of the topics did not fit into these categories. For instance, one game addressed civil engineering as its topic and another addressed fire fighting.

**Table 10**
Subject area studied within games

| Subject Area | n | % of Total |
|---|---|---|
| Science | 12 | 16.4% |
| Mathematics | 15 | 20.5% |
| Social Studies | 8 | 11.0% |
| Language Arts | 11 | 15.1% |
| Technology | 3 | 4.1% |
| Health Education | 7 | 9.6% |
| Business Education | 5 | 6.8% |

## DISCUSSION

To reiterate, our research sample consisted of 73 published manuscripts that met our inclusion and exclusion criteria out of 801 initial articles. These 73 manuscripts reported on 10,145 research participants in several contexts using a variety of games for different educational outcomes. This research takes a different approach to synthesizing literature on games in education. Many previous studies were meta-analyses that attempted to generalize findings and derive the overall effect size of game interventions versus traditional modes of instruction (e.g., Vogel et. al., 2006). This research attempts to generalize gaming literature based on categories of relevant content to inform both educational researchers and educational game designers in future efforts.

Recognizing that much of the digital gaming in education literature is plagued by methodological flaws and a lack of statistical and descriptive data (Vogel et.al., 2006; Hays, 2005), our research aims to demonstrate how a methodologically sound and systematic research approach can help illuminate the current landscape of digital games in education. This landscape is murky and it is difficult to determine concrete findings regarding digital games in education (Kirriemuir & McFarlane, 2004). However, through rigorous research study selection and analysis, we have been able to cut through the murkiness and synthesize several key aspects of digital gaming in education. Our findings are a result of systematic research processes, which are often lacking in research in the field of digital gaming in education. We hope to demonstrate one way to increase the level of rigor in digital gaming in education research and to support the legitimacy of using digital games in teaching and learning.

As mentioned earlier, our systematic research approach synthesized threads that can help inform educators and researchers who are interested in the practice and implications of digital games in the classroom. First, our review demonstrates an overall increase in publishing on games in education over the past ten years. In particular, since 2004, there has been a steady increase in the number of articles published on the topic. There appears to be an increase in the overall interest of games in education based on publication patterns. Another important dimension is where the literature on games in education is being published. Our results clearly illustrate that the international journal of *Computers & Education* appears to be a major venue for publishing games in education research. Other notable journals include the *Australasian Journal of Educational Technology* and *Journal of Educational Technology & Society*.

Second, our research has generalized the types of game genres most frequently studied in the literature and the populations under investigation. As noted, the most commonly occurring game genres in the literature are skill-and-action games, strategy/simulation games, puzzle games, and virtual world games. Do these particular genres of games lend themselves to educational contexts? Further research is necessary to answer this question, but our research has documented the intensity of these genres in the literature. Another important consideration is the populations studied in gaming research studies. Our results clearly indicate that the most frequently studied populations are elementary school students and undergraduate students.

Third, our research has demonstrated the most commonly used research methods and dependent measures studied as part of games in education literature. The most common research method is experimental (approximately 48%), which includes both experimental and quasi-experimental procedures. The second most common is the case study method, which accounts for approximately 37%. As it relates to the dependent measures, achievement measures (e.g., standardized test scores) are most commonly investigated as part of the studies. Second most frequent was affective measures (e.g., usability or attitudes towards technology) followed by behavioral measures (e.g., on task behavior), which was observed least frequently.

Fourth, our research shows that the literature lacks vital information that should be included in a typical journal article published on digital games in education. These gaps in the literature include the treatment duration and intensity, the number of players in the games, the game publisher, and the availability of the game. We make several recommendations to improve the reporting practices of authors in the final section of this manuscript.

Fifth, our research demonstrates that most game interventions selected for use in educational contexts could be classified as educational/serious games (86%). Further, our results demonstrate that approximately 64% of the games used were facilitated on a computer within classrooms and computer labs at schools. Very little of the research documented the efficacy of games used in the homes of the target learner populations. Future research should seek to address this limitation.

Finally, our research shows that most games in education research have been conducted in the K-12 context, followed by higher education. None of the research published addressed the context of business/industry, government, of the military. Further, in terms of the subject matter explored as part of the games, mathematics, followed by science, languages arts and social studies were the most commonly studied areas.

## RECOMMENDATIONS FOR FUTURE REPORTING PRACTICES

One thing our research has done is document the type of information included in a typical research article focused on games used for educational purposes. In particular, we have identified several gaps of information that should be included in articles published on the topic. Consequently, we have compiled a list of several recommendations to improve the reporting of information in future research articles.

We recommend that authors include an annotated screen shot of the game intervention used in the study. This screen shot serves several purposes for the readers. It gives them an idea of the graphics of the game, the layout of controls and types of actions within the game, and provides an understanding of the gameplay itself. A screen shot is a simple and effective way to communicate this vital information to readers.

We also recommend that authors provide information about the game genre. This is an important piece of information that relates to the generalizability of the results of a study. Back to the famous media and methods debate in the field of educational technology (Clark, 1983; Kozma, 1991), we need to pinpoint the type of game genre in order to inform practice and generalize results beyond a single study. The game genre, which establishes the type of game play and activities the learner will experience will traversing the game, is critical information to both educational researcher and game designers.

We recommend that authors describe the player mode of the game. Is the game single-player or multi-player? Is the game cooperative, competitive or both? Research has suggested that the goals structure of games makes a difference in affective measures (Ke, 2008). Further, with the advent of cooperative and collaborative learning environments, we need to account for the types of interactions learners will engage in within games. This information is also vital to generalize the results of studies.

Authors also need to be specific about the treatment duration and intensity in order to generalize results beyond a single study. It is mind boggling that 32% of the articles within this study did not include this vital information. Authors need to be very specific about both the duration (how long the study lasted) and the intensity of the intervention (how frequently the game was played within the duration). There is presently great variability in the durations and intensity of the durations reported in the research literature.

Educational researchers should also address the concern of who published the game and whether the game is available for use by other interested stakeholders. Surprisingly, 60% of the articles within this study did

not specify who published the game and 81% of the articles did not indicate whether the game was available for use to interested stakeholders. Again, critical information that should be included within published manuscripts in our field.

We make these recommendations to educational researchers, game designers, and other authors in the broad field of games in education. Our intent is to improve the reporting practices of authors in the field to better understand our research literature. Such reporting practices are necessary to generalize the results of our studies beyond single instances, and to inform educational game designers in how to effectively and efficiently design games.

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